

# **AUTONOMOUS WAREHOUSE INSPECTION**

## **PROPOSAL**

Madhu Narra Chittibabu  
M.Eng, Robotics  
University of Maryland, MD  
UID: 118206196

Koundinya Vinnakota  
M.Eng, Robotics  
University of Maryland, MD  
UID: 118239811

Sharmitha Ganesan  
M.Eng, Robotics  
University of Maryland, MD  
UID: 117518931

### **INTRODUCTION:**

The utilization of robots for warehouses has been proven to be efficient in recent times. However, some aspects of the warehouse environment require monitoring and human attention. The inspection and notification of such scenarios can be done using our proposed idea.

### **OBJECTIVE:**

- Minimal System : Set up a gazebo environment and spawn a turtlebot in that world and autonomous navigation.
- Target System : Autonomous navigation of turtlebot in a warehouse that recognizes anomalies(i.e Aruco markers) and reports the activity.
- Ambitious System: Launch multiple turtlebots which inspect each division of the warehouse and report anomalies in each location simultaneously.

### **ASSUMPTIONS:**

- Anomalies in any section of the warehouse are represented by the Aruco marker.
- Each type of Aruco marker is encoded to show various kinds of situations.

### **PROJECT DESCRIPTION:**

In this project, our main goal is to achieve autonomous warehouse inspection. We propose to set up a turtlebot and Aruco markers to simulate the proposed idea. The Aruco markers in our case represent different kinds of situations that can possibly happen in a warehouse. The initial step is to create a gazebo environment similar to that of a warehouse. Then, we plan to navigate the turtlebot equipped with a lidar sensor around the map using SLAM package and generate a map of the environment. While creating the environment, we plan to place Aruco markers at various locations in the map representing different activities. The turtlebot inspects the generated map looking for the Aruco markers and reads the information encoded into it. This information is reported to the user.

### **DESIGN AND DEVELOPMENT:**

For this project, we will be following Agile iterative methodology having three sprints spread over three weeks, and following pair programming method. Backlog sheets will be used to track the tasks of the project. We will be using ROS2 Humble as the main framework for the development. The program will be developed using C++ programming language. We will be using few open source libraries such as move-base for autonomous navigation, and aruco markers library to encode them and detect them in the gazebo world.

### **POTENTIAL USAGE OF THE PRODUCT:**

Our aim is to develop an autonomous danger detection robot. We believe that this robot can be deployed in the warehouses, construction sites, etc. where safety is a top priority. This robot can help in detecting and tracking unsafe situations which will be very helpful in avoiding dangerous outcomes.

## RISKS AND MITIGATION:

- Markers placed in the environment might not be detected properly by the turtlebot for a variety of reasons like it might be unable to decode the information encoded. To mitigate this we plan to try various kinds of tags like April tags and other forms of tags that can be easily detected.
- Accurate detection of markers might be difficult in cases where two makers are placed close to one another or in line of sight of the robot. To overcome this we plan to increase the collision space for the turtlebot, so that it detects only after it comes close enough to the marker.

## TIMELINE:

TIMELINE	
TASK	DATE
SPRINT 1	
Setup warehouse gazebo environment	11/24/22
Launching turtle bot in gazebo	11/27/22
Generating map server for autonomous navigation	12/01/22
SPRINT 2	
Achieve autonomous navigation in the warehouse	12/03/22
Implementation of aruco marker to be subscribed by bot's sensor	12/04/22
Turtle bot inspecting anomalies in the warehouse	12/06/22
SPRINT 3	
Develop multiple inspection bots (Ambitious)	12/07/22
Launching multiple bots simultaneously reporting anomalies	12/10/22
Prepare presentation	12/13/22

The link to the GitHub repository of the project can be found [here](#). The UML activity diagram is present in the mentioned repository.

## DELIVERABLES:

- Proposal
- UML Diagrams
- Project Package with CI and coveralls.
- Unit Tests
- Developer level documentation for the package
- Code styling outputs using Cppcheck and Cpplint
- Presentation

## REFERENCES:

- <https://www.prnewswire.com/news-releases/deep-robotics-releases-jueying-x20-hazard-detection--rescue-robot-dog-solution-301593052.html>
- <https://www.euronews.com/next/2022/11/19/this-self-driving-patrol-robot-is-being-used-to-detect-danger-and-alert-police-on-seouls-s>
- <https://roscon.ros.org/2022/>