CS CAPSTONE REQUIREMENTS DOCUMENT

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ROBOTIC TEST BED FOR COLLABORATIVE IMAGING USING MACHINE LEARNING

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Abstract

The robot market has increased drastically and is expected to increase even more to 147.26 Billion US dollars by 2025. This project will be creating a specific type of robot, the collaborative robot. These robots are able to work in tandem with each other without interfering with the each other's work. For our Project, we will be creating a collaborative robot that is able to keep track pf packages in a warehouse. This will be important because companies lose millions of dollars due to lost packages each year. This robot will help to reduce the number of lost packages By the end of this project, we will need to complete both a simulation and a prototype for a collaborative robot. Although, this robot will not be created for consumer purposes and will not be created for any purpose other than display collaborative properties to an audience. We will be complete this project using a waterfall methodology because of our limited resources and time. This waterfall method includes five different phases. The requirements phase will be completed with the authorization of this document. The design phase will consist of understanding the hardware and learn more about the software we will be using. The implementation phase will consist of the simulation and the prototype. The verification phase will consist of client approval of the project and displaying it at the engineering expo. The maintenance phase is beyond the scope of this project and updating it would have to be done by future capstone projects.

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1 Executive summary

The first part of the project will include securing the resources required for this project, learning additional concepts, and planning the project. In terms of funding, this project will require about $4,000 in hardware. This will provide crucial items such as a Turtle Bot Kit, which is what the robot will be build out of. In terms of learning additional concepts, our client has provided us with online courses describing how to use ROS, which is the operating system that the robot will use. Also included is a course on deep learning using key aspects of the robot such as tensor flow. In addition to these online classes, there will be general research looking into algorithms and other ideas about collaborative robots. Planning will be done throughout the first. This will include things like a technical document and creating pseudo-code for the robot.

The second part of the project is where the robot prototype is programmed and built. Completing the second part of the project will require us to create a program for the robot, create a simulation to test it, and to create a prototype that displays the qualities of our collaborative robots. To create the program, we will be using the ROS. This operating system will make it much easier to interact with all the sensors and motors that will be used to build this robot. The robots will be programmed using the Python and Java languages. There are also many instances of open source code that we can draw inspiration from. Using the robots' AI, a simulation will be created to test the AI before the creation of the prototype. This simulation will be run on Gazebo, which is very accurate and uses real world measurements to see what the robots would actually do and provide a low risk test. Finally, we will need to create a prototype to display our findings. We will be using the Turtle Bot Kits for this prototype. They include many sensors and motors that we would be able to use with our robots. The prototype will also run on a NUC, which is a miniature PC. Both the Turtle Bot Kit and the NUC would need to be purchased. Although, it would be valuable to be able to see the robot to work in real life. This second part of the project will last until a week before the engineering expo that occurs in the spring term at Oregon State University.

The third and final part of the project will be verification, which will done to make sure that the project is acceptable by our client. If there are any problems, it will be addressed in the week before the engineering expo. In addition, a display will be created to explain what is going on in the prototype. At the engineering expo, the entire project will be put on display for the public to enjoy and learn from. We could also receive feed back from the general public that would be present at the expo. Once the expo is over reports will be written that go over the successes and problems with the project.

2 Project Description

This project requires us to create a test bed that will test collaborative interfaces, improve the SLAM performance using accelerators integration, and implement Robot-Training Mode using Vision. Testing a comprehensive collaborative interface will allow us to make sure we understand what is going on in the test and how the robot AI preforms. In order to keep track of packages, we will use the camera to read the barcodes of packages. This will allow us to identify the package and record it's location. SLAM performance allows the robot to map it's environment Using accelerator integration allows better prediction of moving objects. Vision is software that allows customizable applications, rich graphical reports, and database management. This will allow us to accurately portray how a robot will act by creating our own program. Overall, completing this project will allow a much more in depth way to test future robots and make sure they are qualified for consumer use.

3 Background

The robot market has increased drastically and is expected to increase even more to 147.26 Billion US dollars by 2025. This project will be important in the development of future robotics by allowing robots to be accurately tested to see if the robot can be released to the consumer market. The test-bed will have the tools to create an environment for the robot AI to interact with. This will be done with creating a program on ROS with Java and Python. Our success depends on whether or not we get a working prototype. This project will be a large factor of the speed of which the robotic market grows.

4 Scope

- Testing Collaborative Inference (Like Multiple Mobile Cameras)
- Read barcodes using the camera and not the package's location
- Improvement in the SLAM performance using Accelerators integration to ROS
- Implementing Robot-Training Mode using Vision
- Creating a simulation using Gazebo
- Building a prototype to keep track of packages using barcodes and display collaborative robots

5 Current Process

We are currently in the implementation phase. We received a robot from our client and we are now downloading packages to use with the robot. We currently have the network connection, SLAM, and the camera operational. The network connection allows us to run the robot without a wired connection. Also, it lets us monitor the robot's movement and see what the robot sees through our laptops. Both SLAM and the Realsense camera are connected and can be interacted with using RVIS. SLAM is implemented using the Turtlebot3 package and the Realsense Camera was implemented with the RealSense package. We still need to be able to read barcodes with the camera. In order to complete this, we have found a ROS package called zbar-ros. This package will allow us to read a barcode with our camera. In addition, we need to find a way to record the package's location once the package is found. To implement this, once the robot finds a barcode, we will report the location using the robot's location on the map.

6 Proposed Process

For the verification phase, both Brandon Villanueva and Onur Sasmaz will present the robot to our client and then show off it's functions at the expo. We will show our client our robot a week before the expo. This will allow him to voice any concerns before we move on. For the engineering expo, both group members will present the final product and answer any questions the audience has. At the expo, we will receive any additional feedback.

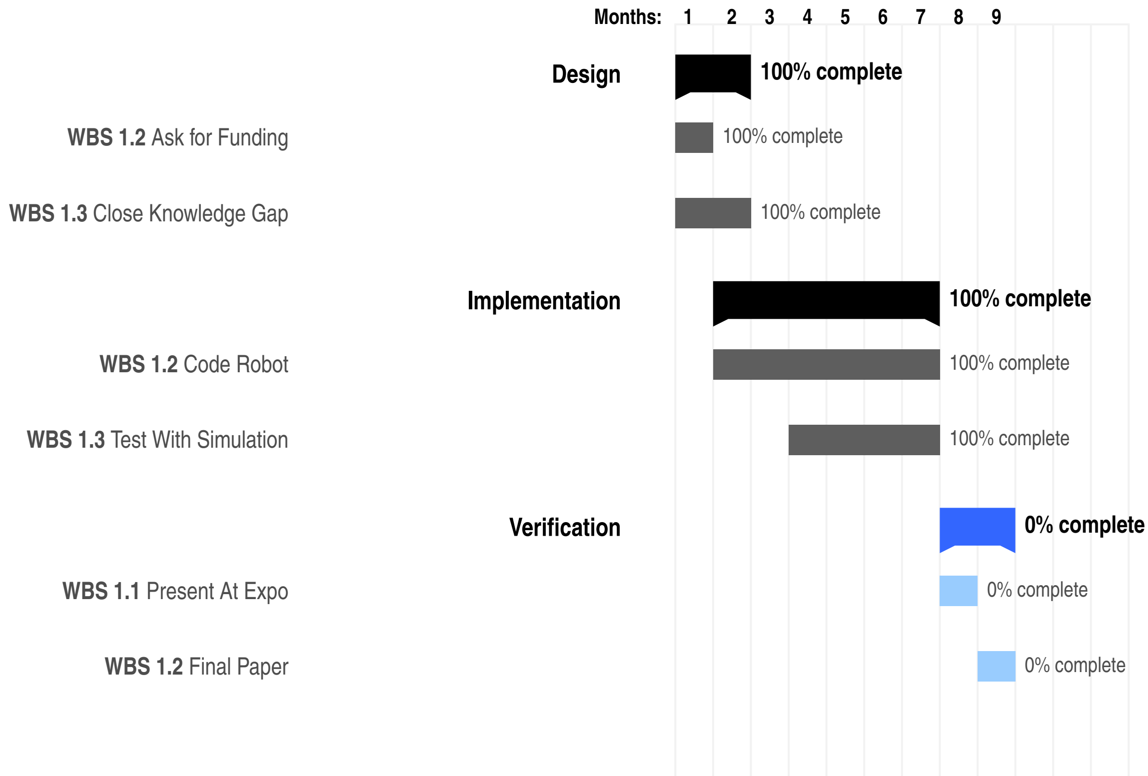
7 FUNCTIONAL REQUIREMENTS

The robot is required to be able to work with other robots. The robot needs to be able to present collaborative qualities. The team will be using collaborative AI technologies to implement a robot that can keep track of packages in a warehouse. The team will be using ROS software libraries and tools to build collaborative robot applications. ROS is a high priority, but the project can be implemented at a bare minimum without this requirement. We will also be using many online packages to help code the robot. We will use the Turtlebot3 package to implement SLAM, the RealSense package to interface with the Realsense camera, zbar-ros package to read barcodes, and many other packages for other parts of the robot. each of these packages are important to the use of our robot as they include code we can use instead of writing it ourselves. To test the collaborative robots, the team will be using the RVIS and Gazebo Simulation. The robot needs to work without breaking, although Gazebo is essential to make sure it does without much risk. The team also will be using Tensorflow for machine learning and deep learning problems such as discovering, prediction, and classification. This requirement is a high priority, but the project can be implemented at a bare minimum without this requirement. The team might use Numpy for implementing homogeneous multidimensional arrays in source code. This requirement is somewhat necessary, as it provides some value, but the project can proceed without it.

8 NON-FUNCTIONAL REQUIREMENTS

In this project, safety is critically important. It is the team member's responsibility to maintain a safe and healthy workplace. In the future team will set safety goals and hold every team member accountable. The reliability of team members has a monumental impact on the project. Also, the source code must be reliable in order to handle all the data. In order to stop the two robots from interfering with each other's work, timing is vital. As well as, power consumption of the robot. The collaborative robot will be able to work over 8 hours.

9 Time Line



10 Limitations

We are limited by our budget and the amount of hardware that we receive. This limits us because there is a limited amount of projects we could work on. For example, there is only one arm, so that we could not create any robots with multiple arms. We are also limited by time and manpower. There is only so much we can complete with two people.

11 Glossary of Terms

Glossary	
Term	Explanation
Gazebo	A Gazebo simulation is a robot simulation made with Gazebo, a 3D simulator with the ability to accurately and efficiently simulate populations of robots in complex indoor and outdoor environments.[1]
Python	Python is an interpreted, high-level, general-purpose programming language. Created by Guido van Rossum and first released in 1991, Python's design philosophy emphasizes code readability with its notable use of significant white space. [2]
ROS	The Robot Operating System (ROS) is a set of software libraries and tools that help you build robot applications. From drivers to state-of-the-art algorithms, and with powerful developer tools, ROS has what you need for your next robotics project.[3]
NUC	The Intel® NUC is a powerful 4x4-inch Mini PC with entertainment, gaming, and productivity features, including a customizable board that is ready to accept the memory, storage, and operating systems that you want.[4]
TurtleBot	TurtleBot is a low-cost, personal robot kit with open source software.The TurtleBot kit consists of a mobile base, 3D Sensor, laptop computer, and the TurtleBot mounting hardware kit.[5]
SLAM	Simultaneous localization and mapping, or SLAM for short, is the process of creating a map using a robot or unmanned vehicle that navigates that environment while using the map it generates. SLAM is technique behind robot mapping or robotic cartography.[6]
Java	Java is a general-purpose, concurrent, object-oriented, class-based, and the runtime environment(JRE) which consists of JVM which is the cornerstone of the Java platform.[7]

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