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Autonomous Tour Guide Robot using embedded system control

Alpha Daye Diallo^a, Suresh Gobee^a, Vickneswari Durairajah^a

^a*Asia Pacific University of Technology and Innovation*

Technology Park Malaysia, Bukit Jalil, 57000

Kuala Lumpur, Malaysia

alphaday2@hotmail.com, suresh.gobee@apu.edu.my, vicky.nesa@apu.edu.my

Abstract

This paper describes an interactive autonomous tour guide robot designed to guide visitors through Asia Pacific University Engineering Labs. Although tour guide robots with various self-localization abilities such as mapping has been introduced in the past, these technologies performance still remain challenged by indoor navigation obstacles. The current approach consists of implementing a low cost autonomous indoor tour guide robot running on an embedded system which is the Raspberry pi 2. The autonomous navigation is achieved through wall following using ultrasonic sensors and image processing using a simple webcam. The bitwise image processing comparison method introduced is writing in OpenCV and runs on the Raspberry pi. It grabs images and look for the tags to identify each lab. A recognition accuracy of 98 % was attained during the navigation testing in the labs. The user interaction was achieved through voice recognition on an android tablet placed on top of the robot. Google speech recognition API's was used for the communication between the robot and the visitors.

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1. Introduction

Various advancements in the robotics industry has taken place in the recent years. Interaction between human beings and robot has been a key focus of research amongst many researchers and engineers. One application where human and robot interaction is emerging is the tour guide robot. An interactive tour guide system will not only provide a dynamic tour experience, but will also give visitors an opportunity to be aware of the presence of a robot with a tour guide technology.

This paper focuses on designing an autonomous indoor tour guide robot capable in assisting visitors by giving them a tour of the Engineering Labs and its facilities in Asia Pacific University. The robot is not only aimed to be made low-cost, it is also expected to be highly reliable. This type of robot is suitable to be used in educational environments such as colleges and universities, as it helps new students have an understanding of what engineering is truly about before they embark into the journey. This robot will then serve the purpose of assisting visitors around the campus with ease. Besides using it in the educational field, the robot can also be used in the travel sectors to improve tourism of a country. It can be placed in various places of interests and be used to guide the tourists around the place. Such robots are popularly used in museums in some countries. If used in suitable environment for a specific purpose, the robot will be very effective in giving visitors an enhanced and meaningful experience of a tour guide.

2. Relate work

A successful tour guide robots is judged based on how well it localizes itself around a certain place and how well it interacts with the humans¹. Several types of tour guide robots have been introduced in the past, each with a unique navigation technique. Researches Yelamarthi et al¹¹ proposed a tour guide robot equipped with an RFID reader for localization and sonar and IR sensors for obstacle detection and avoidance. However, passive RFID readers tend to have a limited operating range which makes them less reliable as the robot has high chances of missing a tag. Furthermore, RFID readers are quite costly. Another alternative to RFID based autonomous navigation is vision-based navigation system using QR (Quick Response) code recognition. Seok et al¹⁰ developed a wall following navigation technique based on real time QR code recognition. The robot is equipped with a Smartphone which continuously scan for the QR tags placed on each lab. However, it is important to mention that this technique had difficulty recognizing the QR tags when the robot was moving fast.

Most localization and mapping techniques involve running complex algorithms. These kinds of operations require powerful processors to analyze all the collected data. Consequently, those approaches might not be fully efficient because they often require considerable amount of time to accomplish the mapping⁶. MacDougall & Tewolde⁸ suggested the implementation of a tour guide robot using the weighted centroid technique. The method consists of placing ZigBee modules at known location to provide reference information to the robot to locate itself. Unfortunately, the robot consistently missed the final destination by a distance of 3.3m up to 4.5m.

When it comes to the human robot interaction, researches employed several approach. A tour guide robot that communicates with visitor through a touch screen was introduced by Yelamarthi et al¹¹. Seok et al.¹⁰ proposed a different approach which consist of using android text to speech application to converts a string into audio and read it to visitors. Another low cost human machine interaction through voice recognition was presented by Haro et al.⁵. The proposed system consists of using a Raspberry pi as the main processing unit to recognize up to 6 different languages using web applications services. Stefanovic et al¹³ introduced a voice control system based on android and Google speech recognition API. The recognition success rate of the system was estimated to be more than 50%. In another related work, bt Aripin et al¹⁴ implemented a voice recognition system via smart phone for controlling home appliances. The common challenge between all this applications using Google voice API is that it very sensitive to the environment noise and it is also highly depends on the internet.

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