Autonomous Robot Based On Fuzzy Controller Admınıstratıon

Mammadova Kifayat, Hamzayev Shamil

Abstract

In this thesis, the application of tracking on a fixed path with the approach of an autonomous robot was implemented. For this purpose, a fuzzy logic system that can exchange information in real time as both system hardware and software has been developed. A system embedded in the hardware section is used to achieve target and location control with fuzzy logic. Through this system, DC motor, servo motor, ultra sound sensor, bluetooth module and optical sensor management were implemented. In addition, desktop software was developed using C# language with microcontroller software and Visual Studio 2015 platform.The coordinates (x, y) and route data sent by the developed autonomous robot in real-time on the designed fixed path are calculated by the fuzzy controller. The obtained data is tracked with the location data and movements of the robot with the map created in the desktop software of the autonomous robot.

Keywords: autonomous robot, fuzzy logic, fuzzy controller, C# interface, process mapping

The applications using the fuzzy controller approach were also tested with the traditional control method and the results were compared.When the autonomous robot is driven to any point on the track, it calculates the starting position and sends the location information to the desktop software via the bluetooth module. In response to this information, the desktop software transmits target information to the autonomous robot to move it to. In the fuzzy approach, the coordinate and distance information from the robot to the desktop software is shown in green, and the route information from the software to the robot is shown in orange. In the traditional method, the coordinate and distance data from the robot to the desktop software is displayed in blue. As a result, the autonomous robot received location information from the target coordinates sent by the desktop software, and the required distance and direction were found with the fuzzy controller [1,2].

When the application areas of autonomous robots are examined in [3,5], it is seen that they have a wide range of applications from military applications to police bomb disposal robots, from agricultural robots to space exploration robots and transport robots. The diversity of applications makes robots systems that require research and development at multiple points, both software and hardware. Autonomous robots are robots that, thanks to their sensors, act according to the information received from the environment and perform the given tasks by themselves. While performing these tasks, they are able to find their own direction to go to a predetermined destination according to their perceived environment, and they are able to advance to the designated place with the least difference by overcoming the obstacles that may come in front of them.

When these cars determine their surroundings, they get help from various sensors such as ultrasonic sensors, GPS (Global Positioning System), radar, laser, camera and the like. They synthesize the data from these sensors with their own control software, determine the best route for themselves, and get to work. In this process, they take into account obstacles along the route, update the difference between the coordinates they need to go to, and move along their normal route.

These robots, used in many studies, show how far robotics has evolved from the past to the present, and that there is no limit to the processes that can be done technologically.

The development of autonomous vehicles using new techniques can ensure that they are brought to a level of sensitivity that can eliminate the margin of error caused by humans.

The autonomous control system should have a structure that can be changed according to reliability, stability, reactions, synthesize the results of the system within itself, and report the results to the user in an easy and understandable way. The technical characteristics of the specially designed robot must meet the desired control method and perform the tasks assigned to it within the circuit.

In addition, it is desirable that system parameters change over time to ensure appropriate and effective control. Therefore, fuzzy logic controls, a control method that can exemplify human reasoning and

knowledge in a control system, can be a good solution. Control actions of the robot should be provided by a closed-loop method, and fuzzy logic should be used for uncertainties within the position control. Few studies have been done on the control of autonomous robot system with fuzzy logic and Atmega2560 (Arduino MEGA).The aim of this work is to process the distance and angle data coming to the robot through a fuzzy logic desktop application, without the need for a map, using an ultrasonic sensor on a pre- prepared path with the autonomous robot under study. Communication between the robot and the computer is ensured by bluetooth connection. In the environment where the robot will be operated, the environment must be trained first. For this purpose, the environment is scanned from many points using a 360-degree rotating laser meter and gyroscope. During scanning, the distances of walls and fixed objects from a certain height are recorded in the database depending on the measurement point by means of a laser meter.

There is no external operator to direct or interfere with the autonomous robot's actions. After the start command is given to the system, all expected sequential actions are controlled by the intelligent mechanism of the robot [2]. The mobile robot works in three states. These states are: fully autonomous, semi-autonomous and non-autonomous robots.

Fully autonomous robots are systems that make decisions by themselves and have the ability to implement the decisions they make. Semi-autonomous robots make decisions in certain situations and are user-controlled systems in others. Non-autonomous robots are completely user-controlled systems.

When the robot is operated in the task area after learning the environment, it creates a map of the environment by detecting the distances of objects around it and calculates its location by comparing it with the maps in its memory. Calculating the starting location, the robot continuously scans its surroundings en route to a given target point and advances to the target point using the encoder information it receives from the wheels. While going to the goal, the ant colony tries to calculate the shortest path using the measurement points in its memory [1,4]. In [7-8], it was observed in simulation studies how and to what extent the error rate in the data received from multiple sensors in multiple mobile robot switching systems is improved. The simulated sensor collected data from the environment using laser, ultrasound and camera sensors and observed how the data values changed considering different combinations of these sensors. The laser and camera sensors used are identified as primary sensors. Microsoft Robotics Development Studio was used as a simulation environment, and opencv (Open Source Computer Vision) libraries were used for image processing. At the same time, data communication between mobile robots was modeled and studied in a simulation environment. Prowler wireless network simulation package is used in the simulation work.

In [9], a new mutation operator was developed for the pathfinding problem with Genetic Algorithms (GA) for an autonomous mobile robot. This new mutation operator and various mutation operators previously presented in the literature were compared. As a result of the comparisons, it was concluded that the new mutation operator performed more successfully. The path finding algorithm with GA was tested on the Pioneer 3-DX mobile robot. "Matlab" program was used to communicate with the robot, and a camera was placed on the ceiling of the laboratory, and pictures were taken and placed. Positioning and wayfinding processes have been tested in a real laboratory environment as an integrated system, enabling the robot to determine its own position and obstacles in the environment.

In the study conducted in [10-11], a fuzzy expert system is designed to ensure helicopter takeoff and landing with fuzzy logic. For this purpose, a model helicopter and a test platform were created where the movements of the helicopter can be tested. Control of the vertical movement of the axis determined by the fuzzy logic control system ensures the movement of the helicopter with the four-degree shaped test platform.

Fuzzy logic motion control was developed with Arduino 2560 Control Panel and Visual Studio 2010 c# software to control the helicopter model and analysis.

The real-time control of the helicopter created on the test platform was verified by empirical research. During the control of the helicopter, the sensor values of the helicopter are read by the Arduino and sent to

the computer with the Ultrasonic distance sensor placed on the axis and two helicopter models. The processed data were processed by the management software to generate the input values. As a result, the movement of the helicopter in the vertical axis was studied as a control experiment and simulation [4,6]. Unmanned vehicles are technologies used in critical areas that do not have human elements, can be controlled remotely or autonomously, and perform predetermined tasks. Perhaps the most fundamental driver of demand for unmanned vehicles is that they can be sent anywhere humans cannot safely go and return.

Conclusion

As can be seen in the literature review, the efficiency of the systems used in PID and fuzzy logic controlled researches was compared, and fuzzy logic control is considered the most important element of the research due to its simple structures and the quick and easy adaptation to the changing conditions displayed in the systems and its success in nonlinear systems. Is being In this work, using the controller, an autonomous robot and a stable road environment have been created. The movements of the robot on the track are monitored through the C# interface, and the margin of error is measured in C#. The obtained results were checked in the Matlab environment and their accuracy was measured.

References

[1] danekoa.I.,. Kosareva.V, tikhonovk.M., tishkovv.V. The use of modern integrated information technologies in the modeling of aviation robotic systems / Ed. Corresponding member RARAN, Doctor of Technical Sciences B.V. Obnosov. M.: Publishing house MAI-PRINT, 2018.212p.

[2] Tang S., Wüest V., Kumar V. IEEE Robotics and Automation Letters, **3**(2). 2018,pp.1152–1159.

[3] Jatsun S., et al. Control flight of a UAV type tricopter with fuzzy logic controller. In: XIII International cientific and technical conference "Dynamics of Systems, Mechanisms and Machines". 2017, pp. 1–5.

[4] Mustapa Z., et al. Altitude controller design for multi-copter UAV. In: 2014 International Conference on Computer, Communications, and Control Technology (I4CT). Pp. 382–387.

[5] Mammadova K.A., Amrah A.B. Development of a method for planning the trajectory of movement of a mobile autonomous robot in a three-dimensional environment based on a fuzzy logic apparatus. Proceedings of the 10th International Scientific and Practical Conference Science and Practice: implementation to modern Society Manchester, Great Britain 4-5.06.2021. Pp.664-672. Https://interconf.top/documents/2021.06.04-05.pdf

[6] Mammadova K.A., melikovax.Y.Design of an industrial robot using production technology and 3d modeling software. Scientific horizon in the context of social crises. Tokyo, Japan.2022, pp. 250-257

[7] Raj, R. And Mohan, B.M. 'Modeling and analysis of the simplest fuzzy PID controller of Takagi-Sugeno type with modified rule base', Soft Computing. Vol. 22, No. 15,2017,pp.5147–5161.

[8] H. W. Kim and S. Jung, "Fuzzy Logic Application to a Two-wheel Mobile Robot for Balancing Control Performance," Int. J. Of Fuzzy Logic and Intelligent Systems, vol.12, no.2, 2018.

[9] Merve Nur Demir Yusuf Altun. Mapping and Location Using Genetic Algorithm with Autonomous Vehicle. Year 2020, Volume 8, Issue 131.01.2020, pp. 654-666,

[10] Chetinkaya A., Okatan A. Emergency Autonomous Robot Design with Fuzzy Logic Control Approach. Computational Intellegence& Wireless Sensor Networks, Vol.1, No. 1, September, 2019,

[11] Kwachas, choib-J. Design of fuzzy logic control system for segway type mobile robots, International Journal of Fuzzy Logic and Intelligent Systems, 2017.