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Professor Levine

JAGH Bot:

The Elderly Assisting Robot

SACRAMENTO STATE

Deployable Prototype Documentation

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Table of Contents

Table of Figures

Table of Tables

Executive Summary

We created an elderly assisting robot that monitors the house and the user to allow more independency to the increasing elderly population.

Our goal for our project centered around the societal problem. We wanted to aid elderly citizens and their families by creating a robot that would aid an monitor their surroundings. This robot would be seen as an intermediary between a senior citizen living by themselves and being forced. Our idea was based off of a vacuum cleaning robot called a Roomba. This robot randomly travels around the house cleaning up messes without any instructions or outside input. We wanted to stick to this concept where the elderly citizen doesn’t need to worry about anything and the robot operates by itself. The robot goes around the house checking for certain hazards and vitals like fires, gas leaks, and humidity levels. If anything is seen out of the ordinary then a immediate text is sent to emergency services and any custom emergency contacts. Along with the roving robot we have a wristband that the patient wears at all times. This wristband has an accelerometer/gyroscope, Wi-Fi module, and a pulse sensor. The point of this is to detect falls and we do this by checking values for g forces in the z plane with the accelerometer. In conjunction we also check for spikes in heart rate which to us indicated the patient has fallen. If both flags are set then we alert the robot to contact emergency services so the patient can receive medical help as soon as possible. We understand that mobility and the overall quality of life deteriorates with the passing of time. We know most elderly patients are not fans of retirement homes. So with our product we want postpone the need for retirement homes or elderly care by letting the senior citizen stay in their own houses which they are most comfortable in. Also with the ownership of our product a person isn’t needed around the clock to monitor the elderly citizen because in the case of emergencies an alert is sent immediately.

***Abstract*—One of the most neglected members of society is the elderly. They are taken granted for and often misunderstood. Much like the rest of society they have their own unique struggles they must overcome. Statistics show the elderly population is doubling in size and their needs are becoming more demanding and must be addressed. Our project, the JAGH bot addresses this problem and allows for more freedom and independency to the elderly people. It is made to be the middle ground from being able to live alone and having the need to be put in a senior citizen home. It gives them a few extra years to enjoy life at their home of choice. It will also allow them and their families to save thousands of dollars on the senior citizen homes that cost thousands of dollars a month. The JAGH robot is a self-sufficient robot that will help ease the burden of dependency that the elderly citizens face in today's society. Through modern technology we will provide a robot that assists in monitoring a patient's vital signs while also checking for potential hazards such as fires or gas leaks. In certain emergency cases the JAGH can also notify the paramedics if the patient has fallen and needs immediate care. All of these signals are done to an efficient system controlled by microcontrollers and communication means via Bluetooth. We hope with our system we can help save mass amounts of money in the health care market and provide ease of mind for the all love ones related to their significant senior citizen. Testing is one of the most important aspects of any item's development. Without testing a product thoroughly the item can fail in certain cases. This is not acceptable in the market and can easily lead to the failing of that particular product. This is why test engineers will develop numerous test cases in order to see all the different ways their product reacts to any situation they see might happen when their product hits the market. Our robot has many functions but its main purpose and function is to assist the elderly people in their homes. Many elderly people are faced with the question of whether or not they can still live independently. Many of them as they get older and older start to wonder what their future will be like when their physical bodies don't function the way it once did and with our robot, it can help them stay independent for as long as they can. Our target market for our robot is the elderly people all over the country who long to have the independency that they were once entitled to. This document has information about the JAGH bot from the problem statement to the design and all the way to the finish product of our senior design project.**

Keywords—Robot, ROS, Max 32 Chipkit, artificial intelligence, GSM module, Sensor, ultrasonic sensors, Kinect, Differential Drive, Fire Detection, Elderly Assitance

I. Introduction

This template, modified in MS Word 2007 and saved as a "Word 97-2003 Document" for the PC, provides authors with most of the formatting specifications needed for preparing electronic versions of their papers. All standard paper components have been specified for three reasons: (1) ease of use when formatting individual papers, (2) automatic compliance to electronic requirements that facilitate the concurrent or later production of electronic products, and (3) conformity of style throughout a conference proceedings. Margins, column widths, line spacing, and type styles are built-in; examples of the type styles are provided throughout this document and are identified in italic type, within parentheses, following the example. Some components, such as multi-leveled equations, graphics, and tables are not prescribed, although the various table text styles are provided. The formatter will need to create these components, incorporating the applicable criteria that follow.

II. Societal Problem

The welsh poet Dylan Thomas was famously quoted saying "Do not go gentle into that good night but rage, rage against the dying of the light." He is referring to the disheartening realization that everyone must face father. So instead of going out quietly, you should raise hell and go out on top. The simple fact is no one is immortal and the vast majority of us will reach an age in our life where no matter how sharp we keep our minds, sadly our bodies will slowly fail us or vice versa. Many of us experience elderly age and cope with it in different ways. However generally speaking the majority of us see signs of detrition both mentally and physically in the latter years our lives. Our bodies simply can't function and quickly recover the way they do in the younger youthful days. Due to this lack of overall sharpness throughout the human body, elderly citizens must deal with life much differently. Everyday activities for the common person can become a hassle for the elderly. It might take them much longer to complete a certain task that a younger person could accomplish in a fraction of the time. They must concentrate harder on a single item because their attention span and hand eye coordination has severely shrunken. Because of this weakened state senior citizens are severely vulnerable to things such as sicknesses, physical injury, or other medical issues.

A. *Body*

Engineers have the ability to change and mold the world to whatever they deem fit. Many say engineers help build the world, doctors help heals it, and lawyers help defend it. The engineering mind is only limited to its own imagination. However, we also have moral responsibility to our fellow citizens of the world to build technology that leads to the betterment of the overall general population. Our job is to take a problem plaguing a group of people and help solve it in new and creative ways. Whether that be something simple like creating a more efficient way of sealing food to make it last longer, or something complex like programming the code to safely land a multimillion-dollar lunar module on the moon. Engineers are always are given the task of turning something impossible and turning it into something that is possible. Nevertheless, we are morally obligated to help the world in the most humane way conceivable. That doesn't necessarily mean each engineer needs to come up with the most cutting-edge gadgets. In fact, most engineers are simply in charge of improving existing systems to make them more efficient or cheaper. At the end of the day engineers are given the task to solve a certain problem.

Our task as seniors for our senior project is to solve a societal problem. Societal problems are issues that negatively affect or are detrimental to a large group of people. We as a team have a wide range of topics to choose from. The societal problem we as a team decided to tackle was trying to ease the burden of assistance for the elderly. As the life expectancy of humans increases steadily every year, our senior citizen population continues to grow. With this increasingly aging population the health of the elderly becomes more vital. In the United States there is an estimated total of 48 million senior citizens meaning the particular individual is 65 years or older [4]. By 2060 that number is predicted to swell to near 100 million. That means a pretty decent size number of the US population are senior citizens.

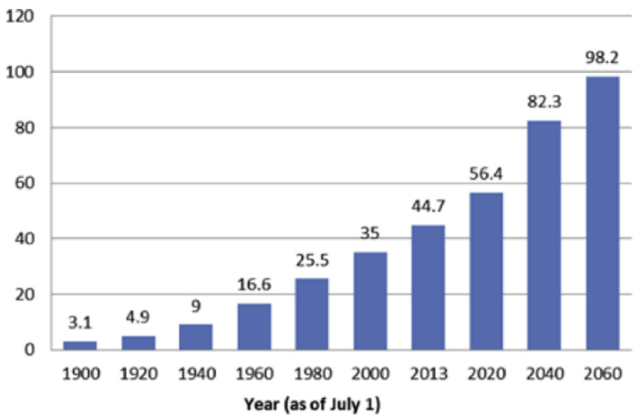


Table1. U.S. Senior Citizens Population Projection

The story for the majority of these citizens is they are retired or close to retirement and are trying to live the remainder of their lives in happiness and peace. However, like many of the rest of us of all ages, the elderly suffer financially. The census calculated the average income of the householder of age 65 or higher have a median income of $38,515. This is close to the United States poverty line. Needless to say, we can safely say most senior citizens can't afford luxuries in their lives. Due to this lack of income many of the elderly spread across the nation can't afford 24 caregiving. The senior living society estimated only a measly 5 percent of the elderly population live in nursing homes where they can receive the proper care 24/7. Nursing homes would be the ideal situation for most senior citizens because they senior citizens can be around like-minded people, receive all caregiving needs, and have staff surrounding them trained to assist in their lives. Sadly this isn't the reality we live in. The reality we live in is 95% of the senior citizens in our nation either receive intermittent care from loved ones or they depend on themselves. Even in the case of being looked after by loved ones of friends, it can be stressful on the caregiver themselves. Most care givers are much younger than the elderly patient they are tending too and are consumed in their own busy lives. The caregiver is taking time out of their schedule to help assist the elderly. More often than not the caregiver can't be with the senior citizen around the clock. This could be potentially dangerous because if the elderly person has an emergency and needs urgent care, the nearest assistance could be too late to reach them. This is apparent in the leading cause of senior citizens injuries and death which is simply they fall down. If a senior citizen is looking after themselves or their care giver isn't there to assist, a simple fall to the floor can be fatal. If a senior citizen slips and falls they could potentially break bones like their arms, hips, or legs.

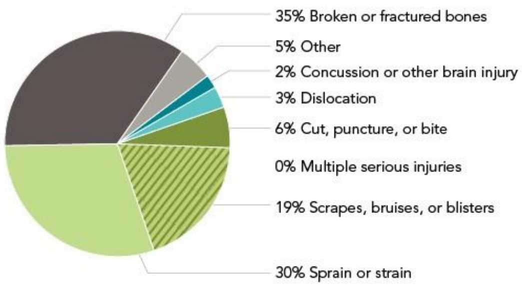


Figure 1. Injures caused by falling

In many of these cases the fallen person has no ability of getting up and contacting emergency help. The sheer pain from head trauma or pain from breaking bones could lead to their fatality. The longer amount of time a patient has to wait to receive care from a traumatic injury the smaller their chances are of survival. Not to mention if they do survive an injury, their life expectancy becomes severely shortened due to more health complications down the road.

B. *Common Injuries Among Elderly*

Elderly people are known to be more susceptible to physical injuries as they progress later in life. As they age minor injuries, such as falling, become a much greater risk and even fatal if there is nobody to assist them after such an event. This makes it especially dangerous for elderly living by themselves. A study done in UK took a census of 2641 non-disabled people over the age of 65 living in the community. It showed that 66.9% lived with someone else while 33.1% reported living alone [1].

i. Falling

Falling is reported as the most common injuries among the elderly with 30% - 50% of falls leading to minor injuries such as bruising, lacerations, and abrasions [2] while 10% of falls lead to serious injuries such as head trauma and fractures. 1% of reported falls lead to hip fractures, which is a very serious injury among elderly people. 37% of hip fracture patients died within a year of the injury, 35% - 50% never fully recovered to the health there were in before the fall and 20% remained in a non-ambulatory state [1].

In 2014 an estimated 27,000 elderly adults died due to falling and 800,000 were hospitalized for injuries sustained during their fall [3]. 28.7% of older adults reported falling which results in around 29 million falls which resulted in 7 million injuries [3], many of which go unreported. It said that approximately half of falls go unreported to healthcare providers. The reason for this is the person who fell is for fear of losing their independence. This is a tough situation because many older adults do take pride in their independence, but this is putting them at greater risk of serious injury. Study shows that up to 22.4% of elderly living alone considered themselves socially isolated [2]. This only elevates the risk of these injuries among independent older adults as almost a quarter of these individuals feel as if they are alone with nobody to call for help.

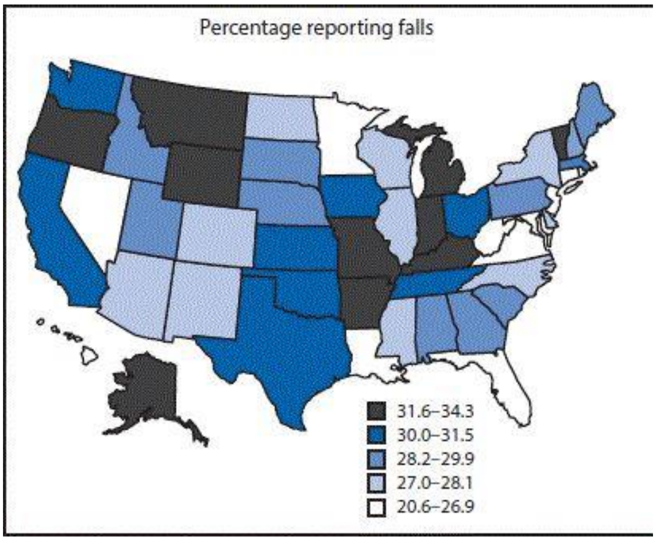


Figure 2. Percentage reporting fall [3]

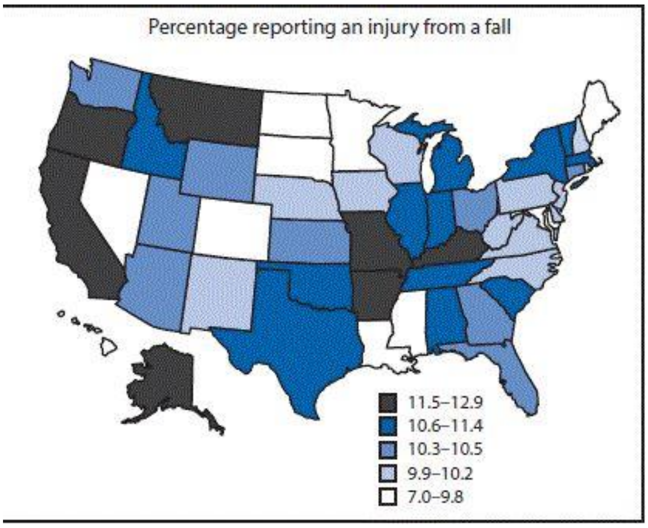


Figure 3: Percentage reported injuries after fall [3]

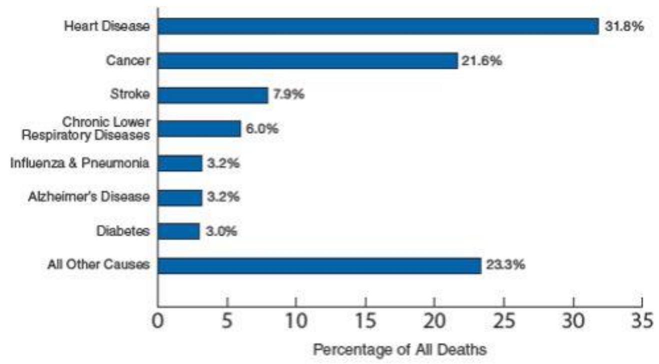
*These are injuries that impaired the person for more than 1 day

Falling outside have the same injury risks as falling inside but can be a mental challenge for the person as they are off put from doing physical activities because they fell. This is a catalyst for other unhealthy lifestyles and behaviors such as weight-gain due to a lack of exercise and social isolation.

Falling indoors can be caused by many things such as tripping over small objects, slipping on wet spots, and falling on steps or stairs. Many of these can be prevented by cleaning messes and picking up the small items on the floor, but that can be challenging for people of age as many have poor eyesight and difficulty bending over and doing other movements required to clean their home.

C. *Degenenerative Diseases*

Another factor the elderly face are degenerative diseases such as dementia, Alzheimer's, heart disease, Parkinson's, etc. These types of diseases can be extremely difficult to deal with even with professional care and family support, even in the early stages of the disease when the person might not even be diagnosed yet. This can be dangerous for independent older adults living alone as they might go a long period of time without contact with others, who would identify a health problem.



Source: CDC, National Center for Health Statistics. Data Warehouse, Trends in Health and Aging.

Table 2: Causes of Death Among People 65 and over [3]

As seen in figure 3, most deaths from diseases occur from heart disease, cancer, and strokes. All of these diseases are quite deadly but if caught early on they can be much more treatable, and the person has a higher chance of living. In many cases it requires another person to nudge the elderly person to seek help and get diagnosed, thus going back to the danger of those who live alone.

i. Issues with Elderly Care Cost

So many elderly Americans and elderly folks around the world face the risk that a illness will strip them of their financial self-sufficiency. Of all the different groups in society, the elderly population is at the highest risk of incurring high health care expenses. On any given day five percent of the elderly folks are admitted into nursing homes; one of every four elderly will enter a nursing home during his or her lifetime. These level of health care utilization, added with the high cost of medical care, put the elderly population at potential risk of financial disasters. Here in the United States we are not prepared for the rapid growth of the older population. Most Americans believe the government should help with the costs of ongoing care [10]. Which is not the fact and is something the people should not rely on.

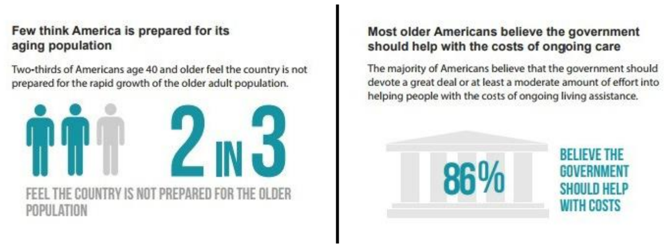


Figure 4: Elderly Statistics [12]

Below are a few forms of elderly care and their functions and costs, giving a better breakdown.

a) Issues with Elderly Care Cost

Home health care offers care such as checking patients' pulse, temperature and respiration and assisting with medical equipment such as ventilators. Such care providers visit the patients home based on medical need. In 2017, the US national average cost is around $21/hour with different state averages ranging from $16-$27 and hour.

b) Adult Day Care

This type of care provides the elderly with supervision and activities in a more time-oriented manner. Meaning the activities are timely mannered and structured according a schedule. The national average is $72 a day, with the averages varying state to state. Adult day care provides more supervisory care, intensive health and therapeutic services for individuals with severe medical problems and those at risk of requiring nursing home care.

c) Assisted Living and Memory Care

This type of care provides the elderly with supervision and activities in a more time-oriented manner. Meaning the activities are timely mannered and structured according a schedule. The national average is $72 a day, with the averages varying state to state. Adult day care provides more supervisory care, intensive health and therapeutic services for individuals with severe medical problems and those at risk of requiring nursing home care.

d) Nursing Homes

Professional nurses offer 24/7 care by licensed health professionals including all housekeeping, medical and social needs. Average cost for a shared room is $227 a day. [13]

ii. Care for Elderly People

Cognitive impairment and behavioral problems

When the Elderly folks are placed in these health care homes, adult day care centers, or any type of assisted care they may develop psychological and mental problems [14]. There is a prevalence and interrelationship between cognitive impairment and behavioral problems in older people in these types of facilities. Cognitive impairment is when a person has trouble remembering, learning new things, concentrating, or making decisions that affect their everyday life. There are many types of cognitive a behavioral problem that are developed, for example; depression, aggression, different forms of anxiety, and many other issues.

a) Depression

Depression is a common problem in older adults. And symptoms of elderly depression can affect every aspect of your life, impacting your energy, appetite, sleep and interest in work, hobbies, and relationships. Nowadays, all too many depression older adults fail to recognize the symptoms of depression, or don't take the precautionary measures to seek out help for this.

Reasons for this is elderly people assume they have good enough reason to be down or that depression is something that comes with age. Being in a elderly care home, and being around other old people that are also in bad health conditions, or even being isolated in your room, in itself can lead to depression, with very few around to notice that distress. Some of the physical or mental complications that occurred maybe from the depression.

The prevalence of depression increases with age. In 2008, the proportion of people age 65+ with clinically relevant symptoms was higher for those 85+ (18 percent) than for people in any of the younger groups (12 to 15 percent). The following image shows the common risk factors as well as protective factors of those that are older in age.

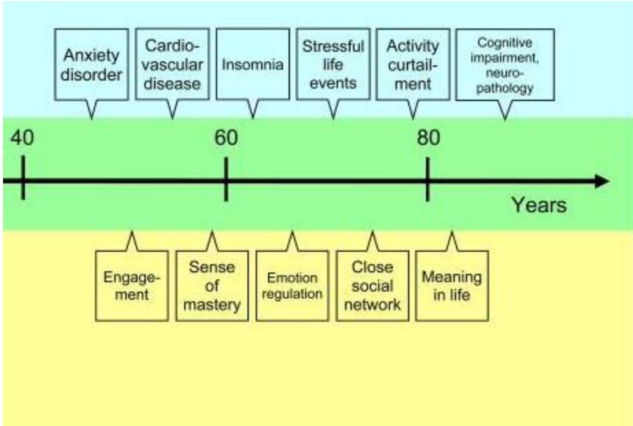


Figure 5: Risk Factors in the Elderly

This does not limit the that the cause of depression comes majorly from loneliness but more reasons for it. Many of the common factors in depression in younger people tend to be much more prevalent in older people as well. Things like stressful life evens and loss of social roles, changes in health, physical ability can lead to limitations in activities they may be used to their entire life. This gives them a slower rate of doing things which can lead to low rates of positive outcomes. The following chart shows possible pathways of getting to depression.

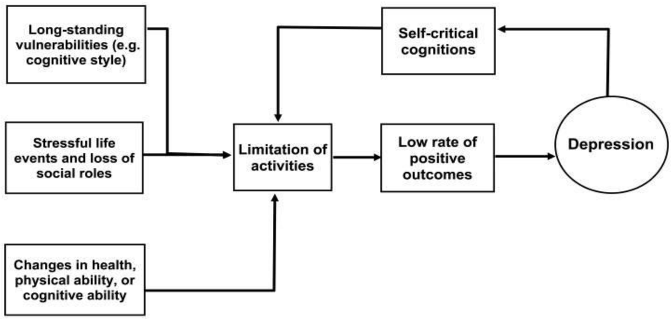


Figure 6: Depression Pathways

Aging is replete with reasons to reduce activity or even engage in occasional negative self-talk, but certain individuals may be more likely than others to do so when faced with the particular types of stressful events that are most common in late life. Depression is a serious problem that can cause tragic fatalities in the elderly world.

b) Depression Facts

- More than two million of the 34 million Americans age 65 and older suffer from some for of depression.
- Older patients with symptoms of depression have roughly 50% higher

healthcare costs than non-depressed seniors.

- Depression is a significant predictor of suicide in elderly Americans.

c) Causes of depression in older adults:

- Health Problems – illness and disability, pain, cognitive decline.
- Loneliness and isolation – living alone, dwindling social circle due to deaths or relocation.
- Reduced sense of purpose – Feelings of purposelessness or loss of identity due to retirement or physical limitations.
- Fear – fear of death or dying
- Medical Conditions – Parkinson's, stroke, heart disease, cancer, diabetes, etc.
- Medication – side affects [15]

d) Aggression:

Aggressive behavior in adults in the facilities mentioned above is a very common thing as well. This aggressive behavior negatively affects caregivers, increases expenses and has negative consequences for dementia patients, injuries to self and others, and decreased quality of care.

Aggression can mean physical or verbal aggression. Some patients are not happy with their caregivers or their quality of living in the elderly homes and therefore show aggression. Use of physical restraint is also used on patient who show physical aggression.

D. Living Conditions

There are many social problems in this world that we live in and many of the problems we face in America seem to also occur all over the world at an increasing rate. One of those problems concerns the elderly or so called "senior citizens." There are also many aspects to the elderly that they face which include things such as injury, health, finance, and many more but one that encompasses a great deal of it is their current living conditions. Many elderly people live by themselves because they are often widowed. There are also a large range of living conditions that they face, and often face alone. Each day, it becomes harder and harder for them to live a "normal" life and one of the problems is that there are not enough services and accessibility features offered to them.

A. Elderly People

The importance of the social problem or societal problem is that the rate at which the aging population is growing at an almost exponential rate.

A study done in 2017 from a government census shows that there are 47 million seniors that live in the United states which they estimate to be about 14.5% of Americans. In 1985, they were only accounted for 11 percent of the United States population. In 2060 the Population Reference Bureau projects that there will be nearly 100 million Americans over the age of 65. Back in 1900, only 100,000 Americans lived to be 85 or older and by 2010, the number has grown to 5.5 million. This shows the rapid growth of the senior population doubling in just over 40 years.

That signifies the fact that elderly people as a population will keep increasing but the accommodations to them have been constant which means that eventually there won't be enough accessories and accommodations to elderly people in the future. Therefore, the social problem of elderly people and senior citizens has such a big importance when it comes to our society.

B. Living Conditions

Elderly people are not what most people think of when they think of elderly. A common thought of those of age are that they are retired individuals that just relax and go on vacations with their retirement money. Living the so called, "good life." That is not often true to many elderly people. They either live alone because they are widowed, live with family, in a nursing home, hospital and other living arrangements where they need to stay because of their individual situations. They face many hardships also with these living conditions

C. Loneliness

One major thing that senior citizens face is loneliness. Those who live alone often are in the house all day with no one to talk except of possible occasional visits from family members and friends. Some people can argue that the modern technology allows elderly to connect and talk to other people wherever they are by social media. They fail to realize though that many elderly people have little to no experience with social media or the modern technology. Leading them to not be able to participate in them. Those who do have social media are taught by their family members on a constant basis but those who live alone do not have that privilege.

D. Neighborhood

Another thing that affects the living condition of elderly people is the environment they are around. As stated before, most senior citizens are not living the "good life" as many people think. Many thinks that when one retires from work, everything gets easier on the financial side. That is not the case though as many elderly people are living at or under the poverty line.

Housing may be a significant player in health outcomes for disabled elderly individuals for at least three reasons. First, physically safe and adequate housing is a rudimentary requirement for the health and safety of all occupants. The effect of the basic physical conditions of the dwelling may apply with added force to disabled elderly individuals, who are likely to spend more time in the home and are potentially less able to compensate for inadequate conditions, thereby being at additional risk for accidents. Either way someone looks at it, the surroundings of the elderly affect them directly and their health directly.

E. Nursing Homes/Caregivers

There are different ways senior citizens are taken care of in terms of their everyday life and one of the most common forms of this is in nursing homes. In the 17 years between 1992 and 2009, admissions to skilled nursing facilities increased almost threefold, from 28 to 80 per 1,000 Medicare beneficiaries. In 2012 that number increased to 1.3 million Americans now living in nursing homes.

Nursing homes although are a good route to take if an elderly person can no longer take care of themselves still has many problems with it. An example of that problem is that loneliness can happen even when surrounded by many other elderly people. These nursing homes often have time to mingle with others but only for a couple hours a day, if that. Loneliness is also contagious, studies have found that loneliness has a tendency to spread from person to person, due to negative social interactions and other factors. In other words, when one person is lonely, that loneliness is more likely to spread to friends or contacts of the lonely individual. Making things even worse, people have a tendency to further isolate people who are lonely because we have evolved to avoid threats to our social cohesion.

It's pertinent that also many times nursing homes are over packed which means they are often understaffed. Being understaffed means that the elderly is not taken care of as well as they should with a full staff team is available. Although Nursing homes are usually a good place to go, many hardships still happen in nursing homes. The mental problems like the feeling of loneliness and depression are still very much present in these places.

A. Hospitals

Another place that elderly people stay at is in the hospital. This is probably the worst place to stay for elderly people. Not because they treat them badly or hurt them, but because those that are administered in the hospital are those that are very ill or injured. This usually isn't a permanent place for the elderly to stay but there are often times when they will stay there for weeks and even months before they are properly discharged.

B. Loved Ones

Care provided by family and friends can determine whether an older person can remain at home. In fact, 50 percent of the elderly who have a long-term care need but no family available to care for them are in nursing homes, while only 7 percent who have a family caregiver are in institutional settings.

Also, in 2011, about 43.5 million adult family caregivers were taking care of someone 50+ years of age. As more people live long enough to experience multiple issues and dependency, more family member will be facing these responsibilities.

Care provided by family and friends can determine whether an older person can remain at home. In fact, 50 percent of the elderly who have a long-term care need but no family available to care for them are in nursing homes, while only 7 percent who have a family caregiver are in institutional settings.

This is usually the ideal option for many elderly people since it provides people to take care of them who are part of their family. They do not live alone so they have the opportunity to have a family member watch them while spending time with a loved one versus in a nursing home where it is a random person taking care of them. Also, many elderly people love seeing their grandkids grow and their family be with them often which causes better health and even better habits for themselves.

Conclusion of Societal Problem:
In Conclusion, elderly people create a large and very important social problem not only in America but all over the world. Elderly population is on the rise, but the resources and help allotted to them seems to not meet the needs and requirements they need

III. Design Idea

The elderly are an often overlooked group in society and their day to day problems sadly are too. A main reason for that is the distain most elderly have towards new technology. They come from a generation of working with your hands and getting stuff done by yourself. Technology in their day was at a bare minimum and all daily life was done through human interaction. This trend has rapidly changed in the past 30 years and the elderly generation has been left behind. Their problems however only grow as they get older and due to their lack of mobility and various other ailments thier independence and self-reliance is stripped from them. They're increasingly in need of care givers or loved ones to overlook them in their later years of life. With the help of our robot we hope to ease this burden of dependency and provide a sense of normalcy to all elderly citizens.

A. *Problem Addressed*

Our robot JAGH will help address the lack of innovative inventions in the elderly assistant market. We believe this is mainly due to the learning curve that is associated with elderly people having a hard time being able to learn new technologies. Most senior citizens aren't technologically proficient so whatever innovative item that is presented to them must be easy to learn and self-sufficient. We believe Our robot addresses both of these requisites. Elderly care costs are astronomic and quickly on the rise. Even with these large costs elderly care still isn't reliable because it consists of human error. Human error in this case would be not having a helper or aid next to the patient 24 hours a day. Humans need breaks and have lapses in judgement. Our robot will counter act this human error by being near or insight of the patient 24/7 monitoring a list of parameters and checking the vitals. This is much more accurate than a caregiver or loved one coming in to check on the patient during different random intervals of the day. If an emergency occurs the caregiver could be too late to alert the paramedics.

A. Technology Utilized

As a self-mapping robot the technology used within it can become quiet extensive and complicated. We wanted to keep the technology to a minimum but utilize it to it effectively and efficiently. For the base of the robot we decided to use the same platform and plastic housing as the very popular self-vacuuming robot commonly known as the Roomba. We wanted to use the same concept of roaming done by the Roomba for our robot however instead of vacuuming up dirt and dust, we would use a variety of sensors to monitor different types of hazards. On the front we will have a bumper that if activated along with PING sensors will determine if the robot is going to or has run into any obstacles within its path. For better accuracy we will also add infrared distance sensors to confirm any obstacles in our path and determine the best route to maneuverer around them. A flame sensor will also be allocated to the front of the robot to determine if a fire is present in the room. There are numerous flame sensors in the market, but we want to use a specific one that is most accurate. The one we plan to use has a photoelectric counter tube that is activated only when the spectral region beyond the solar cut-off. This makes the sensor not only more efficient but also more sensitive to help detect fires and not just hot items that give off high infrared signatures. A gas sensor will also be incorporated to help detect any potential hazardous gas such as methane or carbon monoxide. Another sensor we plan on utilizing is a heart rate monitor that reads the pulse of the patient. This sensor will be located in a bracelet that the patient will wear. The heart rate data will then be transmitted through Bluetooth to the robot itself for processing. On the bracelet itself we also plan on adding a small accelerometer to help detect falls by reading G force readings. Both the heart rate monitor and accelerometer will be connected to a Bluetooth module wired together into a half dollar sized microcontroller. We plan on powering this whole bracelet unit with a small LIPO battery with enough power output to last in the bracelet for weeks at a time without recharging. We want to present the bracelet in a way where the patient wouldn't mind wearing it all day. We also want it small enough so it doesn't disturb the natural hand movements and gestures of everyday movement yet be comfortable at the same time. As a group we also want to incorporate a google assistant into the robot so if the patient has anyone questions or wants to search anything on the internet verbally they are more than welcome to. Lastly the main computing sensor that we plan on using is a Kinect sensor which will be our eyes for the robot. The Kinect is going to be located on the top front of the robot and will give critical information to the microcontroller form camera and infrared sensors to determine the route that will be taken.

B. Design Approach

The reason we believe our design idea is unique is because the technology we are implementing in our robot can't be found in one universal centeral unit. In order to get all of these features that we are providing in our robot you must buy numerous separate units and even then, there wouldn't be any coherence throughout the induvial units. We wanted to address safety issues that senior citizens might deal with on a day to day basis and create an item that could tackle these issues all in one central robot that was also self-sufficient. We understand the elderly aren't the most technological savvy group so by putting all the sensors, motors, and microcontrollers in one unit that could take care of itself, the burden on the elderly would be relieved.

C. Resources

There are many resources we plan on using but the most important will be examples of autonomous driving. Making a robotic car for example map out a room and drive throughout it without hitting objects is easier said than done. We don't want the robot going around the same object multiple times or getting stuck behind something like a couch for example. We also want to eliminate redundancy meaning it wouldn't get stuck in a room and circle the same 4x4 ft path over and over again. We want to see examples of previous projects online to see how they tackle these issues and address them in our own unique way for our robot. Another resource that is going to be crucial to our project is data sheets for each sensor or electronic component. All electrical components have different specs and must be used and connected properly in order to get correct data to be outputted. Not following proper protocol or connecting any electric components in-correctly has the potential of destroying the whole circuit temporarily or even permanently. Damaging circuits from improper use only delays our overall project progression by now having to wait for new replacement parts to come in via the mail.

D. Features

There are many features designed into our robot but the two of the main features would have to be the self-roaming feature mapped into the brain of microcontroller, and the bracelet monitoring the vitals of the patient. The self-roaming part of the robot is programmed into the microcontroller system which is located inside the belly of the robot itself. This helps the robot travel about the users house in an efficient and non-redundant way. Part of the roaming process is to visualize and identify any objects that are obstructing its path of travel. The robot must be able to find alternate routes around an object without the robot going in circles or re-traveling the same area that was just travelled. The other main feature is a bracelet that the patient will be wearing. This bracelet will comprise of a battery, small microcontroller, Bluetooth module, accelerometer, and a small heart rate monitor. The idea behind this is when the patient straps the bracelet tight to their wrist, the heart rate monitor will be pressed tightly against the skin allowing for an accurate heart rate reading. This reading will be read as data and be sent to the microcontroller which is then relayed to the Bluetooth module. Via Bluetooth the data can then be transmitted to the main hub in the robot to help keep track of the heart rate of the patient. We also are including an accelerometer which will be programmed in a way where it will be able to detect if the patient falls. The idea behind this is we will have a set of parameters that if triggered will set off an alarm. This means if the patient experiences a fall, the accelerometer will notice the extreme spike in G-forces and set a high signal to the microcontroller. This signal paired with a spike in heart rate readings means the patient must have fallen and this alert is sent to the robot. The robot is then responsible for traveling up to the patient and asking if they need immediate emergency help. If they respond by saying "yes", the robot will send a signal to the paramedics instructing them to dispatch one of their ambulances to the residence's location.

E. Cost

The cost of this project is hard to say. There are many variables that come into effect such as ordering parts we don't need, re-ordering parts, or last-minute purchases to help complete a certain task. Luckily as a group we had great fortune by discovering a semi used self-vacuuming unit in the riverside building. We knew that was going to be the most expensive part of the project and we found a fully functioning robot with intact motors, battery, and charging station. The second most expensive part was going to be the Kinect sensor off of an old Xbox 360 and Andrew had one laying around the house, so we added that to the project for free too. Our main cost was then going to be all the sensors we needed for the robot and the bracelet. Through amazon I was able to order all parts for the bracelet for under 60 dollars.

B. *Sensors*

A big part of our robot and how it moves as well as the features of it are done by sensors. Almost our entire robot with its functions are based on the sensors we are putting on it. We are using sensors like ultrasonic and IR sensors for the movement of the robot in order to get where we need it to be. Sensors like a water sensor, flame/fire sensor, gas sensor, and temperature sensor are all features we are using in order to ensure the safety of the elderly user that is using it. We are also adding a speaker or mic in order for a two-way communication system between the robot and the user, for more accurate readings and more accurate information getting sent to possible authorities. All of these sensors will be integrated together in order for a smooth operation as well as proper operation of the robot. If the microcontroller is the brain of the robot, the sensors are the eyes, ears, nose, and mouth of the robot.

A. *PING/Ultrasonic Sensor*

Ultrasonic sensors are often used in automation tasks to measure distance, position changes, level measurement, such as presence detectors or in special applications, for example, when measuring the purity of transparent material. They are based on the principle of measuring the propagation time of ultrasonic waves. This principle ensures reliable detection is independent of the color rendering of the object or to the design and the type of its surface. It is possible to reliably detect even such materials as liquids, bulk materials, transparent objects, glass etc. Another argument for their use is them using in aggressive environments, not very great sensitivity to dirt and also the possibility of measuring a distance. Ultrasonic sensors are manufactured in many mechanical designs. For laboratory use, the simple housing used for transmitter and receiver separately or in a single housing, for industrial use are often constructed robust metal housing. Some types allow you to adjust the sensitivity using a potentiometer or digitally. For ultrasonic sensors, detailed parameters of all the sensors operating range and measured distances can be altered [1].

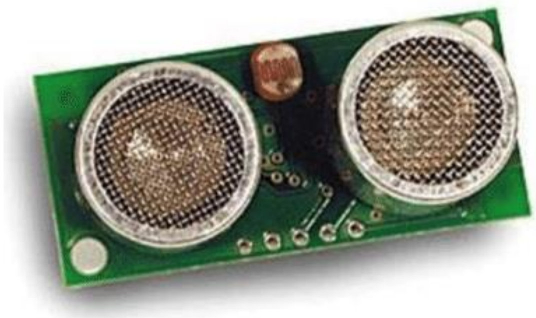


Fig. 7. Sensor SRF08 [12]

As the name implies, Ultrasonic sensors have very similar propagation characteristics in the environment as audible sound. Figure 2 is a picture of the SRF08 ultrasonic sensor also called as sonar. r. It is an ultrasonic obstacle detector. It is able to measure the distance up to 11 m. The principle of measurement of the sensor is the ultrasonic signal on the eighth periods and a frequency of 40 kHz. Sonar measures the time between sending the test signal and the receiving of its reflection. Measured values (individual reflections) are stored up to 16 registers from which data can then be read master system. Although we are not using this exact same sensor, it is a description and has many of the same capabilities of the sensor we will be using.

The communication part of this sensor is the typical I2C configuration. The total ultrasonic sensor is calculated with the following formula:

$$\Delta_{S\,CLK} = \pm \frac{\max(|\Delta_S| + |\Delta_M|)}{300} . 100 \quad (\%)$$

We can see from practical measurements that the ultrasonic sensor measures the distance with high accuracy. In measurements distances up to 3m was accuracy class 0.5%, in case measurements distances up to 6m was accuracy class 0.7% and in case measurements distances over 6 meters the accuracy class was even 0.4% [1]. This is only one of many sensors we are going to put on our robot. Using this for mostly manoeuvrability, the next sensor will detect water spills and possibly prevent a slip causing a fall.

B. *Flame Sensor*

A sensor that senses a flame and high temperature ambient seems to be the new thing when fire alarms often cause false alarms. This sensor is intended to cut down the false alarms caused by fire alarms by sensing the flame directly instead of the often false smoke that fire alarms detect. This will allow safety to the elderly person by alerting them of fires and will contact the appropriate authorities if the user decides it to.

Figure 8. Flame sensor [24]

The flame sensor consists of a photoelectric counter tube which is triggered by ultraviolet photons emitted by flames in the spectral region beyond the solar cutoff. Tubes of this type have been made previously, but this new tube differs in being able to operate in ambient temperatures up to and in excess of 1000°F. The new tube has high sensitivity and a lower operating voltage than older tubes. The flame sensor is encapsulated in a titanium and forsterite ceramic envelope and uses a sapphire window to admit the ultraviolet photons. The photocathode consists of a molybdenum rod which has been cleaned by heating and sputtering. The anode is a molybdenum hemisphere, which also serves as a mirror to concentrate the light from the flame on the photocathode. The gas-fill is 100 torr of a helium-argon mixture, where the small amount of argon is used to help remove helium metastables following a count. The sensor operating voltage is about 150 V, and a dead time of 1 ms or more is used to avoid multiple counting. Typical counting rates obtained with a small methane flame at 12 ft are 60 per second. A sensor was life-tested at 1000°F in air for longer than 2000 hours [3].

This simple sensor has a large potential when it comes to detecting fires. In 2016, there were 1,342,000 fires reported in the United States. These fires caused 3,390 civilian deaths, 14,650 civilian injuries, and $10.6 billion in property damage. [3]. That in itself shows how much this sensor can affect a person’s life. With this working together with other parts of our robot, it ensures the safety of our elderly consumers.

C. *Gas Sensor*

One of the most common gas sensors that people use is a carbon monoxide gas sensor. This sensor detects a lethal gas that has no smell or color causing it to go undetected unless a sensor is put into place. This is the same thing we plan to put on our robot in order to detect this lethal gas. The advantage we will have though is that the robot will be going around the house unlike the general sensors that do not move. This gives the possibility of carbon monoxide not being detected till it is spread around the house. With our robot, it will detect it well before it spreads around the house.

The area of the CO sensor is about 1 mm2. The CO sensor consists of a polysilicon resistor and a CO sensing film. A silicon dioxide layer is located between the polysilicon resistor and the sensing film. The polysilicon resistor is connected to the readout circuit. The CoOOH/CNTs CO sensing film is coated on the polysilicon resistor. The polysilicon resistor is 2 μm wide, 0.4 μm thick and 11,000 μm long. When the sensing film of the sensor absorbs or desorbs CO gas, its energy band produces a change, resulting in changes to the energy band of the polysilicon resistor. The polysilicon resistor generates a change in resistance as its energy band varies [4]. The resistance variation of the CO sensor is converted by the readout circuit into the voltage output.

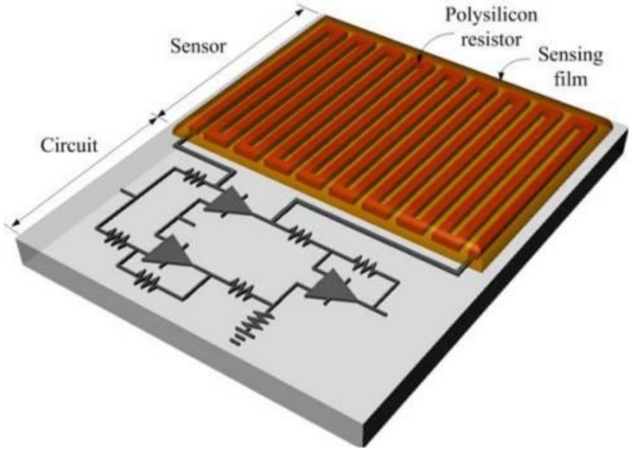


Figure 9. Schematic structure of the CO sensor with a readout circuit. [24]

Protecting our elderly consumers from water spills, flames, and many more dangers is just a start of what we are trying to avoid. With most gases like carbon monoxide being clear and not being able to be seen, it causes more danger that most people will not notice. This robot equipped with this sensor will definitely eradicate the possibility of getting poisoned by gases like carbon monoxide.

D. *Temperature Sensor*

Unlike many of the sensors we are using for our robot that serves a specific task to keep the consumer safe, this sensor will be used more for convenience of the user. Having a temperature sensor that displays the temperature allows the user convenience to know how hot or cold a certain room is.

The Thermostat is a contact type electro-mechanical temperature sensor or switch, that basically consists of two different metals such as nickel, copper, tungsten or aluminium etc, that are bonded together to form a Bi-metallic strip. The different linear expansion rates of the two dissimilar metals produces a mechanical bending movement when the strip is subjected to heat. [6]

There are a lot of different temperature and some of them include semiconductor junction sensors, Infra-red and Thermal sensors, medical type thermometers, and many more [6]. This sensor simply stated takes in the information from the air around it and calculates it to find the proper temperature in either Celsius or Fahrenheit according to what the elderly user would like to see as well as what part of the world they live in.

C. *Software*

With all the sensors and hardware items we have, they are all pointless without the proper programming or in other words, software. The integration of the sensors all working together on the hardware side has to be working together on the software side also. We will need the robot to do its intended task, which means we have to tell the brain or microntroller what to do. That is where the software side of the robot comes in.

A. *Programming Language*

Before going in depth of the specific languages we will be using for this robot, we must first have a basis of what programming language actually is. A programming language is a vocabulary and set of grammatical rules for instructing a computer or computing device to perform specific tasks. The term programming language usually refers to high-level languages, such as BASIC, C, C++, COBOL, Java, FORTRAN, Ada, and Pascal. Each programming language has a unique set of keywords (words that it understands) and a special syntax for organizing program instructions. The two languages we will be using are C/C++ and Python.

B. *Arduino/C*

The Arduino will be used mostly when it comes to the watch or band that the user will be wearing in order to sense for shock as well as the heart rate of the elderly consumer.

Arduino can provide an introduction to microcontrollers without dwelling much into the programming aspect of it or the architecture aspect of it. The implementation of Processing used in Arduino IDE would be a C/C++ ‘dialect’, which makes the transition easy for those who have just started learning C or any other language, and many graphical languages have been built around Arduino. C is a general-purpose, imperative computer programming language, supporting structured programming, lexical variable scope and recursion, while a static type system prevents many unintended operations. By design, C provides constructs that map efficiently to typical machine instructions, and therefore it has found lasting use in applications that had formerly been coded in assembly language, including operating systems, as well as various application software for computers ranging from supercomputers to embedded systems. [8]

C was originally developed by Dennis Ritchie between 1969 and 1973 at Bell Labs, and used to re-implement the Unix operating system. It has since become one of the most widely used programming languages of all time, with C compilers from various vendors available for the majority of existing computer architectures and operating systems. C has been standardized by the American National Standards Institute (ANSI) since 1989 and subsequently by the International Organization for Standardization (ISO).

C is an imperative procedural language. It was designed to be compiled using a relatively straightforward compiler, to provide low-level access to memory, to provide language constructs that map efficiently to machine instructions, and to require minimal run-time support. [8] Despite its low-level capabilities, the language was designed to encourage cross-platform programming. A standards-compliant C program that is written with portability in mind can be compiled for a very wide variety of computer platforms and operating systems with few changes to its source code. The language has become available on a very wide range of platforms, from embedded microcontrollers to supercomputers.

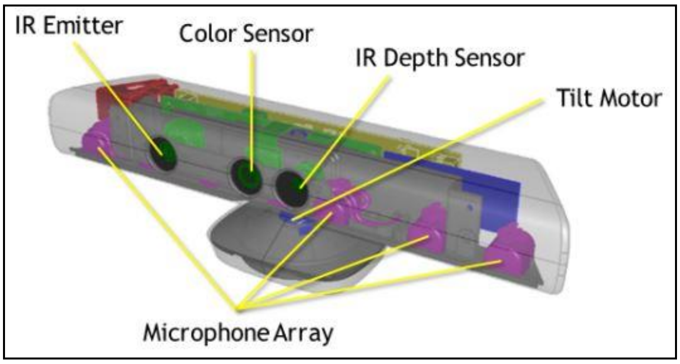
D. *Navigation and Mapping*

This robot will be able to manoeuvre around a complex indoor environment while avoiding large obstacles and unreachable areas (i.e. stairs). In order to do this a combination of software and hardware is required.

A. *Hardware*

The main piece of hardware we we'll use for mapping the environment and navigating through it will be an Xbox 360 Kinect Sensor. For what this piece of hardware can do, it is an extremely inexpensive device that has multiple sensors on it to make 3D mapping and navigation much easier than using only IR sensors or PING sensors.

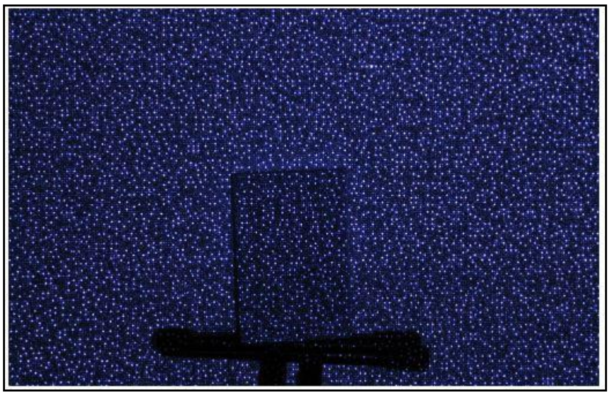
Figure 10 Kinect Diagram [13]



The Kinect has three main sensors (seen in figure 1.2) that is uses to "see" the environment around it. The IR emitter and depth sensor creates a 3D map of the objects in from of it, while the color sensor (RGB camera) adds colors to the objects. There is also an array of four microphones which are designed to record speech as they have an 8KHz cutoff frequency [13]. We won't be focused on using these microphones. What we are interested in is the depth sensors and the camera.

The depth sensor works be projecting a specific pattern of 830 nm IR lasers onto the objects in front of the sensor. The IR camera (depth sensor) records these patters and on-board hardware takes the IR data and the RGB camera image to create a detailed depth map of its surroundings. The range for depth finding is 0.7m to 6m (2.3ft to 19.7ft) [14]. This will allow for accurate room mapping in even the largest rooms in a house.

Figure 11 Projected IR pattern on an object [14]

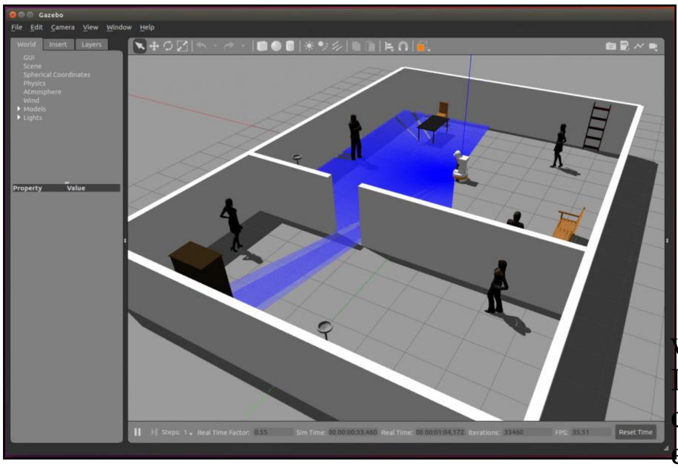


B. *Software*

The software controlling the robot's navigation is going to be a key aspect to the success of our project. The main program running on the Asus Tinker board will be running Robot Operating System (ROS) on an Ubuntu kernel. ROS is a framework for robot-related software. It is a collection of libraries, tools, and conventions that is open source [15]. We will be using its mapping and navigation libraries in conjunction with Kinect-related libraries such as *libfreenect*, *freenectstack*, *freenect_camera*, and a few other auxiliary libraries to control the creation of a map and navigating through it.

To test our software while we are developing the hardware aspect of the robot, we will use Gazebo. Gazebo is a simulation software that allows the developer to build a model of their robot and create a virtual environment. In this simulation we can create a robot that has all the sensors we are implementing in our final design to test the functionality of all components in a real-world environment while we are still working on the real robot. Once we are getting the results we are after in the simulation all we have to do is take the program and put it on our actual robot in order to get it running.

Figure 12 Gazebo Software Example [12]



E. *Data Acquisition*

As mentioned, this robot will be monitoring multiple aspects during its operation. Important data to be collected will include periodic heart rate of the person, when a fall is detected and if it was an injurious fall. Our current plan is to just have the robot display timestamped data into a text file that is accessible by the user. If we have enough time near the end of the semester we implement a GUI and a touchscreen on the robot where the user can access the data through a database server. This will allow the user to easily see all the data organized into different search queries very easily.

F. *Robot Motion/Build*

A Differential Drive:

In our robot we will be implementing wheeled locomotion in the form of the Differential Drive. Nowadays, most indoor mobile robots do not move like cars. There are too many wheels, making it difficult to manoeuvre around tight places. In the differential drive there are two main wheels, where each wheel is attached to its on motor. A third wheel is then placed in the rear to roll along with the other wheels, preventing the robot from falling over. Below, in Figure 16, you can see a differential drive robot.

Figure 13: A Differential Drive Robot [16]

In our robot we will be using the concepts of wheeled locomotion, which is the most common. In wheeled locomotion we must take into consideration stability, ground contacts, the environment our robot will be in, and how much energy and power it will consume [17].

Stability:

Important characteristics:

- Number of contact points with the ground

- Geometry of those contact points (size and shape)
- Robot center of gravity
- Terrain steepness or degradation

Ground Characteristics:
Important characteristics:

- Type of contact
- Angle of contact
- Friction between the robot and the surface

Environment:
Environment has to aspects: the medium (air, water, and ground) and properties (soft or hard).

Our robot will be very stable with the three-wheel design, we will not need to worry about balancing. Also making it power efficient. Our ground characteristic is hard surfaces; such as wood floors, tiles, linoleum, and granite floors. With some modifications the robot should easily be able to manoeuvre across carpeting as well. The environment the robot will be in a one-story home, that includes a few rooms, a bathroom, living space, and a kitchen.

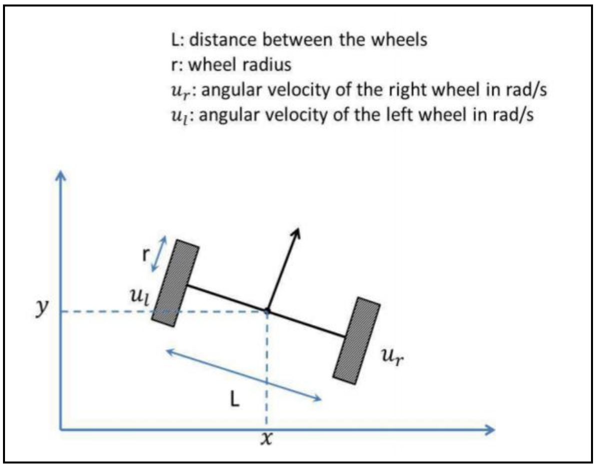


Figure 14: Differential Drive [17]

Looking at the differential drive mathematically, the speed of the robot is $v=(r/2)(u_r - u_l)$. The speed is proportional to r, and v is the average of the right and left wheels velocities. The angular velocity of the robot is $w=(r/L)(u_r - u_l)$. When w is equal to zero both wheels spin at the same speed. Based on angular velocity we have:

Table 3: Angular Velocity formula

- $u_\ell = u_r$: The robot moves forward in a straight line, i.e., pure translation. As a result $\dot{\theta} = 0$.
- $u_\ell = -u_r$: The robot rotates about its reference point. Wheels are turning in opposite directions.
- $u_\ell = 0; u_r \neq 0$ or $u_\ell \neq 0; u_r = 0$: The robot rotates around the left wheel or the right wheel.

B. DC Motors

In the JAGH robot we will be using DC motors to power the wheels on our differential drive styled designed robot.

DC motors are the simplest motors to use in robotics. They can reach very high rotational speeds which is dependent on the input voltage. Though they may be easy to implement, it cannot handle the position as well as the servomotor or a stepper motor. If we want to change the torque of the dc motors, we just need to use a combination of gears, also called the gearbox. Below is a image of a DC motor we are going to use in our robot. [19]

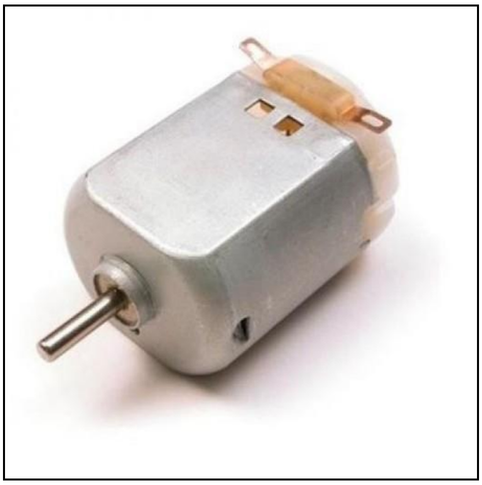


Figure 15: DC Motor [18]

The brush DC Motor consists of six different components: the axle, armature/rotor, commutator, stator, magnets, and brushes. A Brush DC Motor consists of two magnets facing the same direction, that surrounding two coils of wire that reside in the middle of the Brush DC Motor, around a rotor. The coils are positioned to face the magnets, causing electricity to flow to them. This generates a magnetic field, which ultimately pushes the coils away from the magnets they are facing and causes the rotor to turn.

II. *Advantages:*

- Inexpensive
- Lightweight
- Reasonably efficient
- Good low-speed torque

Limitations:

- These motors create a lot of electrical noise which can find its way back into the circuitry causing other problems.

C. H-Bridge

The two DC motors that are going to be moving the robot, will be connected to the H-bridge via the raspberry pi and/or the Arduino. We are more specifically going to be using the L298N H-Bridge, as seen below in Figure 20.

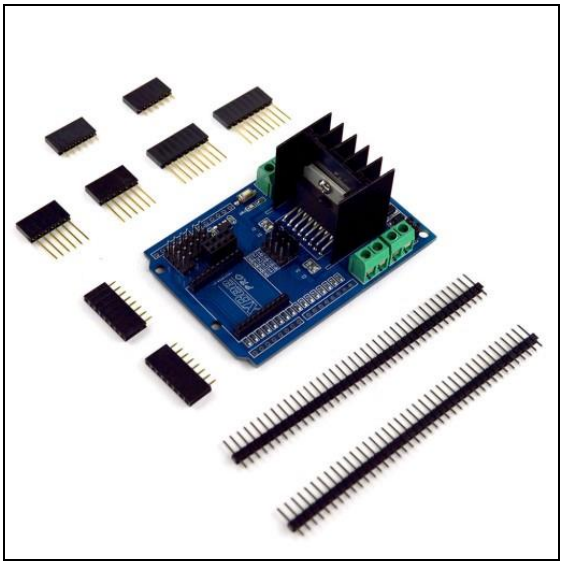


Figure 16: L298N H-Bridge [20]

A H bridge is an electronic circuit that enables a voltage to be applied across a load in either direction. It switches the polarities of a voltage applied to the load. These circuits are often used in robotics and other applications to allow DC motors to run forwards and backwards.

An H-bridge is a transistor-based circuit capable of driving motors both clockwise and counter-clockwise. It's an incredibly popular circuit – the driving force behind countless robots that must be able to move both forward and backward. Fundamentally, an H-bridge is a combination of four transistors with two inputs lines and two outputs. [19]

D. Encoders

In our robot, JAGH, we will use encoders on the dc motors to measure the number of rotations. From the rotations we can calculate the speed and location of the robot. Which will better help us plan and navigate around the house to better help the elderly. Below is a image of what an encoder looks like.

Figure 17: Two different types of encoders [21]

The encoder is a sensor attached to a rotating object (such as a wheel or motor) to measure rotation. By measuring rotation your robot can do things such as determine displacement, velocity, acceleration, or the angle of a rotating sensor. [21]

A typical encoder uses optical sensor(s), a moving mechanical component, and a special reflector to provide a series of electrical pulses to your microcontroller. These pulses can be used as part of a PID feedback control system to determine translation distance, rotational velocity, and/or angle of a moving robot or robot part. [21]

IV. Funding

All of the funding for this project has been paid for and provided by our group only without any other source of funds outside of it. Below is the list of materials we bought and the total cost of our project.

Table 4: Bill of Materials

#	Item	Quantity	Price @ (Qty1)	Order Cost ($)
1	Arduino	2	$10.99	$21.98
2	Ultrasonic Sensor (x5)	1	$9.99	$9.99
3	IR Infrared Sensor (x10)	1	$9.99	$9.99
4	Gas Sensor (x2)	1	$5.99	$5.99
5	L298N Motor Drive (x3)	1	$9.99	$9.99
6	DC Motor	2	$19.99	$39.98
7	Max 32 Chipkit	2	$65.99	$131.98
8	Heart Rate Monitor Sensor	1	$21.00	$21.00
9	Power Supply	1	$35.00	$35.00
10	Chassis/Wheels	1	$50.00	$50.00
11	Robot Structure	1	$30.00	$30.00
12	GSM Module	1	$50.00	$50.00
13				$0.00
14				$0.00
15				$0.00
16				$0.00
17				$0.00
18				$0.00

TOTAL COST	$415.90

V. PROJECT MILESTONES

Our team devoted a lot of time to this project and accomplished many tasks. Below are the list of these accomplishments we made.

1) Problem statement written report
2) Design idea report
3) Kinect able to map a room
4) Work breakdown structure report
5) Finished Project Timeline
6) Sensors working and data is being recorded
7) Autonomous navigation
8) Wi-Fi module
9) Use microcontroller to navigate using ping sensors
10) GSM Module sending alert when hazard is sensed
11) Risk assessment written report
12) Jagpreet finishes team leader responsibilities
13) Andrew finishes team leader responsibilities
14) Hasan finishes team leader responsibilities
15) Gethro finishes team leader responsibilities
16) Navigate through tight corners
17) Bracelet designed and made
18) Communication between robot and wrist band
19) Team member Evaluations
20) Wirelessly communicate between all of the systems
21) Kinect 3d mapping a room
22) Display sensor values and recording data
23) Laboratory Prototype Demonstration
24) Revised problem statement written report
25) Device test plan written report
26) Market review and board review
27) Midterm progress review
28) Deployable prototype technical review
29) Weekly reports
30) Final documentation
31) Finish final presentation video
32) Prepare for showcase day

VI. Work Breakdown Structure

Table 5: WBS

October 22, 2018

TEAM #3 WBS				
WBS	Description	Plan Start Date	Plan Finish Date	Type (Feature,Task,Activity)
1	**Autonomous Path Planning**	Sept-05-2018	Feb-05-2018	Feature
1.1	Build Robot	Sept-26-2018	Oct-31-2018	Task
1.1.2	Check DC motors compatible w/microcontroller	Sept-27-2018	Sept-30-2018	Activity
1.1.3	Check DC motors compatible with H-Bridge	Sept-28-2018	Oct-01-2018	Activity
1.1.4	Disassemble Mami robot	Oct-01-2018	Oct-02-2018	Activity
1.1.5	Reassemble robot with our components	Oct-03-2018	Nov-30-2018	Activity
1.2	Robot drive control	Oct-01-2018	Oct-05-2018	Task
1.2.1	Make sure the robot can go straight and turn	Oct-01-2018	Oct-03-2018	Activity
1.2.2	Make sure the robot can make sharp right angle turns.	Oct-08-2018	Oct-12-2018	Activity
1.2.3	Make sure the robot can make turns given certain angle.	Oct-13-2018	Oct-19-2018	Activity
1.2.4	Program robot to understand if there are drops/edges	Oct-22-2018	Nov-5-2018	Activity
1.2.5	Program robot to understand line following	Oct-15-2018	Oct-19-2018	Activity
1.2.6	Program robot to understand obstacle avoidance using ping	Oct-22-2018	Nov-5-2018	Activity
2	**Flame Detection**			Feature
2.1	Code and make sensor be able to sense a flame	Sept-27-2018	Oct-5-2018	Task
2.1.1	Test sensor to a match/ lighter.	Oct-10-2018	Oct-24-2018	Activity
2.1.2	Test sensor 6 inches away	Oct-10-2018	Oct-24-2018	Activity
2.1.3	Test sensor 1 foot away from flame	Oct-25-2018	Dec-4-2018	Activity
2.1.4	Test sensor 5 ft. away from flame	Oct-26-2018	Dec-5-2018	Activity
2.1.5	Test sensor 10 ft. away from flame	Oct-27-2018	Dec-6-2018	Activity
2.2	Sensor should detect different flame sizes	Oct-24-2018	Nov-9-2018	Task
2.3	Sensor in various environments	Oct-24-2018	Nov-9-2018	Task
2.3.1	Test sensor effectiveness inside a home	Jan-1-	Mar-14-	Activity

		2018	2019	
2.3.2	Test sensor effectiveness in a patio	Jan-1-2018	Mar-14-2019	Activity
2.2	Integrate to robot and system	Nov-10-2018	Nov-27-2018	Task
2.2.1	When senses a flame, system will alert user.	Nov-14-2018	Nov-27-2018	Activity
2.2.2	If user does not respond within 3 min, call emergency personnel	Jan-1-2018	Mar-14-2019	Activity
3	**Gas Detection**			Feature
3.1	Code sensor to accurately detect different gasses	Oct-01-2018	Oct-10-2018	Task
3.1.1	Test sensor with various gasses	Oct-11-2018	Oct-18-2018	Activity
3.1.2	Test for Methane detection	Nov-1-2018	Dec-5-2018	Activity
3.1.3	Test for Carbon Monoxide detection	Nov-2-2018	Dec-6-2018	Activity
3.1.4	Test for smoke detection	Nov-3-2018	Dec-7-2018	Activity
3.2	Sensitivity to various gasses at different distances	Jan-1-2019	May-3-2019	Task
3.2.1	Test sensitivity from 5 and 10 feet away from smoke	Jan-2-2019	May-4-2019	Activity
3.2.2	Test for accurate readings, showing which gas is detected	Jan-3-2019	May-5-2019	Activity
3.2.3	Test concentration of gas needed for sensor to detect	Jan-4-2019	May-6-2019	Activity
3.3	Integrate to robot and system	Oct-28-2018	Nov-15-2018	Task
3.3.1	When senses certain gas, alerts user	Nov-15-2018	Nov-30-2018	Activity
4	**Emergency Call Service**			Feature
4.1	Connect our system to phone service	Nov-3-2018	Dec-6-2018	Task
4.1.1	Have system call 916 area codes	Nov-4-2018	Dec-7-2018	Activity
4.1.2	Have system call other area codes	Nov-5-2018	Dec-8-2018	Activity
4.2	Have system call proper services/people	Jan-10-2018	Apr-25-2019	Task
4.2.1	If given the signal, call 911 for more serious injury	Jan-11-2018	Apr-26-2019	Activity
4.2.2	Call for firefighters if flame/fire is detected	Jan-12-2018	Apr-27-2019	Activity
4.2.3	Call friends or family if minor care is needed	Jan-13-2018	Apr-28-2019	Activity
5	**Robot Downtime**			Feature
5.1	Flame Sensor always on	Oct-27-2018	Dec-6-2018	Task
5.1.1	If fire is sensed, notify user	Nov-2-2018	Dec-7-2018	Activity
5.1.2	After 3 min of no response, call fire department	Jan-15-2018	April-15-2019	Activity

5.2	Gas Sensor is always on	Oct-27-2018	Dec-6-2018	Task
5.2.1	If gas is sensed, notify user	Nov-2-2018	Dec-7-2018	Activity
5.2.2	After 3 min of no response, call fire department/emergency personnel	Jan-15-2018	April-15-2019	Activity
5.3	Robot movement	Oct-28	Nov-30-2018	Task
5.3.1	Every 45 minutes, roam around house to check for possible warning	Oct-28-2018	Nov-15-2018	Activity
5.3.2	If not roaming, be on charging station	Nov-15-2018	May-1-2019	Activity
6	**Bracelet**			Feature
6.1	Connect bracelet to WIFI	Nov-1-2018	Dec-1-2018	Task
6.1.2	send all data from microcontroller to main robot	Nov-1-2018	Dec-2-2018	Activity
6.2	Accelerometer is always on	Nov-2-2018	Dec-3-2018	Task
6.2.2	if fall is detected then alert robot to be dispatched	Nov-3-2018	Dec-4-2018	Activity
6.2.3	if patient needs help, call for paramedics	Nov-4-2018	Dec-5-2018	Activity
6.3	Heart rate is always on monitoring heart rate	Nov-5-2018	Dec-6-2018	Task
6.4	Push button is present to reset system incase of a false alarm	Nov-6-2018	Dec-7-2018	Task
6.5	Small LIPO battery pack powering the whole unit	Nov-7-2018	Dec-8-2018	Task
6.6	Plastic housing that holds all modules together around wrist	Nov-8-2018	Dec-9-2018	Task
7	**Rechargeable power supply**	Nov-01-2018	Dec-01-2018	Feature
7.1	Find batteries that are rechargeable	Nov-01-2018	Nov-05-2018	Task
7.1.1	Find how much voltage will be necessary for the robot	Nov-05-2018	Nov-08-2018	Activity
7.1.2	Disperse the power equally throughout the robot	Nov-08-2018	Nov-15-2018	Activity
7.1.3	Create voltage dividers if necessary	Nov-15-2018	Nov-20-2018	Activity
7.1.4	Power the robot with batteries	Nov-20-2018	Nov-20-2018	Activity
7.2	Find a way to recharge the batteries	Nov-21-2018	Nov-23-2018	Task
7.2.1	Understand how contact points on Mami robot work	Nov-06-2018	Nov-09-2018	Activity
7.2.2	Implement the contact point on Mami to the charging components	Nov-10-2018	Nov-14-2018	Activity
7.2.3	Test to see if contact points make any connection and recharge battery	Nov-15-2018	Nov-30-2018	Activity

VII. Risk Assessment and Mitigation in WBS

A. *Bracelet*

The biggest risk on this whole project in our estimate will be the bracelet that the elderly patient will be wearing throughout the day. The bracelet houses many electrical components that could short or malfunction causing different types of injury.

A. *Design*

The design of our bracelet is stacking a bunch of electric components on top of another instead of spreading them out over the wrist and along the arm. Since the bracelet is in direct contact with the human skin there is potential for shocking or short circuiting on the user's body. We are going to create a shell made of plastic that will house all the electrical components. To make it as normal as possible we will attach on both ends watch bands to help secure the housing to the user's wrist much like any normal watch. One of the risks we can potentially face is having one of the electrical components short one another if the metal pins of the board touch each other. This could potentially short circuit the boards and permanently damage the components. This is a high possibility because we want to make the bracelet as small and compact as possible to be both efficient and aesthetically pleasing. However, the more we try to compress the different components, the higher the risk is of damaging them. So as a group we want to find a middle ground to where its acceptable on both terms.

B. *Voltage*

People often have the misconception that voltage isn't what kills human in electric shock, it's the current. That isn't fully true however. As engineers know without voltage there can't be any current. Resistance also plays a vital role in the equation because with higher resistance the voltage and current can be regulated. Voltage is the amount of energy per unit of charge. This can be seen as the amount of force needed to move electrons through a wire. The more the voltage, the faster the current can move throughout the wire. Our skin has natural resistance built in through dead skin cells to help resist outside voltage effecting our body. However, when the voltage that touches our skin is increased, the overall resistance of our skin to that foreign voltage begins to decrease. The other factor of voltage that is assessed in our risk management is the difference between ac and dc voltages. The human body can handle higher voltages of dc than ac. This is because a much higher dc current is needed to match the same effect of ac current at much lower levels. The scientific reason for this is because the human body acts much like a capacitor. DC voltages apply voltage levels on the capacitor that are only equal or up to the voltage levels of the power supply. This means negative electrons all accumulate on one side of the parallel plates of the capacitor. In the human body this would mean all the charge would build up on the surface of the skin but no current would flow through. AC on the other hand is a whole different story. AC voltages in our capacitor example constantly switch the voltage levels on both sides of the metal plates of the capacitor. This in turn creates current flow by continuous charging and discharging action done by the AC source. This ac current has a much easier time passing through the human body and can be lethal at much lower voltages than dc voltage. In our bracelet we have a single lithium ion battery providing 3.7 volts dc. This level of voltage is non-lethal and not noticeable on the bare skin.

C. *Current*

Current is the amount of flow of electrons in given medium such as a wire. The current is usually measured in milliamps or mA. In ac currents 1mA is not noticeable on the human skin. Around 25 mA the human respiratory muscles can undergo paralysis. This means the muscles give out or begin to work improperly making breathing hard to nearly impossible. Anything above 100 mA is seen as lethal because the heart begins to fibrillate making the rhythm of the heart irregular. This makes the human heart pump incorrectly which leads to improper distribution of blood to the rest of the body. This can result in loss of consciousness, low pulse rate, and eventually death. All these current voltages are in unison with voltage levels. If you have a power source and have low voltage say around 1 volt and really high amperage say around 1 amp, it can't hurt human body. This is because although the amperage is high, the voltage is non-lethal. You need both to harm the body. The power source we are using for our bracelet is in the lower 100 mA range so even during a freak accident where the current somehow shorted on the skin the current and voltage are so low that it still couldn't harm the body.

D. *Lithium Ion Battery*

For our bracelet we are utilizing a 3.7 volt lithium ion battery that is packaged in a low profile slim unit. This battery has many upsides compared to the nickle based competitor battreris such as high density energy cells which can hold higher capacitances. They also have the potential of providing high current without damaging the battery itself. However there are some risks and negatives associated within them. For example, many high voltage lithium ion batteries require voltage circuits that regulate voltage and current levels otherwise they can spike and become dangerous. They tend to also be much more expensive then the common nickel based batteries. On a chemical level the metals within the battery and the chemicals such as lithium metal oxides are constantly varying which can potentially affect the overall life of the battery.

B. *Sensors*

A risk management that is often overlooked in many projects nowadays are sensors. Most engineers look at the "big" risks that come from big blast and heavy duty equipment but often overlook that a simple sensor can cause just as much damage as a large mechanical machine. We will be examining a fire sensor and a gas sensor and the different risks these sensors can have and the testing process can have.

A. *Fire Sensor*

We can look at the small size risks that can happen with the fire sensor which includes a possible short circuit which ends up breaking the sensor. We can also look at the large risks that can include a large fire by improper testing procedures.

One of the risks that can cause a fairly small impact is the sensor breaking or not working. No matter how expensive or "well built" an object is, defects can always happen. Nothing is more frustrating than having a part not work properly. This can lead to hours and hours of trying to debug why the sensor will not work when in the end it is merely because the sensor came broken in the first place. This is the easiest risk that can happen because it is as simple as ordering a new part or asking the manufacture for a new product. Usually this risk is assessed a couple hours after receiving and testing the product, therefore not much time is wasted when this happens. This risk or problem has the lowest impact on the overall project. Where it can become more impactful is if something crazy out of the ordinary happens. Something like the sensor being out of stock or for some odd reason the manufacturer stopped selling/making the product. When that happens it can delay the production of the whole products and the impact on the overall project can be much larger than expected. Even with that though, one can just buy the different sensor from a different brand which solves this so when there is a defect on the sensor, the impact is still pretty low.

Things that can cause more of an impact but still won't completely destroy the outcome of the project or the timeline is something the user has control over. A simple mess in the pin inputs can easily destroy the circuitry and effectiveness of the fire sensor. Although the solution to this would be almost the same thing as a defected sensor, this one would have a bigger impact because of the time and energy the person working on it has. It can range to a short amount for the person to destroy the sensor but in most cases, the person has already put in a lot of time into working on the sensor. Most people unless new to circuits and how to connect things will mess have spent some time already. Those that are new to circuits will have a higher chance of connecting the wires together which in turn short circuits the sensor and ruins it. Most in senior design will have enough knowledge to not immediately break the sensor. The way they will break it is way after they already have it tested and doing exactly what they want. It is usually when they apply it to their project and they accidentally put too much power/ voltage into it or physically breaking the sensor. By this time it usually has been a couple weeks to months of them thinking the sensor is set to go so when it breaks at this stage, the impact is bigger since they will have to reorder it and take more time for it to be delivered. Even when it does get delivered, they will have to do the whole testing phase again and recalibrate the new flame sensor to what they want.

The last and biggest risk as well as the biggest impact comes during the testing phase of the flame sensor. Obviously when the flame sensor is tested, a flame or something similar to it is required. At this point things can get out of hand. Usually testing starts with a simple sensing of a small fire coming from a ligher or a match but to check the accuracy and effectiveness of the flame sensor, we will have to do more extreme things. Things like a bigger flame, or adding obstacles in between the flame and the flame sensor. This is where a fire can possibly start and fires can cause a great amount of damage. It can just burn the object used to test but if it spreads to the rest of the house or building, not only will the project be ruined, but there will be much more damage. This has the biggest impact because not only will a group have to restart the entire project and order everything all over again, but now they will have to deal with burning down a house and possibly adding to the fire crisis California is already in. Overall the flame sensor should be fairly safe as long as the user is safe but we need to take into consideration any possible risks as it will have an impact on our overall project.

B. *Gas Sensor*

The next sensor we will need to assess risk is the infamous gas sensor. Similarly to the flame sensor above, the gas sensor has a lot of the same risks and possible impacts. The biggest difference will just be on the testing of the sensor. Therefore, that is what we will focus this section on.

The gas sensor testing will have the biggest risk as well as the biggest impact. Much like the flame sensor testing the gas sensor testing can be catastrophic. Although the gas sensor depending on the gas being tested can be for the most part safe, some of the more dangerous gases will need to be tested so our overall project can keep elderly safe like we claim it to do. So when we test the gas sensor, we will have to test small amounts of gas just to check the accuracy of the sensor but we will also need to add different situations in order for the practicality of the sensor to be used. This can go downhill very quick as the gas can be deadly to human beings. If a person can't finish the project because they are sick, ill or even dead, the impact on the overall project is huge. Not only will the team be one less person but people will have to deal with the death of a possible close friend. The gas sensor will be able to save lives if used properly but improper testing of the sensor can be very harmful and have a big impact on the total effectiveness of the project. Overall, the gas sensor will have similar risks as the flame sensor but the testing of it can greatly alter the outcome of the project as a whole.

C. *Emergency Calling*

A. *Proper Calling*

The calling portion of the emergency calling part of our robot also has risks to consider into it. Although it is probably not fatal, or as dangerous as other parts of the robot, it still has some risks.

One of the risks comes from it actually calling the right people. If it was supposed to call a caregiver or a family member, for less serious problems, if the call happens late at night or early in the morning and the person intended to call does not answer. Then if this happens, the slightly injured or elderly person that needs some help will not be able to be helped. Will this mean going higher and calling emergency services such as 911? The risk of this is still a fairly decent one but the impact on the total project is not as high. An impact that can affect the project itself is if the system calls the wrong number or calls the wrong people for a specific emergency.

B. *Improper Calling*

The part where the robot calls the wrong person or wrong number is where the risks and the impacts occur a lot higher. One of the mistakes the robot can make is not make the call at all which can lead to catastrophic problems. If there is a fire that it senses and it fails to properly call emergency personnel, the fire can quickly spread not only to the elder's house but to many of the surrounding houses as well. Also if it calls the wrong number, the call is pretty much pointless. If a gas is detected and didn't call the proper person and instead called the caregiver and the caregiver came to the elder's house, now there will be two people in trouble instead of having no casualties at all, there will be another casualty added.

When it comes to the impact it has on the project itself is that we cannot have a robot that does not function properly. If this is the case, our entire setup has been a failure so if the robot improperly calls, the effectiveness of our project goes down by a lot.

D. *Robot Downtime*

The part that is often overlooked and can also cause a lot of risks or impact not only on the project but also to the elder the project is intended for. During the robot's downtime when it is not roaming around checking for certain things, the robot is still fully functioning. The only thing it is not doing is roaming around the house. The risks for this is since it will be charging, we have to make sure the battery has an automatic shut off so it doesn't over charge and cause a fire or even a possible explosion which can also lead to a fire.

The impact this has on the project is that we are going to have a big chunk of time dedicated to the robot moving around successfully and smoothly but when the robot is not roaming, it still has all the functionalities that goes with it. The only difference is the differential drive and the sensors we have for navigation are not functioning. If we forget about this part of the robot, we are almost forgetting about half of the project and therefore the impact would be an unfinished project. The risk for this part is simple, if we don't finish the project, we don't pass the class.

VIII. Design Overview

A. Wristband

Accelerometer

The design of our bracelet is stacking a bunch of electric components on top of another instead of spreading them out over the wrist and along the arm. Our goal was to keep the bracelet as compact as possible. We wanted to make sure the bracelet was safe for human contact too even though we were using small voltage and current levels. Since the bracelet is in direct contact with the human skin there is potential for shocking or short circuiting on the user's body. This is an item we wanted the patient would feel comfortable on a day to day basis. The first component of the wristband is the Accelerometer. The one we chose was the GY-521MPU6050 module which has 3 axis accelerometers and 3 axis gyroscopes. It can measure each axis in the X, Y, and Z planes independently. The raw values given by the accelerometer and gyroscope are all processed within the on-board digital motion processor.

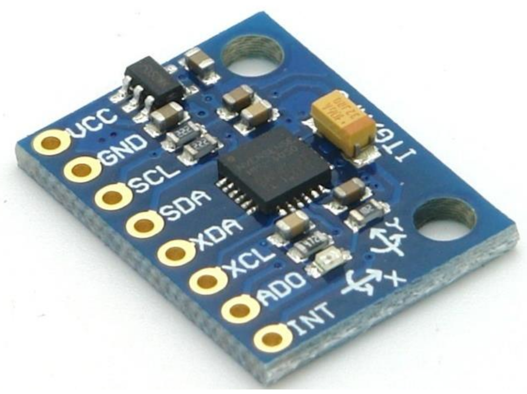


Figure 18: GY-521 Accelerometer/Gyroscope

Included in the chip is a temperature sensor but we had no use for that. For monitoring the patients possible act of falling we were mainly concerned with acceleration in the Z direction. This would give us the best indication of a falling motion. The way the accelerometer works is there is a tiny object with mass located on the board and when there is motion given to the board, the small mass moves. This movement unbalances the differential capacitor in the MEMS sensor. The sensors wave output amplitude is seen as the acceleration for that particular movement. This particular module can measure g forces in a full range of plus or minus 2g, 4g, 8g, and 16g. The main brain of the GY-521 module is the digital motion processor. The chip has 1Kb first in first out register. This register holds the values of the accelerometer and gyroscope which the Arduino uses to read the final values off of. The module talks to Arduino over I2C buses. Arduino boards are seen as the master and the module is seen as the slave. We set the value of the accelerometer to trip when it reaches a value over 12k. We determined this value by actually wearing the wristband and falling numerous times to get an overall average. We came to the consensus that 12k is an acceptable value.

II.A.1 ESP8266 WIFI

The next module on the wristband was the Wi-Fi module which helped send data from the wristband to the robot. For our project we wanted something that was compact as possible to take the least amount of surface area as possible. This particular module is designed to use TCP/IP protocols stacks that can easily connect to the Wi-Fi network. A set of AT command set firmware is pre-installed so it can replace Arduino shields. There is also a pair of GPIO pins that can be used to completely run a program so this Wi-Fi module can be used as its own microcontroller. This module is also low power which means it will take less battery to power it. It actually can’t run on 5 volts because 5 volts would destroy the board. So we powered the board with 3.3 volts. There’s a power down feature that lets you put the chip into sleep mode where the module consumes less than 12 uA of current. Also when the board is connected it uses only 1.0 mW of energy to stay connected to the Wi-Fi network. On board the chip is a 32 bit microprocessor running at 80 MHz which can be bumped up to 160 MHz. The main 5 pins we were concerned with were the GND, VCC, CH_PD, RX, and TX pins. The VCC and CH_PD pins were connected directly to the 3.3 volt line and the GND was connected to ground. We wanted to connect CH_PD to 3.3 volts so the board would never go into sleep mode because we always want to be transmitting values given by the accelerometer and pulse sensor over the internet. The ESP8266 module on the wristband itself was the one running most of the designated code. We set up in a way where every half second it would collect the data from both the accelerometer and pulse sensor and then the other half second it would send that data to the other Wi-Fi module. The second Wi-Fi module is located inside the robot itself. This module is simply the server side collecting data form the host. We have no need for the Wi-Fi module in the robot to send data back to the wristband. The server side (located in the robot) simply opens a port on channel one port number 80 in TCP. Transmission control protocol (TCP) is a type of protocol for networks which is much more secure than the other type of connection which is UDP. In TCP connections data is guaranteed to deliver in order without any data loss. This was critical for our design because we couldn’t afford to lose data for accelerometer and pulse sensor readings. If the patient falls but and the data isn’t sent to the robot notifying it about the fall then our design is useless. The client side (located in the wristband) is coded in a way that it opens and connects via Wi-Fi to the other module. Once connected it loops constantly taking in data from the sensors and pushing it wirelessly to the other module. Once the other module has all the sensor data then it will have a simple if statement checking if the trip flag has been set or not.

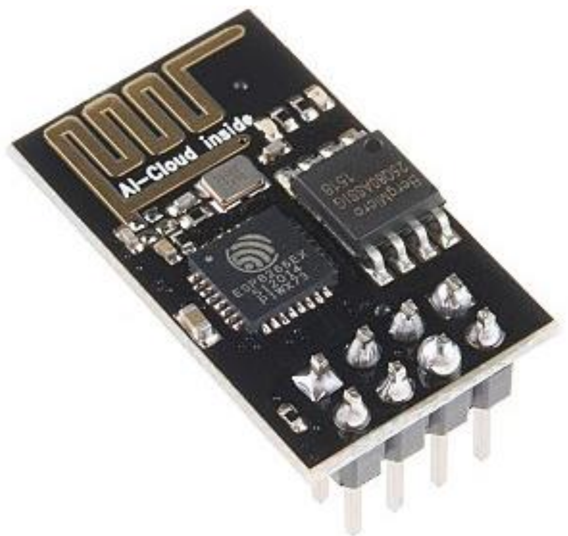


Figure 19: ESP8266 Wi-Fi Module

II.A.2 PULSE SENSOR

The last sensor on the wristband is a pulse sensor. This sensor is used to monitor the patient’s heart rate. The idea behind keeping track of the elderly citizens heart rate is counter check the pulse rate along with the fall detection flag. We set the software to send out a distress signal when the accelerometer senses a fall and the hear rate spikes above normal. To us this indicates the patient has experience a fall and needs assistance. A separate module called the A7 GSM module is responsible for sending a text message alert to any medical emergency contacts. The pulse sensor is essentially a light sensor emitting light into the skin and the reflection of the light is read through a light receiver. It uses the principal of the human where blood through any organ fluctuates up and down proportional to the human heart beating. This fluctuation of blood causes change in the light intensity with in our blood vessels. Since the heart is responsible for pumping blood throughout the body, the sensor detecting differences in the light inside the blood vessels directly corresponds to the a heartbeat. Each pulse in the heart is read by the pulse sensor. This is why we call it a pulse sensor.

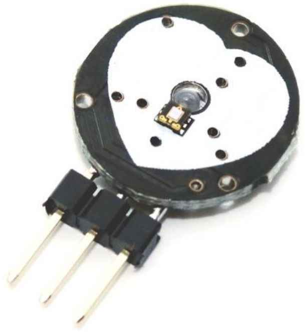


Figure 20: Pulse sensor

The sensor itself is mainly comprised of a light emitting diode which sends waves of light into the skin. Next to that is a light detecting photodiode which searches for any photons of light. The difference of light detected off blood vessels is computed as a pulse. This pulse is what we read in our program and keep track of. The pulse sensor has the wires for ground, VCC, and signal. The signal pin goes to an analog pin on the microcontroller. The VCC can either be connected to a 3.3 volt or 5 volt input but we connected it to 5 volts because the sensor obtains more precise measurements and overall runs more smoothly.

II.A.3 MICROCONTROLLER & BATTERY

Trying to stick to our compact design concept we as a team decided to use an Arduino Nano microcontroller. The reason behind this was it was the smallest board that was readily available to us which also had the necessary amount of GPIO pins needed for our wristband. Our concern was we needed both analog and digital pins along with 3.3 and 5 volt supply pins. After running tests, we ran into our main issue. Our Wi-Fi module that strictly runs off of 3.3 volts for two pins, the VCC and CH_PD, needed the exact same voltage supplied to both pins. We tried connecting the 3.3 volt supply line to both pins but it was splitting the voltage and each pin was only receiving around 1.5 volts. This was not nearly enough power to turn the chip on. We then tried an elaborate voltage divider hoping to keep constant voltage however nothing worked. Our next idea was to use an unused digital pin rated for 5 volts and step the voltage down to 3.3 volts to supply one of the pins independently. We than ran into another problem which was both VCC and CH_PD pins apparently need exactly the same voltage at the same time. After running countless tests, we observed if both pins didn't receive the exact same voltage then the Wi-Fi module might turn on, but it wouldn't operate correctly. Our last-ditch effort was to attach a separate power supply externally in VIN to hopefully provide enough current to its on board 3.3-volt pin so it could successfully provide both pins on the Wi-Fi module properly. The only solution to our problem was to ditch the Arduino Nano all together and use the Arduino Uno. Even though it was much bigger and seen as overkill for a microcontroller, its 3.3-volt pin had enough power to provide the proper voltage to both pins at the same time.

The Arduino Nano was going to be powered by a slim 3.7-volt external battery. However, since we had to change designs and replace the Nano with the Uno which takes a 5 volt external source input. We couldn't find a sleek 5 volt battery pack so we defaulted to using a AA battery pack with 5 batteries inside of it.

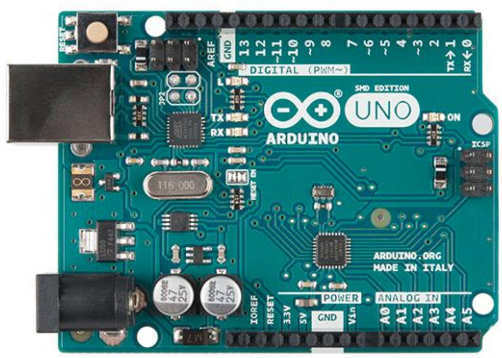


Figure 21: Ardunio UNO

B. *Robot*

II.B.1 Sensors

Our main sensors on our robot are there to check for certain hazards that might threaten the patient's life. These sensors are constantly monitoring around the house even when the patient is away or sleeping. Our robot is mainly designed to use sensors and make certain decisions based on sensor outputs. We are using sensors like ultrasonic and IR sensors for the movement of the robot in order to get where we need it to be. Sensors like flame/fire sensor, gas sensor, and temperature sensor are all features we are using in order to ensure the safety of the elderly user that is utilizing our product. All of these sensors will be integrated together in order for a smoother operation as well as full functionality of the robot. If the microcontroller is the brain of the robot, the sensors are the eyes, nose, and mouth of the robot. The PING/Ultrasonic sensors are often used in automation tasks to measure distance, position changes, level measurement, such as presence detectors or in special applications, for example, when measuring the purity of transparent material. They are based on the principle of measuring the propagation time of ultrasonic waves. This principle ensures reliable values of distance are independent of the color rendering of the object or to the design and the type of its surface. It is possible to reliably detect even such materials as liquids, bulk materials, transparent objects, glass etc. Another argument for their use is them using in aggressive environments, not very great sensitivity to dirt and also the possibility of measuring a distance. Ultrasonic sensors are manufactured in many mechanical designs. For laboratory use, the simple housing used for transmitter and receiver separately or in a single housing, for industrial use are often constructed robust metal housing. Some types allow you to adjust the sensitivity using a potentiometer or digitally. For ultrasonic sensors, detailed parameters of all the sensors operating range and measured distances can be altered. As the name implies, Ultrasonic sensors have very similar propagation characteristics in the environment as audible sound. SRF08 ultrasonic sensor is also called sonar. It is an ultrasonic obstacle detector. It is able to measure the distance up to 11 m. The principle of measurement of the sensor is the ultrasonic signal on the eighth periods and a frequency of 40 kHz. Sonar measures the time between sending the test signal and the receiving of its reflection. Measured values (individual reflections) are stored up to 16 registers from which data can then be read master system. Although we are not using this exact same sensor, it is a description and has many of the same capabilities of the sensor we will be using. The communication part of this sensor is the typical I2C configuration. We can see from practical measurements that the ultrasonic sensor measures the distance with high accuracy. In measurements distances up to 3m was accuracy class 0.5%, in case measurements distances up to 6m was accuracy class 0.7% and in case measurements distances over 6 meters the accuracy. This is only one of many sensors we are going to put on our robot. Using this for mostly manoeuvrability. Another sensor that we will be using is a flame sensor. This sensor detects a flame and high temperature ambient seems to be the new thing when fire alarms often cause false alarms. This sensor is intended to cut down the false alarms caused by fire alarms by sensing the flame directly instead of the often false smoke that fire alarms detect. This will allow safety to the elderly person by alerting them of fires and will contact the appropriate authorities if the user decides it to. The flame sensor consists of a photoelectric counter tube which is triggered by ultraviolet photons emitted by flames in the spectral region beyond the solar cutoff. Tubes of this type have been made previously, but this new tube differs in being able to operate in ambient temperatures up to and in excess of 1000°F. The new tube has high sensitivity and a lower operating voltage than older tubes.

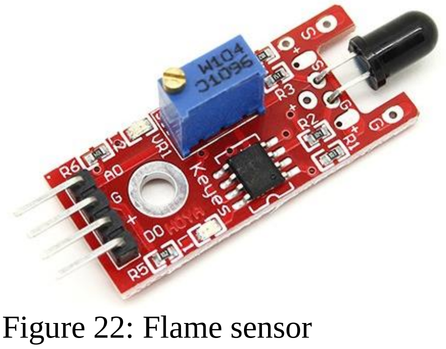


Figure 22: Flame sensor

The flame sensor is encapsulated in a titanium and forsterite ceramic envelope and uses a sapphire window to admit the ultraviolet photons. The photocathode consists of a molybdenum rod which has been cleaned by heating and sputtering. The anode is a molybdenum hemisphere, which also serves as a mirror to concentrate the light from the flame on the photocathode. The gas-fill is 100 torr of a helium-argon mixture, where the small amount of argon is used to help remove helium metastables following a count. The sensor operating voltage is about 150 V, and a dead time of 1 ms or more is used to avoid multiple counting. Typical counting rates obtained with a small methane flame at 12 ft are 60 per second. A sensor was life-tested at 1000°F in air for longer than 2000 hours. This simple sensor has a large potential when it comes to detecting fires. In 2016, there were 1,342,000 fires reported in the United States. These fires caused 3,390 civilian deaths, 14,650 civilian injuries, and $10.6 billion in property damage.

Figure 23: Gas sensor

That in itself shows how much this sensor can affect a person’s life. With this working together with other parts of our robot, it ensures the safety of our elderly consumers. Carbon monoxide gas sensors are one of the most common gas sensors that people utilize. This sensor detects a lethal gas that has no smell or color causing it to go undetected unless a sensor is put into place. This is the same thing we plan to put on our robot in order to detect this lethal gas. The advantage we will have though is that the robot will be going around the house unlike the general sensors that do not move. This gives the possibility of carbon monoxide not being detected till it is spread around the house. With our robot, it will detect it well before it spreads around the house. The area of the CO sensor is about 1 mm2. The CO sensor consists of a polysilicon resistor and a CO sensing film. A silicon dioxide layer is located between the polysilicon resistor and the sensing film. The polysilicon resistor is connected to the readout circuit. The CoOOH/CNTs CO sensing film is coated on the polysilicon resistor. The polysilicon resistor is 2 μm wide, 0.4 μm thick and 11,000 μm long. When the sensing film of the sensor absorbs or desorbs CO gas, its energy band produces a change, resulting in changes to the energy band of the polysilicon resistor. The polysilicon resistor generates a change in resistance as its energy band varies. The resistance variation of the CO sensor is converted by the readout circuit into the voltage output. Schematic structure of the CO sensor with a readout circuit. Protecting our elderly consumers from water spills, flames, and many more dangers is just a start of what we are trying to avoid. With most gases like carbon monoxide being clear and not being able to be seen, it causes more danger that most people will not notice. This robot equipped with this sensor will definitely eradicate the possibility of getting poisoned by gases like carbon monoxide. Another sensor we are using is an IR sensor. This sensor unlike some of the other sensors we are using will be on our robot to improve the movements of our robot. In order for it not to run into things or get close to things it shouldn’t, we will be adding IR sensors to help with the manoeuvring of the robot. Schematic of a typical PIR Passive IR (PIR) sensors are excellent devices for wireless sensor networks (WSN), being low-cost, low-power, and presenting a small form factor. PIR sensors are widely used as a simple, but reliable, presence trigger for alarms, and automatic lighting systems. However, the output of a PIR sensor depends on several aspects beyond simple people presence, as, e.g., distance of the body from the sensor, direction of movement, and presence of multiple people. In this paper, we present a feature extraction and sensor fusion technique that exploits a set of wireless nodes equipped with PIR sensors to track people moving in a hallway. Our approach has reduced computational and memory requirements, thus it is well suited for digital systems with limited resources, such as those available in sensor nodes. Using the proposed techniques, we were able to achieve 100% correct detection of direction of movement and 83.49%-95.35% correct detection of distance intervals. Low-cost, low-power PIR sensors are used in surveillance and automatic light switching applications because of their ability to provide a reliable indication of people presence. If this is the case then avoiding static objects that are not moving will be no problem for the movement portion of the robot. Temperature sensors unlike many of the sensors we are using for our robot that serves a specific task to keep the consumer safe, this sensor will be used more for convenience of the user. Having a temperature sensor that displays the temperature allows the user convenience to know how hot or cold a certain room is. The Thermostat is a contact type electromechanical temperature sensor or switch, that basically consists of two different metals such as nickel, copper, tungsten or aluminium etc, that are bonded together to form a Bi-metallic strip. The different linear expansion rates of the two dissimilar metals produces a mechanical bending movement when the strip is subjected to heat.

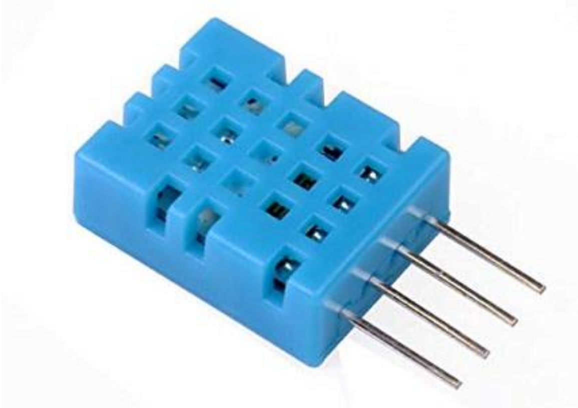


Figure 24: Temperature sensor

There are a lot of different temperature and some of them include semiconductor junction sensors, Infra-red and Thermal sensors, medical type thermometers, and many more. This sensor simply stated takes in the information from the air around it and calculates it to find the proper temperature in either Celsius or Fahrenheit according to what the elderly user would like to see as well as what part of the world they live in.

II.B.2 Motor Control

There are countless ways to control the direction of our roving robot. We for various reasons decided to use differential drive. Nowadays, most indoor mobile robots do not move like cars. There are too many wheels, making it difficult to maneuver around tight places. In the differential drive there are two main wheels, where each wheel is attached to its on motor. A third wheel is then placed in the rear to roll along with the other wheels, preventing the robot from falling over. Below, in Figure 16, you can see a differential drive robot. In our robot we will be using the concepts of wheeled locomotion, which is the most common. In wheeled locomotion we must take into consideration stability, ground contacts, the environment our robot will be in, and how much energy and power it will consume.

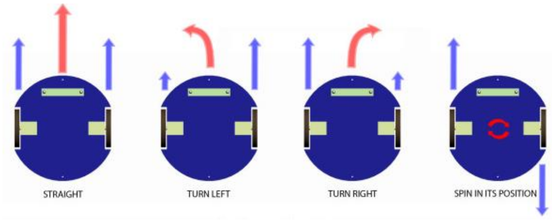


Figure 25: Differential Drive

IX. DEPLOYABLE PROTOTYPE STATUS

At the end of our second semester we were successful with meeting most of our planned feature set that we had said we were going to do for our project. Let’s start first with the things that we have accomplished before we get to the things that we were not as successful with.

The first thing we can see that we accomplished is having it an autonomous robot. We have the robot set up to where it can avoid obstacles in its way as well as navigate its way around tight corners and edges using the ping sensors that we have put on the robot. The next thing is the bracelet that we have. This bracelet is used to detect the elderly persons heart rate and as well as if they have fallen. We have a heart rate monitor on the bracelet and we also attached a gyroscope to figure out if someone has fallen. The way we had it to where it knows if someone has fallen versus just a regular arm motion when exercising and doing various things in the house is by only triggering something when the bracelet senses a “fall” on the gyroscope as well as a spike in the persons heart rate. This then sends a notification to whoever the person may be in order for the elderly person to get help and not cause more damage to themselves. That brings us to another feature set that we successfully made on our project which is calling for help when a hazard is detected. We have a few sensors attached to the robot itself that will sense for fires and gas leaks. With that being said, these can also trigger the gsm module to call for help. We have met most of our project goals except two.

The first thing we were not able to accomplish is having the "smart" path planning using the Kinect. We do have the kinect mapping the room and creating a map but it does not communicate to the motors in order to move autonomous through that. To counter that, we instead used the ping sensors to ensure the reliable obstacle avoidance of the robot. The second feature we were not able to accomplish is having it use voice command. We planned to integrate the google home or even alexa but quickly realized it was out of our reach with the amount of time we are given for our project.

In addition to meeting most of our feature set, we were also able to complete many of these feature ahead of our schedule that was set up by our project timeline. Our project does a good job addressing our societal problem. By monitoring the house and the elderly person themselves, it allows for more independency to the user.

X. Deployable Prototype Marketability Forecast

A. *Market For Our Product*

Our robot has many functions but its main purpose and function is to assist the elderly people in their homes. Many elderly people are faced with the question of whether or not they can still live independently. Many of them as they get older and older start to wonder what their future will be like when their physical bodies don't function the way it once did and with our robot, it can help them stay independent for as long as they can. Our target market for our robot is the elderly people all over the country who long to have the independency that they were once entitled to.

A. Elderly Wanting to Stay Independent

The elderly market is not the same market it used to be a couple decades ago. With improved technology and medical advances, the global life expectancy is continuing to rise than from our recent ancestors. The current worldwide average life expectancy is at 71.5 years old. That includes everyone from third world countries to the countries that lead the world in all these advances. In 2017, 47 million senior citizens live in the U.S, estimating at 14.5% of Americans. In the following graph, it shows that the number of people in the world aged 60 and older is expected to grow past 2 billion by the year 2050.

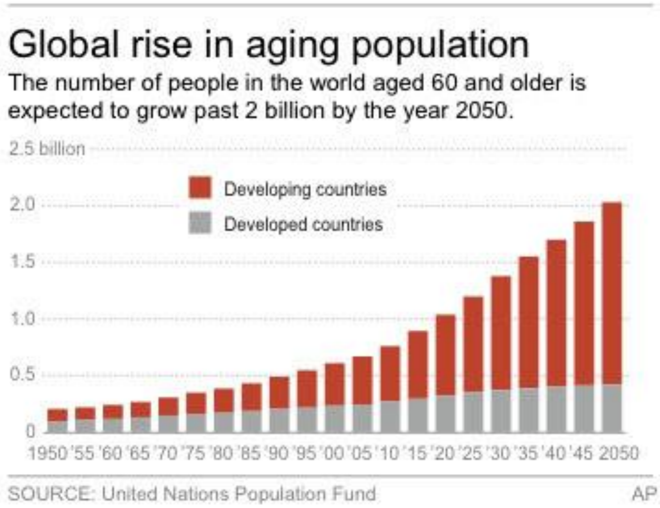


Figure 26: Global rise in Aging Population

With that being said, that just means our market for our robot is on the continual rise due to the fact that more and more people are able to live longer. This brings us to our market of the elderly people that want to stay independent and keep their independency. We'll start by talking about how many elderly people live by themselves which opens this market to needing our robot. 11 million people in the United States alone aged 65 and older live alone which gives us a safe assumption that they are either widowed or divorced. The likelihood of living alone increases with age. Among women age 75+, almost half (47 percent) lived alone in 2010. Older women are twice as likely as older men to live alone. In 2010, 72 percent of older men lived with a spouse, only 47 percent of older women did. With all this being said, there are many elderly people that live alone and a big reason for this is because they want to. There are many different nursing homes that are offered, but like many people, most elderly do not want to be taken care of by someone else.

Our product is marketed for these kinds of elderly people, the ones that want to be able to fend for themselves for as long as possible. The reason for this is our product will be able to provide the elderly and their families the comfort that they will be ok in their homes alone even when no one is checking on them. The way our robot can reassure this is monitoring the possible dangers of the house while also making sure it monitors the elderly user as well. The importance of monitoring the house for dangers but the elderly person is crucial for us and for our market which is the elderly people. The most Common injury among elderly persons age 65 and up are falls. Of the falls that get reported, about 30% result in injuries requiring a hospital visit. With that information, it was apparent that we had to monitor the elderly person also. We want to make sure the elderly people we are selling it to know that without a doubt they can be able to live independently. We keep them safe by monitoring them through a bracelet that detects for falls and also monitors the user's heart rate. This ensure that we keep the elderly users that want to buy this robot safe and if something were to happen the robot would detect it and alert whoever it is that needs to be alerted.

Our robot will continually be sensing and monitoring which will give those elderly people that are scared to fend for themselves the freedom to choose what they would like to do instead of having just one option to choose from.

B. Elderly Wanting Independence Back

Very similar to what was already mentioned, but our next market that we are directing to is the elderly that want their independence back. Many of those that are in senior care homes that want the independence back. Below is a simple analogy of the average monthly payments an elderly person or their family has to pay.

Figure 27: Gaussian Curve

Average Monthly carehome payment

This market that we are trying to reach to are the elderly people that were put into senior healthcare but either don't like it or don't have the means to afford it anymore. With the launch of our robot, it will give elderly people and their families the option of having the elderly person live on their own or even possibly live with them.

For those that believe their elderly family can live by themselves, they can easily have faith that their loved one will be safe because our robot will ensure their safety around the house. Even if a family is not quite sure whether their elderly family can take care of themselves, they can still keep them at their house knowing that their elderly person will be ok. Many times, the elderly is sent to senior homes because the family has work and is busy throughout the day which means they cannot look after the senior citizen that they are responsible for. Now with our robot in the equation, they can have ease of mind knowing that their loved one is safe and they can monitor their safety. With any sort of incident they can be contacted and have that peace of mind instead of worrying if their loved one has fallen or if they have been hurt or there is something wrong in the house that they are not aware of.

Our robot is directed also at the people who "lost" their independency but now realize they can have it back. Our market is made not only for elderly that are already living independent lives but also those elderly that are eager to have that independence they once had.

C. Other Possible Markets

Although our market is specific to the elderly people and senior citizens, we know our robot has many other markets that it can be used for. We shoot for the elderly people but that doesn't mean our market is limited to just elderly people. That would mean we limit our robot and our expectations, and as a group, we know that our project that we put so much work in can be used in many aspects. For example these care homes can use our robot. Sometimes it is expensive for senior care homes to keep someone watching each patient all the time and with our robot, it can alleviate some of that and instead have our robot monitor the elderly people instead.

Aside from just using our robot for just elderly uses, it can also be used for children. When parents are busy taking care of other things at home, they can have peace of mind knowing their

kid will be safe from harmful elements as well as knowing that if their kid falls or has irregular heart rate, they are quickly alerted through our robot.
Our robot in general has many markets but our main market that we targeted is those elderly people wanting to be able to live their life independently again without the need for senior care homes.

B. *Competitors*

The population of older adults is growing significantly all over the world and in most particularly in developed countries, where the conditions of living are much comfortable than third world countries. With the rise in the elderly community, there has been a noticeable number of demands for special services such as health care-systems and assistive medical robots and devices. Nowadays, there are many different types of robots who play a very big role in the medical industry to help facilitate human life among the elderly community. These assistive robots are created in many different designs to meet the specific needs of that specific elderly individual. The following below will bring insight on the various elderly assisting robots currently in the market or may potentially hit the market.

C. *Mobile Manipulator Robots*

These types of robots are robots that have mounted arm on the mobile platform. More degrees of freedom of the mobile platform also provide the user with more choices.

An example of this is the RIBA is a two armed care support robot that can lift people from a prone position on the floor to a wheelchair which is one of the most physically demanding tasks in nursing homes. The RIBA robot is co-developed by Tokai Rubber Industries. RIBA stands for Robot for Interactive Body Assistance. The RIBA can be seen below:

Figure 28: RIBA robot assisting patient [34]

D. *Assistive Walking Devices*

Devices that help the elderly with their disability, which help maintain better balance, stability, and walking support. These types of robots also help in the manoeuvrability, walking, standing, sitting, and independency. These devices help prevent falls.

E. *Animal-Like Robots*

Nowadays, many medical professionals believe animals have animals carry infectious diseases or patients are allergic to them. Therefore, their solution for this problem is to make animal robots with the purpose of communicating with and entertaining older adults, and relieving distressing there patients with these animal robots.

An Example of this type of robot is the AIBO, made by sony. The main purpose is to serve as a companion The AIBO features a rounded form the exudes an unmistakable vitality even showing physical signs of body-temperature changes. That is the depth at the heart of the AIBO experience. AIBO gives facial expressions, and different levels of speaking volumes. He also performs tricks and gestures. Studies have shown the positive impact bots can have on seniors picture of the AIBO can be seen below.

Figure 29: AIBO robotic pet priced at $3000 [25]

F. Home Health-Care robots

These robots primary task is associated with home health care. This type of robot assists medical specialists or care takers to monitor elderly at their house. The main purpose of this robot is to improve the well-being of the elderly and to alleviate long-term hospitalization in medical centres and nursing homes.

G. Humanoid Robots

This type of robot identifies older adult's needs and provides services for both elderlies and their caregivers. Main feature of this robot are to provide medication reminder, to detect issues and take action to inform caregiver, manage plans, and assist elderly to take off.

H. Smart Home robots

These are robots that are used in homes, that track and sense change in air quality, like dangerous gases or allergens, and monitor noise level. These robots patrol the house and notify the home owner instantly when he senses something strange, lik e a fire, gas leak, or even and intruder. An example of this rebot is the CARL robot, designed by DESIGN 3.

Figure 30: CARL house monitoring robot [6]

Another example of a house robot is the Vector robot, made my Anki. This robot is also a house robot, it can tell you the weather, as a built in timer, can take a photo on command, and play blackjack. The robot also features edges detection and obstacle avoidance. The company in the future wants make it into a security camera add a calendar, music recognition, notifications, read news, and other features. A picture of the Vector can be seen below:

Figure 31: Vector robot [21]

Our robot the JAGH bot fits in this category, our robot performs the same functions as the CARL robot and also 3d maps the environment and is also obstacle avoiding. A picture of the JAGH BOT can be seen below:

Figure 32: JAGH BOT

I. *Smart Wearable Tech*

A smart wearable tech device that is a wearable computer in the form of a wristwatch; modern smartwatches provide a local touchscreen interface for daily use, while an associated smartphone app provides for management and telemetry.

An example of this is the apple watch, which features a ecg and electrocardiogram, tracks steps, heart rate, gyro, speakers, and many more. The apple watch can be seen below:

Figure 33: Apple Watch [38]

Another example of wearable tech is the life alert. Is a device wear you press a button to inform the authorities of a medical emergency, shower emergency, and home intrusion. Life alert device can be seen below:

Figure 34: Life Alert [39]

XI. Conclusion

In Conclusion, elderly people create a large and very important social problem not only in America but all over the world. Elderly population is on the rise, but the resources and help allotted to them seems to not meet the needs and requirements they need

Our project tackles this exact societal problem. Our JAGH bot gives more independency to the elderly people while giving the peace of mind to themselves and family members that their loved one is safe and sound. That if something were to happen to their loved ones, they would get a notification quickly as well as knowing that they will get the proper help they need.

The JAGH bot allows a few more critical years an elderly person has to be able to live in their own choice of house knowing that everything will be well. Our robot is catered to the growing elderly population this world has but definitely is not limited. It is a robot that can have many uses.

References

[1] "Apereo Central Authentication Service (CAS)," SacLink Login, 19-Jun-2018. [Online]. Available: https://link-springer-com.proxy.lib.csus.edu/article/10.1007/s11205-018-1945-9. [Accessed: 22-Sep-2018].

[2] A. Daraghmi, "Smart Water Leakage Detection Using Wireless Sensor Networks (SWLD)," American Journal of Medicine and Medical Sciences.[Online].Available:http://article.sapub.org/10.5923.j.ijnc.20170701.01.html#Sec5.3. [Accessed: 28-Sep-2018]..

[3] A. Fiske, J. L. Wetherell, and M. Gatz, "Depression in Older Adults," Current neurology and neuroscience reports., 2009. [Online]. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2852580/. [Accessed: 22-Sep-2018].

[4] About ROS | About ROS (n.d). Retrieved from http://www.ros.org/about-ros/

[5] Administration on Aging. (2017). Aging America. [online] Age Safe America..

[6] aibo. (2019). aibo. [online] Available at: https://us.aibo.com/feature/feature1.html [Accessed 25 Feb. 2019].

[7] Anki US. (2019). Vector Aware. [online] Available at: https://www.anki.com/en-us/vector/vector-aware [Accessed 25 Feb. 2019].

[8] Anon, (2018). [online] Available at: https://www.robotshop.com/en/solarbotics-regular-motor-2.html [Accessed 1 Oct. 2018].

[9] Anon, (2018). [online] Available at: https://www.robotshop.com/en/motomama-h-bridge-motor-driver-shield.html [Accessed 1 Oct. 2018].

[10] Apple. (2019). Apple Watch Series 4. [online] Available at: https://www.apple.com/apple-watch-series-4/?afid=p238%7Cs0FYFsN2K-dc_mtid_20925qtb42335_pcrid_295216235241&cid=wwa-us-kwgo-watch-slid---apple+watch+series+4-e [Accessed 25 Feb. 2019].

[11] B. Freedman, A. Shpunt, M. Machline, and Y. Arieli, "Depth mapping using projected patterns," Patent US 2010/0 118 123 A1, 05 13, 2010. [Online]. Available: http://www.freepatentsonline.com/20100118123.pdf

[12] Belkhouf, F. (2018). EEE 187: Robotics "Summary 2: Wheeled Locomotion". [online] Athena.ecs.csus.edu. Available at: http://athena.ecs.csus.edu/~belkhouf/Lect2E187.pdf [Accessed 1 Oct. 2018].

[13] Bergen, G., Stevens, M. R., & Burns, E. R. (2016). Falls and Fall Injuries Among Adults Aged ≥65 Years — United States, 2014. MMWR. Morbidity and Mortality Weekly Report, 65(37), 993-998. doi:10.15585/mmwr.mm6537a2

[14] C. Fernández-Carro, J. A. Módenes, and J. Spijker, "Living conditions as predictor of elderly residential satisfaction," Current neurology and neuroscience reports., Sep-2015. [Online]. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5549235/. [Accessed: 22-Sep-2018].

[15] C.-L. Dai, Y.-C. Chen, C.-C. Wu, and C.-F. Kuo, "Cobalt Oxide Nanosheet and CNT Micro Carbon Monoxide Sensor Integrated with Readout Circuit on Chip," Current neurology and neuroscience reports., 03-Mar-2010.[Online].Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3264449/. [Accessed: 28-Sep-2018].

[16] Centers for Disease Control and Prevention and National Association of Chronic Disease Directors. The State of Mental Health and Aging in America Issue Brief 1: What Do the Data Tell Us? Atlanta, GA: National Association of Chronic Disease Directors; 2008

[17] Design3.de. (2019). Design3 | CARL. [online] Available at: https://design3.de/work/living/carl [Accessed 25 Feb. 2019].

[18] E. Nakane, N. Tanaka, Y. Kimura, T. Sekihara, H. Hayashi, M. Okano, K. Su, M. Kimura, M. Funasako, T. Kato, S. Miyamoto, T. Izumi, T. Haruna, and M. Inoko, "LIVING ALONE OR LIVING ONLY WITH AN ELDERLY SPOUSE IS AN INDEPENDENT PREDICTOR OF HOSPITAL READMISSION IN ELDERLY PATIENTS WITH DECOMPENSATED HEART FAILURE," JACC: Journal of the American College of Cardiology, 13-Mar-2018. [Online]. Available: http://www.onlinejacc.org/content/65/10_Supplement/A1033. [Accessed: 22-Sep-2018].

[19] G. C. M. Meijer, "Temperature sensors and voltage references implemented in CMOS technology - IEEE Journals & Magazine," An introduction to biometric recognition - IEEE Journals & Magazine, Oct-2001. [Online]. Available: https://ieeexplore.ieee.org/document/954835. [Accessed: 28-Sep-2018].FLEXChip Signal Processor (MC68175/D), Motorola, 1996.

[20] Ghani, M. F., & Sahari, K. S. (2017). Detecting negative obstacle using Kinect sensor. International Journal of Advanced Robotic Systems, 14(3), 172988141771097. doi:10.1177/1729881417710972

[21] H.H. Glascock, H.F. Webster. "A flame sensor for high-temperature ambients - IEEE Journals & Magazine," An introduction to biometric recognition - IEEE Journals & Magazine. [Online]. Available: https://ieeexplore.ieee.org/document/1476516. [Accessed: 28-Sep-2018]..

[22] Helpguide.org. (2018). Depression in Older Adults: Recognizing the Signs of Elderly Depression and Getting Treatment. [online] Available at: https://www.helpguide.org/articles/depression/depression-in-older-adults.htm [Accessed 24 Sep. 2018].

[23] Hertado, J. (2018). Long-Term Care in America: Who Should Bear the Responsibilities & Costs of Care - Roper Center. [online] Roper Center. Available at: https://ropercenter.cornell.edu/long-term-care-america/ [Accessed 24 Sep. 2018].

[24] https://www.census.gov/library/visualizations/2017/comm/cb17-ff08_older_americans.html

[25] Kharicha K, Iliffe S, Harari D, Swift C, Gillmann G, Stuck AE. Health risk appraisal in older people 1: are older people living alone an "at-risk" group? The British Journal of General Practice. 2007;57(537):271-276.

[26] Koval, L., Vaňuš, J. and Bilík, P. (2018). Distance Measuring by Ultrasonic Sensor. [online] Science Direct. Available at: https://www.sciencedirect.com/science/article/pii/S2405896316326623 [Accessed 28 Sep. 2018].

[27] LaValle, S. (2006). 13.1.2.2 A differential drive. [online] Planning.cs.uiuc.edu. Available at: http://planning.cs.uiuc.edu/node659.html [Accessed 1 Oct. 2018].

[28] Lee, W., Cheng, Y., Liu, J., Yang, K., & Jeng, S. (2011). Living alone as a red flag sign of falls among older people in rural Taiwan. Journal of Clinical Gerontology and Geriatrics, 2(3), 76-79. doi:10.1016/j.jcgg.2011.06.006

[29] Lifealert.com. (2019). Medical Protection for Life Alert ®members. [online] Available at: http://www.lifealert.com/medical_50.aspx [Accessed 25 Feb. 2019].

[30] Lin, "Microphone arrays and speaker identification - IEEE Journals & Magazine," An introduction to biometric recognition - IEEE Journals & Magazine,Oct-1994.[Online].Available: https://ieeexplore.ieee.org/document/326620. [Accessed: 28-Sep-2018].

[31] Longtermcare.acl.gov. (2018). Costs of Care - Long-Term Care Information. [online] Available at:

https://longtermcare.acl.gov/costs-how-to-pay/costs-of-care.html [Accessed 24 Sep. 2018].

[32] M. Lvov and V. Kruglyk, "TEACHING ALGORITHMIZATION AND PROGRAMMING USING PYTHON LANGUAGE," Informing Science The International Journal of an Emerging Transdiscipline, 01-Jul-2014.[Online].Available: https://doaj.org/article/89cfb9b9f9104bfcad0c84abe2ba2b1e. [Accessed: 28-Sep-2018].

[33] Microsoft Developer Network, "Kinect SDK," 09 2012. [Online]. Available: http://msdn.microsoft.com

[34] Newman and Sandra, "Living Conditions of Elderly Americans | The Gerontologist | Oxford Academic," OUP Academic, 01-Feb-2003. [Online]. Available: https://academic.oup.com/gerontologist/article/43/1/99/618879. [Accessed: 22-Sep-2018].

[35] Newman and Sandra, "Living Conditions of Elderly Americans | The Gerontologist | Oxford Academic," OUP Academic, 01-Feb-2003. [Online]. Available: https://academic.oup.com/gerontologist/article/43/1/99/618879. [Accessed: 22-Sep-2018].

[36] P. Martin-Ramos, "First exposure to Arduino through peer-coaching: Impact on students' attitudes towards programming,'" Science Direct, Nov-2017. [Online]. Available: https://www-sciencedirect-com.proxy.lib.csus.edu/science/article/pii/S074756321730691X. [Accessed: 28-Sep-2018]..

[37] Pierro Zapi, "Tracking Motion Direction and Distance With Pyroelectric IR Sensors," IEEE, Sep-2010. [Online]. Available: https://ieeexplore-ieee-org.proxy.lib.csus.edu/document/5503973. [Accessed: 28-Sep-2018]. (2002) The IEEE website. [Online]. Available: http://www.ieee.org/

[38] raquo;, t. (2018). Complete Motor Guide for Robotics. [online] Instructables.com. Available at: https://www.instructables.com/id/Complete-Motor-Guide-for-Robotics/ [Accessed 1 Oct. 2018].

[39] Rice, T. and Gabel, J. (2010). Protecting the Elderly Against High Health Care Costs. [online] Healthaffairs.org. Available at: https://www.healthaffairs.org/doi/full/10.1377/hlthaff.5.3.5 [Accessed 24 Sep. 2018].

[40] Rice, T. and Gabel, J. (2010). Protecting the Elderly Against High Health Care Costs. [online] Healthaffairs.org. Available at: https://www.healthaffairs.org/doi/full/10.1377/hlthaff.5.3.5 [Accessed 24 Sep. 2018].

[41] Rtc.nagoya.riken.jp. (2019). RIBA Official Page RIKEN-TRI Collaboration Center for Human-Interactive Robot Research (RTC). [online] Available at: http://rtc.nagoya.riken.jp/RIBA/index-e.html [Accessed 25 Feb. 2019].

[42] Societyofrobots.com. (2018). How to Build a Robot Tutorials - Society of Robots. [online] Available at: http://www.societyofrobots.com/sensors_encoder.shtml [Accessed 1 Oct. 2018].

[43] Stevenson, S. and Profile, S. (2018). 10 Symptoms of Mental Illness in the Elderly. [online] Aplaceformom.com. Available at: https://www.aplaceformom.com/blog/2013-10-7-mental-illness-in-the-elderly/ [Accessed 24 Sep. 2018].

[44] Tinker Board | Tinker Board. (n.d.). Retrieved from https://www.asus.com/us/Single-Board-Computer/Tinker-Board/overview/

Uslu, E., Çakmak, F., Altuntaş, N., Marangoz, S., Amasyalı, M. F., & Yavuz, S. (2017). An architecture for multi-robot localization and mapping in the Gazebo/Robot Operating System simulation environment. Simulation, 93(9), 771-780. doi:10.1177/0037549717710098

Glossary

A. adult (noun) - a grown up; someone 18 years of age or older

B. adult (adjective) - something related to people 18 years of age or older; something intended for people 18 years of age or older

C. anxiety (noun) - nervousness; a concern that something bad is going to happen

D. care (noun) - the act of watching over someone; the act of providing food, shelter, and other things

E. care (noun) - a worry; a concern

F. care (verb) - to watcher over; to provide food, shelter, and other things that are needed

G. care (verb) - to have feelings about

H. cost (noun) - value placed on or given to something

I. cost (verb) - cause a loss (cost me my job)

J. death (noun) - the end of life; when one dies

K. death (noun) - the end of something

L. depression (noun) - sadness; a period of dark mood

M. depression (noun) - a mental sickness that causes sadness, hopelessness, inability to do anything, and sometimes more serious effects

N. depression (noun) - a low area

O. depression (noun) - an economic period with high unemployment

P. health (noun) - the overall condition of something

Q. health (noun) - the condition of a living thing; a balance of internal and external forces that lead to optimal functioning

R. health (noun) - the study of how to care for the human body and mind

S. living (adjective) - having life; being a plant, animal, or other organism that has one or more cell, needs energy, grows and reproduces, and responds to the environment

T. living (adjective) - constantly changing; dynamic and evolving

U. memory (noun) - an image of something past kept in the mind

V. memory (noun) - the part of the brain that stores facts from the past

W. population (noun) - entire number of people in a country, city, etc.

APPENDIX A. USER MANUAL

JAGH BOT

User's Manual

Please read this manual before using the product.
Please keep this manual in your sight.

Please check if the machine works properly several times before you use the JAGH bot.
Please check the status of the machine when you use it for the first time.
Please stop operating the machine if you see any scratches or damages on your floor. We are not responsible for the problems if you did not check the circumstances listed above.

Please check if there is any problem especially when you use the machine on wooden floors.

* This is a user manual. Some images in this manual can be slightly different with actual product.

Thank your purchase of the JAGH BOT.

JAGH bot robot is made by Team #3; Jagpreet Singh, Andrew Stitch, Gethro Cabading, and Hasan Javed, students at Sacramento State University, California. The JAGH bot has a remarkable alert system that checks for hazards and navigates in an individual's home.

1. JAGH BOT is designed to monitor a person's home and assist the elderly.
2. With front distance sensors and the Kinect sensor camera, JAGH BOT navigates smoothly in a person's home.
3. The JAGH Bot has a rechargeable nickel metal hydride battery, the battery life is long and very efficient.

Table of Contents

Before Using

Safety Information

Before using the JAGH Bot, read all safety precautions and keep these in mind to reduce the risk of accident or damage.

JAGH bot is for indoor use only. Do not use outdoors or on wet surfaces. It may cause a failure.

Before using, put away any obstacles which interrupt JAGH bots movements on the floor. Obstacles could be clothes, papers, power cords, etc.

Product is designed for monitoring the house of hazards.

Children and pets should be supervised to ensure that they do not sit or stand on JAGH bot.

During operation of the JAGH bot, close any doors to prevent it from exiting the room.

Do not use on a table, furniture or other products, JAGH bot can be damaged by falling down.

Do not use on the outdoor surface such as concrete or asphalt. It can cause failure.

Use only the charger and battery supplied by the manufacturer. Do not charge the JAGH bot around electronic products which generates heat such as refrigerator.

Do not disassemble or repair JAGH bot except by authorized techs. Disassembling or repairing by unauthorized person will void the warranty.

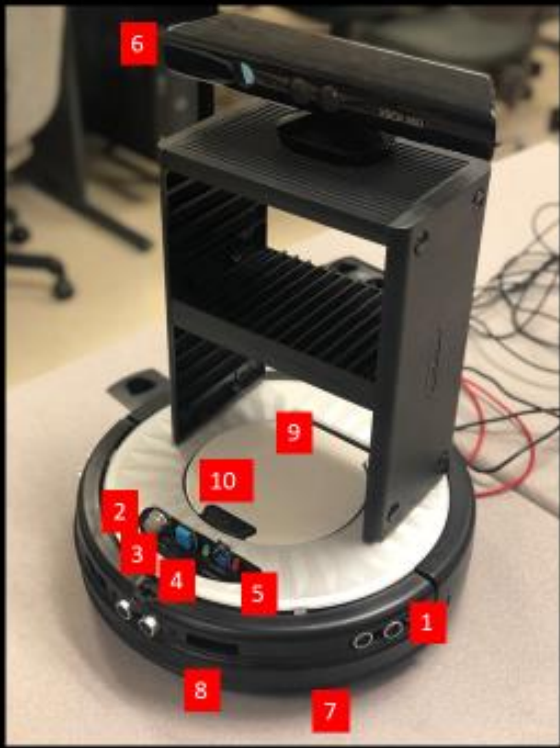
Know-How for Using

1. If machine is not used for more than 1-2 months, battery capacity could be down. Please separate the battery from the product when you don't use the machine for a long period of time.
2. Due to the chemical properties of NI-MH, changes in recharging that battery may occur, and will be reduced. Please use the machine after full recharge and use until the battery is completely discharged.
3. We are currently providing no warranty for this product.
4. Please contact 1-800-xxx-xxx or send item to xxx,xxxx,xxxxx,xxxx.
    - Store the packing box in case you need to send the product for the repair.

Components

Components:

- Name of Parts
    1. PING Sensor
    2. Smoke Sensor
    3. Temperature/Humidy Sensor
    4. Flame Sensor
    5. LEDs
    6. XBOX Kinect Sensor
    7. Bumper
    8. Rubber Bumper
    9. Microcontroller Cover
    10. Microcontroller Cover Button



Components:

- Name of Parts (Cont)
    11. Front Wheel
    12. Rear Wheel
    13. Battery Cover

Preparing

Battery Installation

1. Place JAGH bot upside down on a flat, padded surface such as on a towel or blanket. Press and slide the battery cover.
2. Insert the battery, make sure the battery is installed properly.
3. Place the rechargeable battery in the battery counsel, and close the battery cover after arranging it properly.
4. JAGH bot dismount, is in reverse order.
5. No need to remove battery once installed. Simply plug the battery outlet to the adapter.
   - Never touch an electrical socket with wet hands.
   - If you will not use the machine for a long time, remove the battery from the machine and keep in a cool and dry place.

Recharge using Adapter

1. Recharge battery when the JAGH is low or has a dead battery.
2. Stop operating before charging.
3. After inserting adapters terminal into the charging point, plug the cord in the socket.
4. Charging will begin

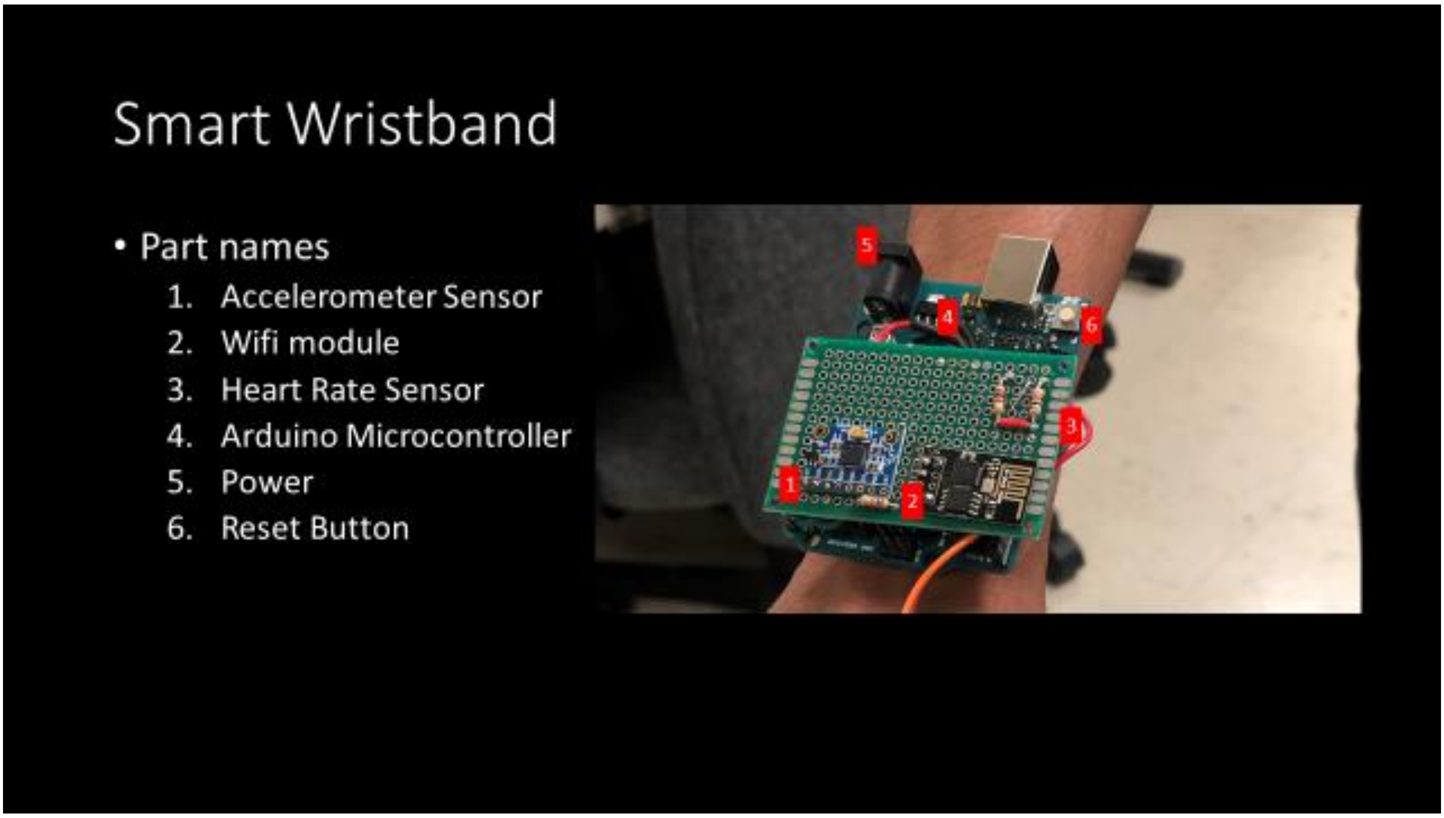
Operation

Operating JAGH BOT

1. Once the battery is in the JAGH, JAGH will be turned on.
2. The JAGH has two modes, which are controlled by a toggle switch, as seen in the above image.
3. In the first mode, known as Stand By Mode, the JAGH bot is stationary, and is monitoring the room/environment while it is not moving.
4. Toggle the switch in the other direction and the JAGH bot will start traversing through the environment while checking for hazards.

Smart Wristband

Parts Name



About

- This wristband module detects for falls and checks the individual's heart rate.
- When fall is detected and message is sent to the JAGH bot through wifi, which then sends an alert text message to the care taker of the individual.

Important Information

1. Do not immerse the wristband and charger under water.
2. Do not use with damaged charging adapter.
3. The adapter cannot be repaired nor can the wristband, Damaged items should be discarded.
4. The Smart wrist band is intended for the use of tracking falls and heart rate of an individual.
5. Please make sure children do not play with the Smart wristband, as this may lead to false data.
6. Do not rinse or clean the body of the Smart Wristband with water, only dust it off with tissue or duster.
7. Use only charger and batteries supplied by the manufacturer.
8. During charging heat may be generated, this does not mean the device is defected or broken.
9. After using please turn off the wristband, this may lead to drainage of the battery.
10. Turn the power off during charging.

Recharging Battery

1. Locate the power charging port on the wristband.
2. Remove the 4 AAA nickel metal hydride batteries from the casing.
3. Place the batteries in the charging adapter provide.
4. Once the green light goes off on the charger, the batteries are now fully charged.
5. Place the recharged batteries back in the battering casing.

Operating

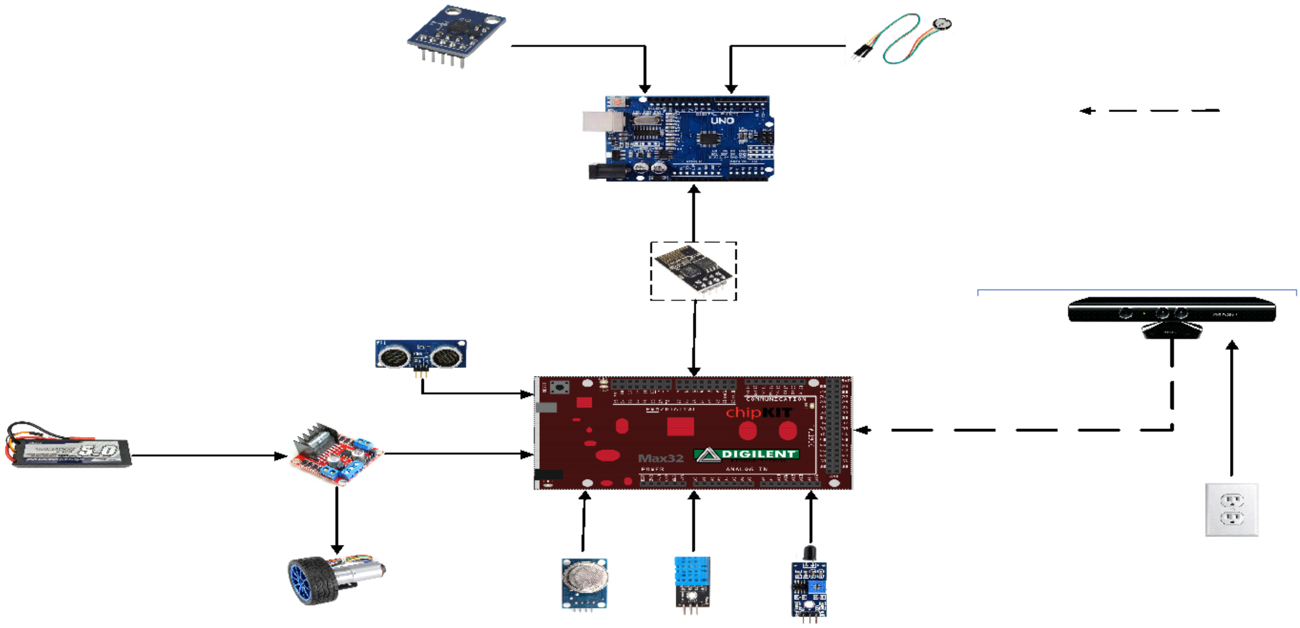
1. Turn the power on by flipping the power switch on the microcontroller.
2. Turn the power off by flipping the same switch.
3. When resetting the wristband, press down on the white button on the Arduino microcontroller.

Specifications

Product Name	JAGH BOT
Model	JAGH 1
Size	14 inches (Diameter) 17.5 inches(Height)
Weight	6.5 pounds (include Battery)
Rechargeable Battery	16V 4500 milli Amps
Charging Time	About 2 Hours
Max Operational Time	About 3 Hours
House Monitor Time Mode	Sensor Mode, Sensor Navigate Mode

End of User Manual

APPENDIX B. HARDWARE

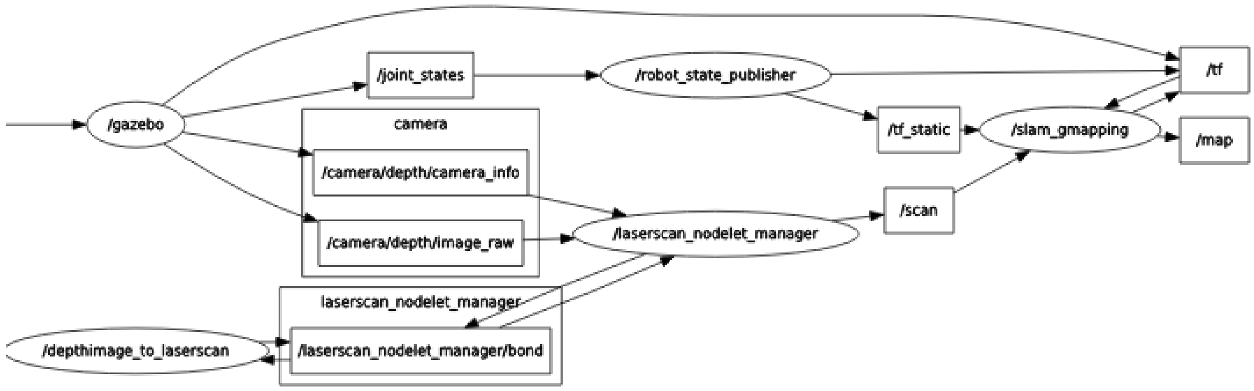


APPENDIX C. SOFTWARE

Robot Operating System

Our project uses Robot Operating System (ROS) to control the mapping capabilities we have implemented in our design. ROS is an open source framework that makes it much easier to write software to control complex robotic applications. At the most basic level, ROS uses a message passing system to relay information from sensor "nodes" to other "nodes" that manipulate this information to create useful data to control the robot's movements. An example of this message passing between nodes is shown in figure 1.

Figure 1: an example of message passing between nodes.



[1]

We have used this system of message passing to interface with a Microsoft Xbox 360 Kinect. We are using the Kinects ability to create a 3D map of an environment to create a map for the robot to navigate through. Using ROS we are able to take a 3D depth-map with a 360x240 depth resolution and convert it to a 2D laser scan, similar to the output of a LIDAR device but at a fraction of the cost. With this 2D laser scan data we are able to cerate a 2D grid map of the environment that creates a map that marks all the objects that the robot could potentially collide with when in operation. Figure 2 shows an example of a 2D grid map generated by the Kinect.

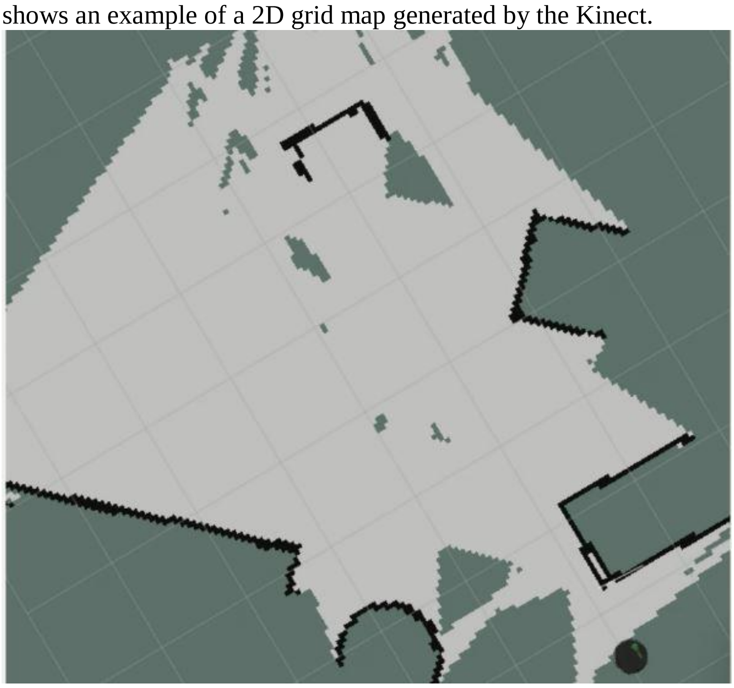


Figure 2: a 2D grid map. The black spaces represent obstacles, the grey represents safe space for navigation.

While its creating this map our robot relies on three PING sensors to navigate the unknown environment to avoid objects while the Kinect takes in all the depth image data. If an object gets within 30cm of a sensor, a signal will be sent to tell the motors to navigate away from the object. If the left sensor is activated, the robot will turn right and vice versa. If an object is directly in from of the robot the system will read data from the left and right sensor and move in the direction of the sensor that read the farthest distance.

Future Work

Our original design idea included taking the 2D grid map generated by the robot and using it to intelligently navigate through its environment and move to set navigation goals. While we were able to create a system that did just that, we were only able to implement it in simulation, not in the real world. Figure 3 shows an AMCL (Adaptive Monte Carlo Localization) demonstration of the robot guessing where it is in the environment and then creating a path to a navigation goal that I entered.

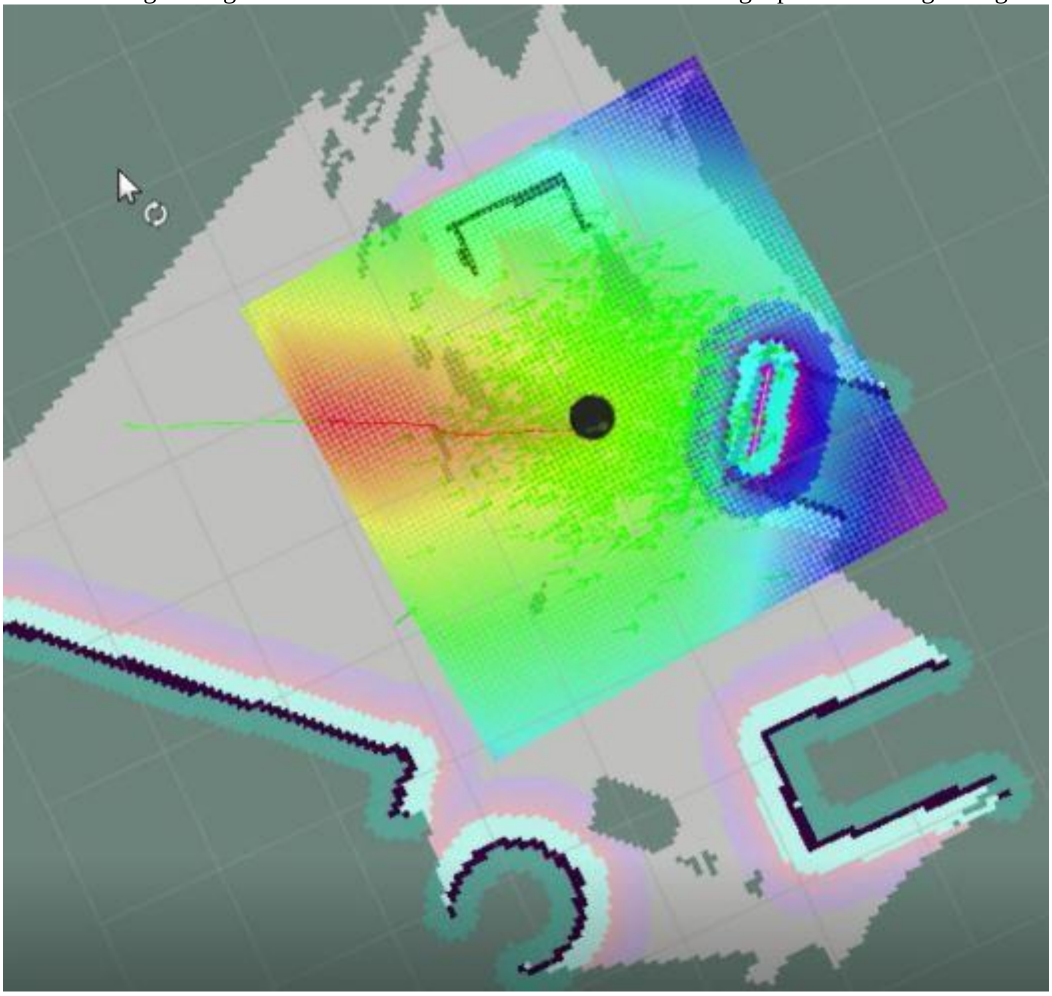


Figure 3: an AMCL demonstration. The green arrows are guesses of the robot’s location. The red and green line is the path the robot has planned out to navigate to the end goal.

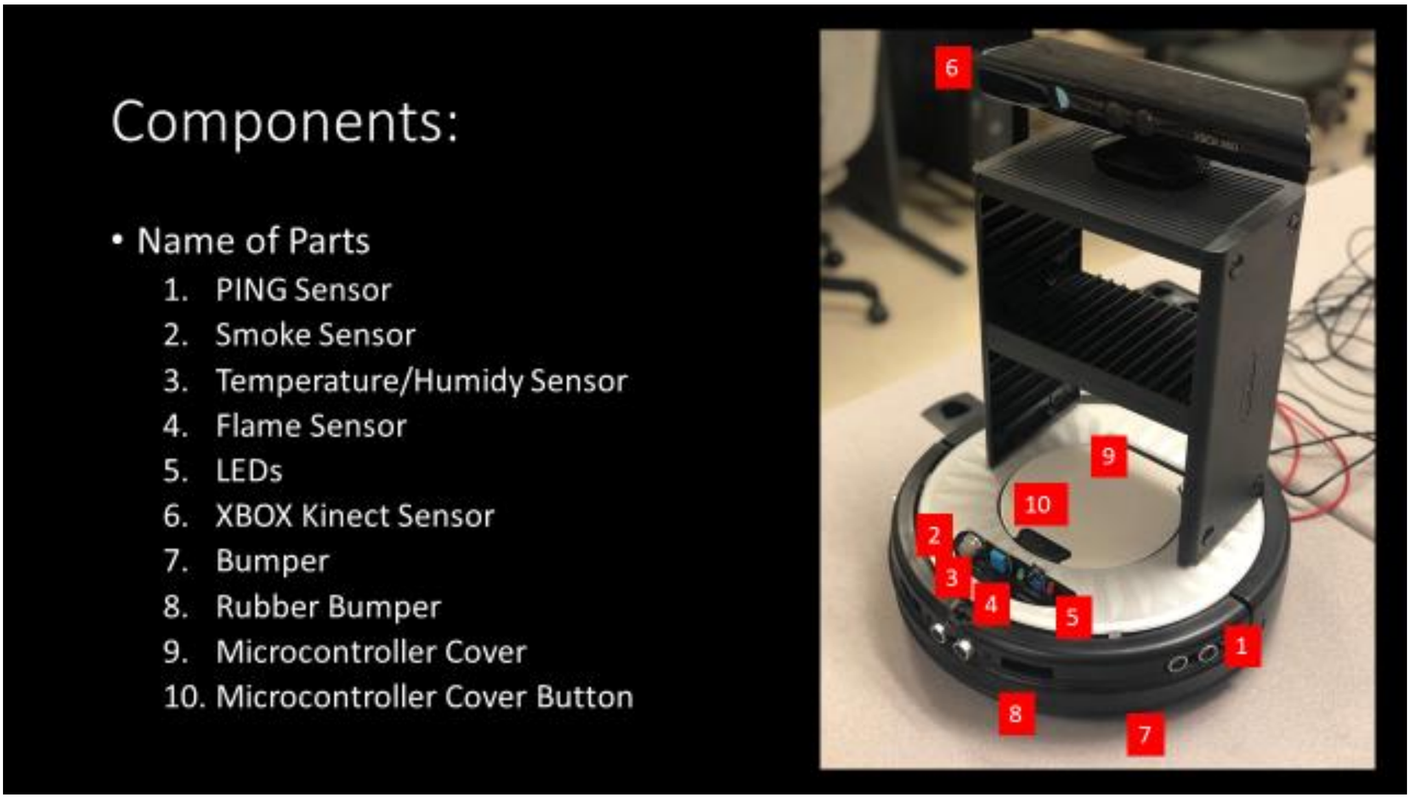
While this worked in simulation, we were unable to implement it into our final design as we were unable to have ROS send the signals to the motors to tell them how fast to turn to follow the planned path. Our setup had our microcontroller connected to the laptop running ROS over a USB connection but we couldn’t figure out how to receive the messages on the microcontroller in the time allotted to us. Therefore we were unable to send these very important velocity command signals.

APPENDIX D. MECHANICAL

A. Dimensions of our Robot

Product Name	JAGH BOT
Model	JAGH 1
Size	14 inches (Diameter) 17.5 inches(Height)
Weight	6.5 pounds (include Battery)
Rechargeable Battery	16V 4500 milli Amps
Charging Time	About 2 Hours
Max Operational Time	About 3 Hours
House Monitor Time Mode	Sensor Mode, Sensor Navigate Mode

Components of our Project and the overall design of our project.



APPENDIX E. VENDOR CONTACT

No Vendor Contact. We did not have a vendor associated with our project

APPENDIX F. RESUMES

Jagpreet Singh

OBJECTIVE: An entry level/internship position in Electrical/Electronics Engineering

EDUCATION:

In progress: **BS, Electrical Engineering •** CSU Sacramento, **3.35/4.0** • Dean's List • Expected: May 2019

Related Courses:

Applied Electromagnetics
CMOS And VLSI *
Electronics I
Electronics II *
Electromechanical Conversion
Engineering Graphics
Intro to Circuit Analysis
Intro to Feedback Systems
Intro to Logic Design
Intro to Microprocessors
Modern Communication System
Network Analysis
Product Design I *
Probability & Random Signal
Robotics *
Signals & Systems

*Fall 2019 (in progress)

KNOWLEDGE AND SKILLS:

Programming: C, Verilog, MATLAB, Python

Software Applications: MS Office, Arduino, Visual Studio, PSPICE, NI Multisim, ADS, AutoCAD, Solidworks

Hardware Applications: Raspberry Pi, Arduino, Deo Nano, Parallax Propeller board, FPGA, Network Analyzer

Communication/Organization:

Bilingual: Fluent in English, Punjabi, and Hindi
Excellent writing skills, able to create effective lab reports and documentation
Experience in leading groups; effective team member and individual worker
Led 10-person study group review sessions. (Folsom Lake College)

PROJECTS:

Motion Detecting Alarm System:

Collaborated in a team of four to develop an alarm that detected motion and alerted user when detected. Used RF motion sensors, Raspberry Pi, Parallax Propeller board, and camera to accurately notify when someone is detected.

Autonomous Robot (Senior Design)

Senior team project, in which we built an autonomous differential drive robot that assists the elderly around their house. Robot is controlled by Max32 microcontroller, implemented Wi-Fi communication which sent data to wrist module that checked for heart rate and detected falls, robot also mapped environment using Kinect sensor.

WORK EXPERIENCE:

Student Engineering Intern — **Department of Water Resources, Sacramento, CA**

Assist Technical Documentation Standards Section's engineers in creating and maintaining databases for organizing State Water Project drawings and technical documents. Assist engineers in the review of plant mechanical and electrical drawings, designs, plans, and specifications for technical accuracy. Catalog documents pertinent to operations, maintenance, and engineering of the State Water Project. Perform data collection and data entry in addition to record keeping, analysis, and status reporting for the section projects.

Mathematics Tutor — **Folsom Lake College, Folsom, CA**

Assisted students in targeted subject areas via individual or group tutoring. Hosted workshops on selected topics including; Algebra, Geometry, Trigonometry, Pre-Calculus, Calculus series, and Differential Equations. Modeled and encouraged collaborative studying strategies. Created and managed resources. Contributed to a friendly and productive learning environment.

ACTIVITIES:

- Institute of Electrical and Electronics Engineers (IEEE), active member, Secretary of Sacramento State University chapter.

Andrew Stich

Objective: To obtain an internship or entry-level position in the computer engineering field.

Education

A.S. Applied Science, Spokane Falls Community College ▪ 3.1 GPA, June 2016
- ▪ Graduated as part of the American Honors program

B.S. Computer Engineering, CSU, Sacramento ▪ 3.3 GPA, In progress, May 2019
- ▪ Captain of the NCAA division 1 track and field team

Related Coursework

Computer Interfacing	CMOS and VLSI	PCB Design
Adv. Logic and Design	Computer Hardware Design	Operating System Pragmatics
Adv. Computer Organization	Operating System Principles	

Knowledge and Skills

- **Programming experience** - C ▪ C++ ▪ Java ▪ Verilog ▪ VHDL ▪ Python ▪ PowerShell ▪ SQL ▪ PyTorch ▪ TensorFlow ▪ Git
- **Design/simulation experience** - Xilinx ▪ FPGA ▪ Cadence Virtuoso ▪ Altium Design ▪ Robot Operating System
- Development Experience – Linux/Unix, Windows, Android

Communication, Project Management, and Organization

- Excellent verbal and written communication skills
- I've been told by my non-technical peers I am able to convey complex concepts in laymen terms
- A curiosity and passion for learning new technologies
- ▪ Public speaking

Work Experience

Computer Engineering Tutor, Sacramento State University **Feb 2019 – Present**

- ▪ Assisted and mentored students who came in for help regarding a certain class or assignment they were struggling with.
- ▪ I helped with classes ranging from introductory CS courses to Adv. Computer Architecture and CMOS and VLSI.
- ▪ I maintained a positive attitude and personal skills to be sure the student felt comfortable coming in for help.

Advanced Coursework and Projects

House Monitoring Robot for the Elderly (Senior Project)

- ▪ Group of 4 developing and designing an autonomous robot that monitors the house for hazards and detects if the user has fallen.
- ▪ I am in charge of the robot's movement throughout the environment and obstacle avoidance.
- ▪ I am using an Xbox 360 Kinect to create a 2D map of the environment and then use that map to navigate to set positions while avoiding obstacles. I am using Adaptive Monte Carlo Localization to predict the robot's location and plan paths.
- ▪ I have Robot Operating System running on a Linux-based laptop to interface with the Kinect to generate the map and create the path.

ASIC/VLSI Arithmetic Logic Unit in Cadence Virtuoso and SPICE

- ▪ Group project to design a 4-bit ALU that subtracted, added, and multiplied using ASIC and VLSI design techniques.
- ▪ I was the team leader throughout the project and made sure we delivered a working design with documentation.
- ▪ I designed simple logic gates, then implemented them into larger, more complex logic units using hierarchical design.
- ▪ My partner and I worked together to design the final top module.
- ▪ I designed test circuits for each individual component and tested them with SPICE simulations to test functionality

5-stage Pipelined Datapath in Synthesizable Verilog

- ▪ Group project to design a 5-stage pipelined data-path to execute a given set of pseudo MIPS instructions.
- ▪ I was team leader throughout the project and was in charge of delegating workloads to each individual.
- ▪ We first designed the microarchitecture of the data-path using Visio to visualize the flow of data and control signals.
- ▪ I implemented our data-path using synthesizable Verilog.
- ▪ I wrote the testbench to test our entire design, running through each instruction thoroughly.

Embedded Systems Electric Longboard

- ▪ Co-developed a custom electric longboard with an onboard Raspberri Pi 3 and an external android device.
- ▪ The RPi ran a Debian kernel and ran a python application that took serial Bluetooth input and output a PWM signal for motor control.
- ▪ I wrote the Android app in Java. It took input from the user and output a Serial Bluetooth signal to the RPi.
- ▪ Used I2C to include a compass that output the direction of the board on the android device.

Gethro Cabading

www.linkedin.com/in/gethro-cabading

OBJECTIVE: A full time position in Electrical/Electronics Engineering with a concentration in controls

EDUCATION:

In progress: **BS, Electrical/Electronic Engineering •** CSU, Sacramento, 3.18/4.0 • Dean's Honors List
Graduation: May 2019
Related Courses:

Electronics I, II	CMOS &VSLI
Robotics	Applied Electromagnetics
Logic Design	Signals & Systems
Network Analysis	Probability & Random Signal
Microprocessors	Power Electronics*
Modern Communication System	Electromechanical Conversion
Machine Vision*	Feedback Systems

*Spring 2019

AS, Intelligence Studies and Technology • Community College of the Air Force • August 2017

KNOWLEDGE AND SKILLS

Programming: C, C++, Verilog, MATLAB, Assembly Language, Linux, Database

Software Applications: Cadence Virtuoso, MS Office, Arduino, Visual Studio, PSPICE, NI Multisim, ADS

Hardware Applications: Raspberry Pi, Arduino, Deo Nano, Parallax Propeller board, FPGA, Max 32 Chipkit

Communication/Organization:
Bilingual: Fluent in English and Tagalog
Excellent writing skills, able to create effective lab reports and documentation
Experience leading groups
Effective team member and individual worker.
Led 12-person group fireworks stand (Phantom Fireworks).

PROJECTS:

Motion Detecting Alarm System:
Collaborated in a team of four to develop an alarm that detected motion and alerted user when detected. Used IR motion sensors, Raspberry Pi, Parallax Propeller board, and camera to accurately notify when someone is detected.

Elderly Assisting Robot:
Worked in a team of four to create a robot assisting elderly people living alone. Implemented multiple sensors to a differential drive robot in order to detect harmful elements and elderly injury, then calling appropriate personnel all while 3D mapping home for seamless navigation throughout building.

WORK EXPERIENCE:

Intelligence Specialist — **38th IS, Beale AFB, CA 2013-Present**
Targeting, Collection management, analytical production management, and dissemination to maximize the success of ISR operations. Gather and evaluate information, using tools such as aerial photographs, radar equipment, and sensitive radio equipment.

Engineering Assistant — **Department of Water Resources, 2018-Present**
Assist Senior engineers, analyze, identifying and reporting on program and project engineering deliverables utilizing the (Grants Review and Tracking System) GRanTS for water use efficiency programs and other infrastructure run database queries in GRanTS to create MS spreadsheets of applicant information including grant requests.

Customer Service Associate — **Hornet Bookstore, 2015 -2017**
Provide Customers information and resolving their complaints. Establish or identify prices of goods, services or admission, and tabulate bills using cash registers or optical price scanners.

ACTIVITIES AND ACCOMPLISHMENTS:

Youth Leader: International Bible Baptist Church (IBBC) – Capitol
Staff Sergeant (SSGT): United States Air Force Reserves

Hasan Javed

Objective

To obtain position in a tech company that will further utilize/grow my skills as a computer engineer and hopefully land me a full time job after graduation.

Education

california state univeristy Sacramento | Graduating May 2019 |

Major: Computer Engineering

Related coursework: I have taken many classes in both electrical engineering and computer science to help broaden my horizons both in software and hardware technologies.

Skills & Projects

Skills

- Programming languages: Java, C/C++, Python, X86 Assembly
- Hardware languages: Verilog, VHDL
- Hard working individual that is task driven and self-learning
- Extremely reliable and a great team player
- 3.2 Major GPA

Projects

- Senior Design
  - As a group my senior project team members and I are building a mobile robot for the elderly that maneuvers around the house checking for certain hazards. The robot also dispatches a call to the paramedics if it senses the patient is in distress with the help of heart rate monitors and shock sensors.
- Home Security System
  - In a microcontroller hardware class my group members and I created a home security system that would search the landscape and alert the user of a tripped alarm. We connected a camera to a Raspberry Pi for visual feedback. To search a wide area we connected the camera to a servo to help point the camera in different directions. The direction was determined by multiple infrared sensors that when tripped would control the servo to rotate into the appropriate direction.
- RFID Verification
  - I created a simple RFID identifier that would take a low energy signal from a key fob to help unlock and gain access to an input. This technology could be used to help give access to users with security clearance and deter all others.
- Functional CPU
  - My group member and I created a fully functional CPU in Verilog language that would take lines of instructions and execute them. We used a pipeline approach to help break up instruction lines in parallel to help perform them faster. Included in the CPU were functioning buffers, ALU's, registers, memory blocks, and hazard detection units.

Experience

I.T Intern | delta Stweardship council | may – January 2016

- Provide technical support to agency employees. Include tasks such as unlocking accounts, resetting passwords, replacing toner, and basic troubleshooting of software and hardware. Assist the I.T. team to complete daily tasks including monitoring software patches, research upcoming technology projects and purchases.

Manager | quick stop smog repair shop | 2014 - 2017

- I was in charge of handling all day to day business such as taking care of customers, filling out paperwork, answering phone calls, ordering parts, managing employees, and managing financial records.

Manager | Moon motors car dealrship | 2014 - 2017

- I was in charge purchasing used vehicles at auction, keeping track of all paperwork and record them in computers database, maintain and update websites to reflect inventory, and help with sales of all vehicles.

lead | avis budget group | 2014 - current

- I'm in charge of taking over all operations for day to day activates such as customer service and data management.