VILNIUS UNIVERSITY
FACULTY OF MATHEMATICS AND INFORMATICS
INSTITUTE OF COMPUTER SCIENCE
INFORMATION TECHNOLOGIES STUDY PROGRAM

Problem-Based Project

Rover

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Contents

1 Keywords

- Autonomous robot

- Pathfinding

- Room mapping

- Stereo computer vision

- Obstacle avoidance

2 Abstract

The goal of this project was to prepare an autonomous robot companion with the ability to map a room, detect and avoid obstacles, and recognize humans with the use of stereo computer vision. The start of the document will include the overview of the project, followed by the functional and non-functional requirements, as well as other implementation details. The main task of the robot is to detect and avoid obstacles using cameras and distance sensors. The robot will use a Raspberry Pi, stepper motors, multiple sensors and two cameras. The precise movement will be calibrated using an electronic compass. The room mapping will be explained and examples of test results will be presented. The robot's hardware details and implementation will be presented in a diagram and part list. The robot's mapping algorithm will be explained in detail. The robot will use stereo computer vision to recognize and follow humans. The robot will be able to execute the following tasks: find a human in a room, follow a human, find an object, and produce sound signals. The task will be given to the robot by the user using a remote controller. The expected result is an autonomous robot with the described functionality.

3 Related Work

[1] On autonomous robots
[2] Autonomous robots: from biological inspiration to implementation and control
[3] Blanche: Position estimation for an autonomous robot vehicle
[4] Computer vision based distance measurement system using stereo camera view
[5] Modeling, Path Planning and Control
[6] Development of an autonomous inverted pendulum mobile robot for outdoor environment
[7] Development of autonomous navigation performance criteria and related test methods for autonomous mobile robot in the outdoor environment
[8] Exploring a computer vision and artificial intelligence-based approach to sit-and-reach distance measurement
[9] Motion recognition based cooperation between human operating robot and autonomous assistant robot
[10] The design and implementation of autonomous driving pallet robot system using ros
[11] Autonomous navigation and mapping in underground mines using aerial robot
[12] Ambient intelligence meets autonomous robotics
[13] Obstacle detection and obstacle avoidance algorithm based on 2-d rplidar
[14] Design of an autonomous tracked mower robot using vision-based remote control

[15] Stereo vision-based fast obstacles avoidance without obstacles discrimination for indoor uavs

References

[1] George A Bekey. On autonomous robots. *The Knowledge Engineering Review*, 13(2):143--146, 1998.

[2] George A Bekey. *Autonomous robots: from biological inspiration to implementation and control*. MIT press, 2005.

[3] Ingemar J Cox. Blanche: Position estimation for an autonomous robot vehicle. In *Autonomous robot vehicles*, pages 221--228. Springer, 1990.

[4] Emre DANDIL and Kerim Kürşat ÇEVİK. Computer vision based distance measurement system using stereo camera view. In *2019 3rd International Symposium on Multidisciplinary Studies and Innovative Technologies (ISMSIT)*, pages 1--4, 2019.

[5] Farbod Fahimi. Autonomous robots. *Modeling, Path Planning and Control*, 2009.

[6] H. Igarashi, T. Saito, T. Kinjyo, and F. Matsuno. Development of an autonomous inverted pendulum mobile robot for outdoor environment. In *2008 SICE Annual Conference*, pages 2282--2285, 2008.

[7] First A. Jaesub Shin and Second B. HyeonSeok Jang. Development of autonomous navigation performance criteria and related test methods for autonomous mobile robot in the outdoor environment. In *2021 21st International Conference on Control, Automation and Systems (ICCAS)*, pages 1653--1656, 2021.

[8] Cheng Jiang, JiaQi Sun, KeXin Qi, ChengZhu Jin, and GangTie Jin. Exploring a computer vision and artificial intelligence-based approach to sit-and-reach distance measurement. In *2022 3rd International Conference on Computer Vision, Image and Deep Learning International Conference on Computer Engineering and Applications (CVIDL ICCEA)*, pages 225--229, 2022.

[9] H. Kimura and G. Kajiura. Motion recognition based cooperation between human operating robot and autonomous assistant robot. In *Proceedings of International Conference on Robotics and Automation*, volume 1, pages 297--303 vol.1, 1997.

[10] Ung-Gyo Lee, Kyung-Jea Choi, and Soon-Yong Park. The design and implementation of autonomous driving pallet robot system using ros. In *2021 Twelfth International Conference on Ubiquitous and Future Networks (ICUFN)*, pages 372--374, 2021.

[11] Christos Papachristos, Shehryar Khattak, Frank Mascarich, and Kostas Alexis. Autonomous navigation and mapping in underground mines using aerial robots. In *2019 IEEE Aerospace Conference*, pages 1--8, 2019.

[12] Alessandro Saffiotti and Mathias Broxvall. Peis ecologies: Ambient intelligence meets autonomous robotics. In *Proceedings of the 2005 joint conference on Smart objects and ambient intelligence: innovative context-aware services: usages and technologies*, pages 277--281, 2005.

[13] Madhavan T.R. and Adharsh M. Obstacle detection and obstacle avoidance algorithm based on 2-d rplidar. In *2019 International Conference on Computer Communication and Informatics (ICCCI)*, pages 1--4, 2019.

[14] Kittipong Yaovaja, Pongsakorn Bamrungthai, and Prapapan Ketsarapong. Design of an autonomous tracked mower robot using vision-based remote control. In *2019 IEEE Eurasia Conference on IOT, Communication and Engineering (ECICE)*, pages 324--327, 2019.

[15] Hu Yuan-yan and Wang Ying-xun. Stereo vision-based fast obstacles avoidance without obstacles discrimination for indoor uavs. In *2011 2nd International Conference on Artificial Intelligence, Management Science and Electronic Commerce (AIMSEC)*, pages 4332--4337, 2011.