

**Proposal
IntOps**

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**“How might we use technology to improve
the mobility of Parkinson's patients?”**

Problem Statement

How might we use technology to improve the mobility of parkinson's patients?

Problem:

- Who - We will be assisting Parkinson's patients who experience freezing of gait.
- What - We will be helping with increasing independence and improving mobility for these patients.
- Where - We will be working directly with the Atlanta based support groups that we have been in contact with
- When - We plan to have a working prototype by the end of Fall 2017 semester and will continue to develop this prototype in the spring semester.
- Why - Parkinson's Patients deserve the right the basic human needs of safety and independence.

Significance: As of now, Parkinson's Disease (PD) is incurable and will stay with patients once they are diagnosed. Due to a focus on curing the disease rather than assisting those currently diagnosed, many people are oblivious to the struggles that a Parkinson's patient faces in their daily life. One of the largest detrimental impacts of PD is a decline in mobility and independence. By addressing this problem, this proposal hopes to better the lives of these patients and give back some of their independence.

The limited mobility of Parkinson's Patients often means that working becomes very difficult if not impossible. The limitation of productivity of Parkinson's Patients means these individuals have a harder time contributing to society. They also become more dependent on others for care as the disease progresses. One of the later symptoms of PD is a loss of motor control when experiencing a rush of emotion. This symptom is known as freezing of gait. With freezing of gait, many of those diagnosed with Parkinson's begin to need full time caregivers.

There is also a large social stigma associated with Parkinson's as it is easily noticed. From our interviews, we learned that those with the disease are less likely to go out as well. They become less of a part of society, especially towards the end of their lives as the disease progresses.

Despite decades of research, the cause of PD is still not fully known. According to researchers, the disease is caused by a combination of genetic and environmental factors that vary from patient to patient (Parkinson's Disease Causes, 2017). The symptoms of parkinson's are caused by the cell death process of dopamine neurons, which is where the main focus of research for a cure lies. In addition, PD is impacted by age as those who are older are much more likely to be diagnosed and the symptoms often worsen over time. (Defranco, M., 2011)

Many of the symptoms of PD heavily affect sufferers' daily lives negatively, making them depend on others to provide for them. Some Parkinson's patients will have caregivers within their family, which takes away from the time that their family could be working. The symptoms of PD also limit the activities that they can do, which prevents them from being able

to walk to places on their own. However, visual cues have been proven to help PD patients escape freezing of gait (Bhimani, R., 2014). The ability to quickly break out of freezing of gait would prevent any embarrassment from the immobility that freezing of gait can cause. Furthermore, Parkinson's patients usually spend large amounts of money on caregivers and medication, which can lead to a financial reliance on relatives. Because the disability often affects the people around the Parkinson's patient (Freezing of Gait, 2017), solving this problem of freezing of gait would help take financial and emotional stress off Parkinson's patients, their friends, and family.

Stakeholders: The four stakeholders considered are Parkinson's patients, doctors of Parkinson's patients, caregivers, and family members of Parkinson's patients. Parkinson's patients are most directly impacted by this issue because they experience limited mobility first hand. After interviewing/talking with Parkinson's patients we know that limited mobility and freezing of gait are top concerns and most expressed frustration in the lack of existing solutions. Doctors of Parkinson's patients are impacted by this issue in a number of ways, including responsibility of diagnosis and developing treatment options. These doctors are responsible for ensuring their patients have a healthy quality of life. Most Parkinson's patients require caregivers, who are responsible for taking care of the patient and ensuring their safety. To Caregivers limited mobility and freezing of gait are large issues as they pose a threat to the safety of Parkinson's patients. It is important to note that most Caregivers are family members of the Parkinson's patient (H. Fletcher, personal communication, February 2017) and similarly the concern for safety is top priority. In addition, limited mobility of Parkinson's patients often means that their environment needs to be adapted so that they can move easily and safely. For example, many families have to install grab bars, electric beds/mattresses, and make spaces wheelchair accessible. The adapted environment impacts family members of Parkinson's patients since they often share the same space, meaning family members must also make accommodations that best suit the patient.

Context and Existing Solutions - Assistive technology, objects that increase or maintain the capabilities of people with disabilities, are critical for those with PD. Various approaches have been tried with respect to improving the quality of life for people with PD. These solutions range from general devices like "smart" spoons to devices such as laser canes and PD glasses which specifically target freezing of gait. "Smart" spoons attempt to improve mobility by automatically adjusting position to counteract tremors in the hand. The automatic adjustments all Parkinson's Patients to eat with more ease and accuracy. However, a single smart spoon cost approximately \$200 dollars, which is a steep price for patients to pay for one utensil (LiftWare T., 2012). The primary functions of laser canes are to provide stability and help prevent shuffling or freezing of gait while walking. This is accomplished by projecting a line from the cane onto the ground in front of Parkinson's Patients. The drawback of existing laser canes is that they are upwards of \$200 and entirely replace a cane that a patient might be used to using or find using most

comfortable. PD glasses improve mobility, similar to laser cane, by projecting a rolling line into the view of the user, ultimately helping keep proper pace and stride while walking (Introducing LaserCane for Parkinson's and Other Neurological Conditions., 2009). The main issues with the Parkinson's glasses are the battery life is relatively short and the glasses are cumbersome to adjust, especially with limited dexterity. These existing solutions simply do not take into account all areas in which Parkinson's impedes mobility. Expensive and complicated products are unsuccessful at solving this issue since primary treatments for PD already place a heavy financial burden and most patients struggle adapting to new technology due to age and impaired executive processing abilities.

Why is it still a problem?:

Although the problem of freezing of gait has been known by patients and doctors for a long time, it is a prevailing problem with Parkinson's patients today. Some of the primary reasons why freezing of gait is still a problem is because most of the news and coverage on PD is on drug trials and medical treatments, and as a result, not as much funding is being used for solving Parkinson's patients' daily problems. While finding a cure for PD is very important and deserves attention, it is overshadowing the present problems that patients are having, such as freezing of gait. People cannot understand the poor quality of life that Parkinson's patients have if it is not being told in the news or told by organizations. Not only is the overshadowing of certain aspects of PD in the media causing this problem, but the amount of Parkinson's patients is also increasing. This is because the aging population is increasing due to the baby boomers. The symptoms of Parkinson's Disease also deteriorate the quality of life amongst patients as they have much more difficulty performing daily tasks. Health expenditures are projected to grow at an average rate of 5.9 percent for 2018-19, the fastest of the sub-periods examined, as projected spending growth in Medicare and Medicaid accelerates (Is there a Cure for Parkinson's Disease? How is it Treated?, 2017). The problem will continue for the next few years until either a medical treatment can be provided for all patients or a cure to stop the symptoms is found. Another reason why this is still a problem is because the patients have a lack of voice for their issues. Many of the symptoms are embarrassing and harmful for the patients. Not only will they not speak because they are embarrassed but some of the symptoms actually affect communication. Patients report trouble speaking, writing, and typing which are the main forms of communicating to others.

Proposed Work

Goal: The goal of our project is to provide a cheap, effective solution for freezing of gait to Parkinson's Patients. We are looking to improve the mobility and security of Parkinson's patients, make their daily lives safer, and save them from the embarrassment they might feel from freezing of gait. With our project, we aspire to specifically help Parkinson's patients who use assistive walking tools, such as walkers and canes, by creating an attachable device that can help prevent freezing of gait and improve mobility.

Objective: The first aspect of the objective is to detect the freezing of gait when the patient is going through this condition. This is important because finding a way to detect freezing of gait will allow us to understand when and how to get the patient out of the freezing of gait. It would be truly unpredictable to know when the gait would happen because there are many causes of the problem (National Parkinson's Foundation, 2017). It can be either a rush of emotion, panic, or just being embarrassed in certain circumstances.

The other objective is to get the patient out of freezing of gait. A prospective 20-year follow-up of PD patients reported a high prevalence of falls (87%) and fractures (35%) (What Causes Parkinson's, 2017). Falls and fractures from the episodes increase the risk for falls and is a major concern to the safety of the patient and their quality of life (NHE Fact Sheet, 2017). Falling is the number one cause of hospitalization and mortality for people above the age of 65 (CDC, 2014). If we want to improve the mobility and the security of Parkinson's patients, it can only be done by helping them out of freezing of gait. The best way of helping them is to place an attachable device on a walking tool. Walkers or canes are used by many parkinson's patients and are usually present during the freezing of gait, because they are moving when something initiates the symptom.

Lastly, and probably one of the most important objectives for our project is to provide a solution that is cheap and effective. People with PD need financial support for their medication and caregiving. The cost of insurance, caregivers, medication with an income coming from one person is not enough to buy expensive devices. Most devices are at prices at \$500 or more, which is ridiculous for the standard of living of most people with PD. Providing a low cost device is necessary for this project, because if not then the solution cannot be even considered by people with freezing of gait symptoms.

Objectives:

1. Develop a method for detecting freezing of gait.
 - a. Background: One of the most important aspects of our project is to be able to actively detect freezing gait when it happens, so that we can deliver a solution to it.
 - b. Methods:
 - i. Perform further research on freezing of gait
 - ii. Possibly speak with additional experts and patients
 - iii. Brainstorm detection methods both hardware and software solutions
 - iv. Develop the detection technology through gyroscopes and other current devices.
 - v. Test detection method to ensure accuracy and consistency
 - c. Outcomes: As a result of our project, we hope to create a method for detecting freezing of gait and apply it to our device. For instance, we might find that freezing gait occurs when all muscles in the body lock up. We need a device that will detect this. Our measureable outcomes will be the percent of time in which freezing of gait was correctly detected and identified. Our smart cane should also have high sensitivity to ensure that we capture when freezing of gait occurs and high enough specificity so that the device will not constantly turn on. We would rather have higher sensitivity than specificity in order to make sure that their freezing of gait does not put them in any danger. Specifically, we are hoping for sensitivity values above 60%.
 - d. Anticipated Problems: Based on our current knowledge freezing of gait is highly unpredictable for the patient. It most often occurs when the patient experiences a rush of emotions, or even frustration. Due to this unpredictability even to the patients, developing a detection method, which can be cost effectively incorporated into our product will be one of our largest challenges.
2. Develop a method to remedy freezing of gait and improve mobility
 - a. Background: Now that we know what causes freezing of gait, we need a way to implement this into a device that can break someone out of freezing gait. We learned from interviewing Brian Parise that projecting either a laser line or a staircase can break people out of Freezing gait. We would need to further test and research these ideas.
 - b. Methods:
 - i. Research into technology and electronics and find a way to transform our findings into a device.
 - ii. Talk to some experts to hopefully help steer our solution direction.
 - iii. Develop the technology to break out of freezing of gait.

- c. Outcomes: The desired outcome in this situation would be confirmation of our method to break a patient out of freezing of gait. We would want a very high sensitivity for this, with a value of at least 70%.
 - d. Anticipated Problems: We would be able to develop a prototype soon and need to learn a lot about electronics and current technology. Without expert help, it could be difficult to develop a prototype with our limited engineering knowledge.
- 3. Implement the device into a prototype (adding it to a cane/walker, etc) and test our prototype with human subjects
 - a. Background: We need to test the device in the real world and create various iterations based on these results. Feedback would from those with Parkinson's would also be very helpful in improving our device.
 - b. Methods: We will get several walkers and attach it to the device. We will also include the laser light and stair projection. Then, we will go to different Parkinson's support group meetings and test different configurations of our cane device with different canes, walkers, etc and with different test subjects. We will let the subjects take home the cane for an extended period and will periodically interview them. It might also be useful to have a control group of individuals using regular assistive devices so we can compare the efficacy of our device. Hopefully, during the test period, our device will help detect and allow someone to snap out of freezing gait to realize our original goal.
 - c. Outcomes: Our outcome would include IRB approval and randomized trial to make sure our final product is actually helping.
 - d. Anticipated Problems: During the testing period we could run into situations where our device fails or there may not be a freezing gait event which means our walker is not properly tested. We may also find that for some reason our device is not practical for those with parkinson's. It is hard to account for all possible situations when freezing gait occurs and freezing gait could be a different reaction each time.

Project Team: Our team will consist of a total of 6 members. Each member will be expected to attend class and contribute equally to all project assignments, complying with deadlines set by the group. One expected role is that of product design, implementing 3D modeling knowledge to create the basis for our project. Another expected role will be the manufacturing of any physical components needed. Our group will also likely require the role of a materials manager to order proper sensors and components. In addition, our project will require electrical/wiring considerations as well as some degree of computer science and programming skills. Also, a financial manager that oversees the budget and general production will likely be implemented. The previously listed roles will not be limited to a single group member but will be evenly delegated based on skill possessed and workload. The three individuals that would provide useful advice for our proposed project are Herman Fletcher, Brian Parise, Dr. Evatt. These three individuals have been extremely important to our ideation process. Herman Fletcher, a Parkinson's patient that started a support group in his community, was an important part of connecting with our target demographic and understanding how Parkinson's affects the daily lives of those who have it. Brian Parise, the creator of Itrem and a Georgia Tech faculty member will be an important resource in understanding how to best utilize Georgia Tech's resources. Finally, Dr. Evatt, a leading researcher at Emory University will sustain a large role in connecting us to local support groups and giving us a better medical understanding of how PD affects its patients.

Timeline:

Summer 2017:

- Perform additional research and brainstorm detection methods

Fall 2017:

- Develop detection technology through use of gyroscopes and other existing devices
- Test detection method to insure accuracy and consistency
- Develop technology to break out of freezing of gait
- Make first prototype/proof of concept

Spring 2018

- Test prototype
- Improve design based on test results

Budget:

Materials and Supplies: material for band to wrap around cane/walker, accelerometer, gyroscope, cane/walker, microprocessor, access to 3D printing resources.

Equipment: No special equipment will be required for this project.

Services: We will not require any other outside services.

Travel: Some travel expenses may be required for getting to support groups, meeting further with experts, and for testing purposes. Travel expenses should not exceed more than \$100.

Expected Outcomes and Future Directions: We expect to have a tested and fully functioning proptype that is ready to be moved into final production stages when this project is over. After year two we hope that our product will continue forward in development and production so that it will eventually be effectively improving the lives of Parkinson's Patients. Our end goal is to develop an affordable and reliable product that will provide one way in which to remedy freezing gait, ensuring safety of the patient and restoring confidence. Two possible sources of funding would be the National Parkinson's Foundation and the Parkinson's Disease Foundation these organizations are national funds for Parkinson's research. Collaborative relationships with Parkinson's researchers such as Dr. Evatt and continued connection with Parkinson's support groups would serve as a primary force in keeping the project going.

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