

GuardBot

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Abstract

Our project is to create a robust, dynamic, and ultimately useful robot to guard the halls of Halligan. We plan for this robot to be capable of interrogating students or faculty as to whether they are friendly or not through gesture and command recognition.

1 Introduction

1.1 Problem

Maintaining a secure environment can be a challenge in a wide array of applications. In some cases, the need for security warrants hiring personnel. We aim to eliminate this need by developing a low cost robotics system to act as a substitute for security personnel in some scenarios. This robotics system will be able to save company's money by eliminating the need for security personnel. We aim to create a prototype for this robotic security guard, or GuardBot.

1.2 Goals of the Project

There are three chief goals for this project. At the most basic level, we wish for our robot to be able to safely and competently patrol a pre-mapped area. Upon encountering a person, the robot should request for some signal of recognition, through either a specific phrase or a movement. Goal number three is to ensure that the robot responds appropriately to the human response. If the human gives the password (or the pass-movement), the robot should back off and continue its patrol. However, if the human fails to give an adequate response within a certain period of time, the robot should intimidate, making noise and potentially shooting foam balls or a nerf gun at the recognized target.

2 Related Work

1. Lee, Jinhan, et al. "Vision-based contingency detection." Proceedings of the 6th international conference on Human-robot interaction. ACM, 2011.
2. Hawes, Nick, et al. "The strands project: Long-term autonomy in everyday environments." IEEE Robotics & Automation Magazine 24.3 (2017): 146-156.
3. T. Theodoridis and H. Hu, "Toward Intelligent Security Robots: A Survey," in IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews), vol. 42, no. 6, pp. 1219-1230, Nov. 2012.
4. G. Randelli, L. Iocchi and D. Nardi, "User-friendly security robots," 2011 IEEE International Symposium on Safety, Security, and Rescue Robotics, Kyoto, 2011, pp. 308-313. doi: 10.1109/SSRR.2011.610678

3 Technical Approach

GuardBot will follow the general procedure:

```
while patrolling:
    if encounterPerson():
        promptPerson()
        valid = checkGesture() || checkPhrase()
        if valid:
            continue
        else:
            detonate()
```

We plan to separate some of the core logic into several ROS packages, with patrolling and interacting as our two packages. Patrolling will handle all the movement logic for GuardBot, leaving our "interacting" package to handle identifying a person, prompting them for a response, and determining whether they are a friend.

First off, we believe we can easily implement patrolling (especially considering our homework 6 involves the TurtleBot patrolling between two fixed points).

As for person/gesture recognition, we have several ideas. We could use webcams with a live video feed to do face recognition on a person (see http://wiki.ros.org/face_recognition for examples/details) which could be a method of identification and simply recognizing that a person has

approached the robot. Alternatively, there are methods for hand recognition using the kinect that could be how we approach the robot recognizing a “secret gesture” (<http://wiki.ros.org/mit-ros-pkg/KinectDemos/HandDetection>).

Finally, tackling natural-language processing can be done using external non-ROS packages (such as Natural Language Toolkit <http://www.nltk.org/index.html>). There are extensive examples and libraries available for our basic usage (simply identifying a single “secret phrase” or command) that we think it can be easily incorporated into our GuardBot. There are also examples of ROS packages (<http://wiki.ros.org/pocketsphinx>) that connect an audio stream to a speech recognizer.

4 Success Criteria

For a minimum viable product, we hope to at a bare minimum implement patrolling and response to language commands or phrases. We believe that both should not be too difficult to implement (patrolling we will already have experience with, and with NLP there are a lot of resources for basic usage and implementation). If we can succeed in having the robot successfully navigate a particular space (room, or section of hallways) and be able to identify friend or foe from audio, we believe GuardBot will fill some purpose.

Ideally, we would like to have some form of facial recognition to be able to identify people as it patrols its assigned area, and even the ability to have a particular gesture to disarm the robot. We believe this is not only doable but also enhances the capabilities of GuardBot in performing its duties.

4.1 Performance Metrics

We plan on having five categories to determine how well GuardBot performs its intended functions.

- Patrol Time
 - Percentage of the time that the robot gets lost and has to cease operations
 - Average time of patrol before an error occurs
- Facial Recognition Success Rate
 - Percentage of the time that GuardBot can recognize combatants and friendlies
 - Minimize false positive rate
- Pass-phrase Success Rate

- Percentage of the time that GuardBot can correctly identify whether target has provided the correct pass-phrase when it is a single word
- Percentage of the time that GuardBot can correctly identify whether target has provided the correct pass-phrase when it is an entire phrase or sentence
- Gesture Recognition Success Rate
 - Percentage of the time that GuardBot successfully recognizes the pass-gesture
 - Percentage of the time that GuardBot passes an incorrect gesture as the pass-gesture
- Overall Threat Elimination Rate
 - Percentage of the time that given a recognized gesture or pass-phrase GuardBot can identify a friendly target
 - Percentage of the time that given no recognized gesture or pass-phrase GuardBot can identify an enemy and sound the appropriate alert.

5 Conclusion

We have established what we are going to work on for the base of this project, and we feel that this project has many areas that we can expand if time allows. We can make the robot smarter both in how it identifies combatants and how it identifies friendlies. Additionally, we can further develop responses to threats. This project will allow us to explore rudimentary navigation and mapping in small subsections of Halligan Hall and explore our personal interests in NLP and recognition software.