3-D Exploration: Applied Robotics
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## 1. Introduction

It has been an incredible experience to be a part of a program as pioneering and revolutionary as Botball. The reason for this is simple: never have I felt more comfortable in a room full of individuals whom I have never met in my life, than I feel when at one of the many robotics competitions. Each of my competitors and my teammates and myself share a singular goal: to advance both ourselves and our generation. Botball is an amazing experience, for each and every participant is interested solely in what they might contribute to the future, and how the skills they gain from this program will further their potential as engineers, scientists, and programmers. I personally, have become recently involved in a project that has extended beyond the routine Botball competition, yet the foundation for my participation, or even my basic ability to understand what is transpiring, originates from the botball robotics program.

## 2. The Concept

Over this summer, myself, Micheal Nguyen and Rutvick Velega have begun a project that utilizes the knowledge we have gained from our participation in the Botball program. We began with the concept of utilizing the ASUS Xtion mounted on a create to 3-D map a room or specific space, and use the Wallaby's self-generated wi-fi to transmit the data to a virtual reality device, allowing one to visualize the situation of a remote location in nearly real-time.

There were two general possibilities with such a project: Use for personal recreation, or use in emergency scenarios. The recreational possibility in experiencing an inaccessible or remote location in a virtual reality format holds incredible potential for enjoyment. Real life structures and/or locations would become the canvas for impossible creations, allowing imaginative experience in realistic settings. The other practical application for a live updated 3-D map is emergency communication. One of the current innovations in medical technology is the Telemedicine robot, a mobile communication device that allows otherwise removed professionals to both see and provide input during dire situations. While the Telemedicine robot is indeed effective and has been successful in assisting in many emergency situations, having a similar yet more advanced design providing three dimensional information to necessary yet absent medical personnel would revolutionize medical capabilities, allowing for far more in-depth interaction between the medical personnel on site and the medical specialist.

Thus, by not only utilizing the equipment provided by the Botball program, but also the knowledge we obtained from competing and attending the global conference, Micheal Nguyen, Rutvick Velaga and I were able to begin working on this very project.

**3. Applied Robotics**

One of the necessities for the 3-D exploration project was the physical body of the robot that would allow the Xtion to be both mobile and mounted at waist height. Instead of attempting to utilize metal or legos to complete this task, I opted to use pvc piping, as it is both lightweight and sturdy. By attaching 3 pvc pipes of 3 foot length to a Create, I formed a triangular stand to which I attached an omni wheel metal drivetrain, and then mounted the Xtion onto this structure. By mounting the Xtion halfway between the normal human height of vision and the floor, we were able to better utilize the Xtion's range of vision, as its infra-red emissions are directed in equal quantities above and below it.

One of the programming aspects that was incredibly important to the robot was its ability to autonomously navigate a both freely and impeded. Be it in situations of emergency or recreation, the 3-D exploration unit is required to continue travelling, even if it faces hindrances. We programmed the create so that it would be capable of following a set, prior path, so that one could have the create either arrive at a desired location, or traverse the entirety of a room. The issue, however, became the necessity of pathfinding and course correcting for the create. While making the robot able to be remotely controlled would allow the operator to try and avoid obstacles, we chose to include for the create the ability to autonomously navigate, so that it could overcome both human error and latency issues. In order to do this, we tried to include a function that would activate when the Xtion saw an obstacle approximately a foot in front of it. The create would then utilize the Xtion to determine which side to navigate around would be the shorter option, as the Create would simply travel towards the side where less of the obstacle was seen by the Xtion, mapping its own progress in the x axis and z axis, and returning to its original path.

There were unfortunate flaws with this function, however. One was the inevitability of variance in recorded and actual distance travelled, which, without a point for the Xtion to use as reference to align itself upon, became a currently unsolved issue. The next flaw in the pathfinding capabilities was the robot's inability to navigate around moving objects. Unfortunately, we were unable to spend enough time on the project to give the 3-De the ability to analyze the movement of an object in front of it, which would either result in unnecessarily long movements to get around an obstacle that was no longer present, or, in the worst case scenarios, collision. Thus, the hindrance-avoidance autonomy of the robot was flawed, yet this project could very well be continued to be further improved.

The final primary challenge with a live updating 3-D map is the latency caused by the massive amount of data transferred between the controller and the operator. This is an issue that our team struggled extensively with: While using a google cardboard as the virtual reality emulator for cost effectiveness purposes, we began to face continued issues in the transfer of data collected by 3-De, the ability to process the information, and the ability to format the three dimensional imagery to be a virtual reality operator. Each of these issues caused increased latency issues, and we found ourselves quickly running out of time, doing everything we could to

compress the data and send it faster, speeding up the processing however we could, and reformatting the data in the most efficient manner possible. While our efforts may have been too little and too late, I believe this project still exemplifies the purpose behind Botball, to truly apply the skills we have learned as a part of this program, and to face the challenges of today so that we might have a brighter future.