AUTONOMOUS WHEELED MOBILE ROBOT CONTROL

Janos Simon*

University of Szeged – Faculty of Engineering
Szeged, Hungary

DOI: 10.7906/indecs.15.3.6
Received: 23rd August 2017.
Accepted: 16th September 2017.

ABSTRACT

The autonomous wheeled mobile robots are very interesting subject both in scientific research and practical applications. The article deals with the fuzzy control of autonomous wheeled mobile robotic platform motion in an unstructured environment with obstacles. The simulation results show the effectiveness and the validity of the obstacle avoidance behaviour in unstructured environments and the velocity control of a wheeled mobile robotic platform motion of the proposed fuzzy control strategy.

KEY WORDS

autonomous wheeled mobile robots, fuzzy control strategy, unstructured environments, obstacles, simulation results

CLASSIFICATION

ACM: D.1.1.
JEL: L64
INTRODUCTION

A wheeled mobile robot is a vehicle which is capable of an autonomous motion. The autonomous wheeled mobile robots are very interesting subject both in scientific research and practical applications [1-3].

Figure 1. show the recent situation and the future of the market size of the personal and service robots (source: Japan Robotics Association).

The article deals with the fuzzy velocity control of an autonomous wheeled mobile robots motion in an unstructured environment with obstacles [4-9]. This article presents how to control of motion and velocity of wheeled mobile robots in an unstructured environment that contains obstacles with using ultrasonic sensors and a stereovision system.

The simulation results show the effectiveness and the validity of the obstacle avoidance behaviour in unstructured environment and velocity control of a wheeled mobile robot motion of the proposed fuzzy control strategy.

The article is organized as follows:

Section 1: Introduction.
Section 2: The structure of the general indoor/outdoor applications of mobile robots.
Section 3: Control strategy for wheeled mobile robots.
Section 4: Simulation results.
Section 5: Conclusions.
THE STRUCTURE OF THE GENERAL INDOOR/OUTDOOR APPLICATIONS OF MOBILE ROBOTS

The structure of the general indoor/outdoor applications of autonomous mobile robots are presented in Table 1 and Table 2.

| Indoor/Structured Environments |
|-------------------------------|
| Cleaning large buildings      |
| Transportation industry and service |
| Research entertainment        |
| Surveillance buildings        |
| Customer support museums, shops |

| Outdoor/Unstructured Environments |
|----------------------------------|
| Agriculture                      |
| Forest                           |
| Space                            |
| Underwater                       |
| Military                         |
| Fire fighting                    |
| Sewage tubes                     |
| Mining                           |

CONTROL STRATEGY FOR WHEELED MOBILE ROBOTS

In this section fuzzy control is applied to the navigation of the autonomous wheeled mobile robotic platform in unstructured environments with obstacles and slopes [10-15].

It is supposed that: the autonomous wheeled mobile robotic platform has two wheels driven independently and groups of ultrasonic sensors to detect obstacles in the front, to the right and to the left of the autonomous wheeled mobile robotic platform.

When the autonomous wheeled mobile robotic platform is moving towards the target and the sensors detect an obstacle, an avoiding strategy is necessary.

While the autonomous wheeled mobile robotic platform is moving it is important to compromise between:
- avoiding the obstacles and
- moving towards the target position.

With obstacles present in the unknown environment, the autonomous wheeled mobile robotic platform reacts based on both the sensed information of the obstacles and the relative position of the target [16-23].

In moving towards the target and avoiding obstacles, the autonomous wheeled mobile robotic platform changes its orientation and velocity.

When an obstacle in an unknown environment is very close, the mobile robot slows down and rapidly changes its orientation. The navigation strategy has to come as near to the target position as possible while avoiding collision with the obstacles in an unknown environment.
The block diagram of the fuzzy inference system is presented in Figure 2. In the present implementation of the fuzzy controller the Center of Area method of defuzzification is used.

**SIMULATION RESULTS**

The author applied the proposed fuzzy controller to the autonomous wheeled mobile robotic platform moving in an unstructured environment with obstacles. The control strategy was tested through simulations of wheeled mobile robot motion [24-27]. A simulation example of a wheeled autonomous mobile robotic platform is presented in Figure 3. The corresponding fuzzy control is implemented to perform tasks of obstacle and collision avoidance. In particular, the navigation strategy proved to be extremely sensitive to the balance between avoid obstacle and reach the target behaviors. Simulation results are shown in Figure 3.

**CONCLUSIONS**

The article deals with the fuzzy control of autonomous wheeled mobile robotic platform motion in an unstructured environment with obstacles. The simulation results show the effectiveness and the validity of the obstacle avoidance behaviour in unstructured environments and the velocity control of a wheeled mobile robotic platform motion of the proposed fuzzy control strategy.

Wheeled mobile robot navigation strategies using fuzzy logic have major advantages over analytical methods also simulation results recommends fuzzy logic controller for the wheeled mobile robot motion in unstructured environments.
REFERENCES

[1] Simon, J. and Martinović, G.: Navigation of Mobile Robots Using WSN’s RSSI Parameter and Potential Field Method. Acta Polytechnica Hungarica 10(4), 107-118, 2013,

[2] Simon, J.: Concepts of the Internet of Things from the Aspect of the Autonomous Mobile Robots. Interdisciplinary Description of Complex Systems 13(1), 34-40, 2015, http://dx.doi.org/10.7906/indecs.13.1.5.

[3] Simon, J.: Optimal Microclimatic Control Strategy Using Wireless Sensor Network and Mobile Robot. Acta Agriculturae Serbica XVIII(36), 3-12, 2013,

[4] Mester, G.: Wireless Sensor-based Control of Mobile Robots Motion. Proceedings of the IEEE 7th International Symposium on Intelligent Systems and Informatics, September 25-26, 2009. Subotica, pp.81-84, 2009, http://dx.doi.org/10.1109/SISY.2009.5291190.

[5] Mester, G.; Pletl, S.; Pajor, G. and Rudas, I.: Adaptive Control of Rigid-Link Flexible-Joint Robots. Proceedings of 3rd International Workshop of Advanced Motion Control, March 20-23, 1994. Berkeley, 1994,

[6] Mester, G.: Neuro-Fuzzy-Genetic Trajectory Tracking Control of Flexible Joint Robots. Proceedings of the 1 ECPD International Conference on Advanced Robotics and Intelligent Automation, 1995, Athens, 1995,

[7] Mester, G.; Pletl, Sz.; Pajor, G. and Rudas, I.: Adaptive Control of Robot Manipulators with Fuzzy Supervisor Using Genetic Algorithms. In Kaynak, O., ed.: Proceedings of International Conference on Recent Advances in Mechatronics, August 14-16, 1995. Istanbul, 1995,

[8] Mester, G.: Service robots. In Hungarian. A Magyar Tudomány Napja a Délvidéken, November 13th, 2010. Novi Sad, pp.470-482, 2010,
Autonomous wheeled mobile robot control

[16] Mester, G. and Pletl, S.: Hybrid Control of Flexible Robots. In Hungarian. Gép, LV. évf., 37-38, Budapest, 2004,

[17] Gyeviki, J. and Mester, G.: Dynamics of a Servopneumatic Positioning System. Proceedings of the Workshop on Mechatronics, 1-5, Varna, 2003,

[18] Mester, G. and Pletl, S.: Fuzzy Control of Robot Manipulators with joint Flexibility. Proceedings of the XXI Yugoslavien Congress in Theoretical and Applied Mechanics, 29th May - 3rd June 1995. Niš, pp.127-132,1995,

[19] Mester, G. and Kutri, L.: Non-linear Parametric Vibrations of Motor Gear Machinery. Proceedings of the International Symposium on Gearing & Power Transmissions. Tokyo, pp.37-42, 1981,

[20] Mester, G.; Jeges, Z.; Pletl, S. and Gizella, P.: Dynamic modeling of robot manipulators with flexible joints.

Bullitons for Applied Mathematics 731(91), 137-143, 1991,

[21] Mester, G.; Jeges, Z.; Pletl, S. and Gizella, P.: Dynamics and Control of Basic Configuration of Industrial Robot with Flexible Joints.

Proceedings of the 37th International Conference Annual Gathering KoREMA. Zagreb, pp.644-648, 1992,

[22] Mester, G.; Kutri, L. and Jeges, Z.: Nonlinear Parametric Torsional Oscillation of the Motor-Reductor Shaft. In Croatian.

Proceedings of the XV Yugoslavien Congress in Theoretical and Applied Mechanics. Kupari, pp.423-430, 1981,

[23] Mester, G.; Pletl, S. and Pajor, G.: Adaptive Dynamic Hybrid Control of Industrial Robots with Flexible Joints. In Croatian.

Proceedings of the XX. Yugoslavien Congress in Theoretical and Applied Mechanics. Kragujevac, pp.94-97, 1993,

[24] Kasač, J.; Stevanović, S.; Žilić, T. and Stepanić, J.: Robust Output Tracking Control of a Quadrotor in the Presence of External Disturbances.

Transactions of Famena 37(4), 29-42, 2013,

[25] Stepanić, J.; Kasać, J. and Ćosić Lesićar, J.: What is taken for granted about quadrotors: Remarks about drive and communication.

Proceedings of the 3rd International Workshop on Advanced Computational Intelligence and Intelligent Informatics (IWACIII 2013), October 18-21, 2013. Shanghai, 2013,

[26] Attila, N.: Genetic Algorithm-Based Adaptive Fuzzy Logic Systems for Dynamic Modeling of Quadrotors.

Proceedings of the 3rd International Conference MechEdu, May 14-15, 2015. Subotica, pp.96-103, 2015,

[27] Puskas, B. and Rajnai, Z.: The Requirements of the Installation of the Critical Informational Infrastructure and its Management.

Interdisciplinary Description of Complex Systems 13(1), 48-56, 2015, http://dx.doi.org/10.7906/indecs.13.1.7.