Intelligent Performance of the Proposed Fuzzy Logic Controller

Dr. Rekha

Assistant Professor, Department of Electronics Govt. College (Autonomous), Kalaburagi.

Abstract

The proposed structure is implemented by integrating multiple ultrasonic sensors into a robot to collect data from a real- world environment. The decisions that govern the robot's behavior and autopilot navigation are driven by a field programmable gate array- (FPGA-) based fuzzy logic controller. The validity of the proposed controller was demonstrated by simulating three real- world scenarios to test the bionic behavior of a custom-built robot. The results revealed satisfactorily intelligent performance of the proposed fuzzy logic controller. The controller enabled the robot to demonstrate intelligent behaviors in complex environments. Furthermore, the robot's bionic functions satisfied its design objectives.

Introduction

With the increasingly widespread application of robots in today's fast-changing and diverse environment, it is essential for robots to possess autonomous movement capacity and intelligent decision-making processes, as well as behavioral control through sensory awareness of the surrounding environment to complete tasks in complex situations. In this regard, navigation and obstacle avoidance are the two crucial concerns that require attention.

Fuzzy logic [8–11] has been deemed appropriate for applications in automatic navigation of robots. This is mainly because of its capacity to process large quantities of incom- plete and inaccurate input signals. Such signal processing can enable automatic navigation for robots in uncertain environments. Abundant research has been reported on the application of fuzzy theory in automatic navigation for robots. A typical application requires the robot to carry various sensors for sensing environmental information. The outputs of the sensors serve as inputs to the fuzzy con- troller. Expert experience is adopted to prebuild a fuzzy rule database, which is required for the robot's subsequent behaviors. Fuzzification, fuzzy inference, and defuzzification generate decisions that control the robot's behaviors [12, 13], enabling the robot to navigate automatically.

A fuzzy logic controller can accept input from a diverse range of sensors. Ultrasonic sensors can detect the distance between a robot and obstacles [14–16]. Global positioning systems can detect the robot's current position [17–19]. With fuzzy inference, the final output enables a robot to differ- entiate between various environments and to perform the behaviors desired by the designer. For example, differences in wheel speeds can enable a wheeled robot to turn at an angle and roll in a new direction to avoid an obstacle. Regarding multilegged robots, the final input may be the rotational angle or forward velocity.

Behavior of Intelligent Robots

Behavior of Bionic Robots. The term "bionic robots" refers to robots that mimic the body structures, functions, problem- solving behavior, and motions of living creatures, with simple mechanical structures or electronic devices. Multilegged bionic robots belong to this category; their motion patterns and tread movements resemble those of insects and spiders. Such a robot uses each leg, with its embedded multiple rotational joints, to mimic the behavioral patterns of insects. Among such robots, the six-legged type is the most common type of bionic robot.

Applying Fuzzy Controller in Obstacle Avoiding. The central nervous system contains the brain and spinal cord; the brain is responsible for the movement of the discriminant action and the spinal cord is responsible for the aggregation of sensory signals and finishing the brain cortex movement area issued by the action instructions and links the various parts of the neural network; it also contains the reflection of this part of the movement.

Robots in unknown environments need sensors to detect environmental conditions; after their sensors have mea- sured environmental information, the robots' controllers can generate decisions to control the robots' behaviors. In this study, multiple ultrasonic sensors were adopted to measure distances between a robot and the environmental obstacles that surrounded it.

In this study, the neural pulse signal of the organism is used as the control structure of the imitation of the electronic circuit, and the information between the main control system and the subcontrol system is integrated. The main control system must transmit the analog signal. The auxiliary control system only needs to transmit the sensed analog signal to the main system and receives the motion instruction given by the main system, and the auxiliary functions of the main system and subsystems are complementary to each other.

Multiple sets of ultrasonic distance measurements were used as input to develop an intelligent navigation system. With this distance information, the fuzzy logic controller enabled the robot to safely complete tasks in an unknown environment. An individual ultrasonic sensor is shown in Figure 1(a). A photograph of the six-legged robot with an operative sensor array is shown in Figure The positions of the distance sensing ultrasonic sensors are shown in Figure 1(c): right (S1), front (S2), left (S3), right front (S4), and left front (S5).

The control system of this study combines the main con- troller, subcontroller, organization, and computer software.

Design of Obstacle Avoidance. Figure 5 shows obstacle avoidance is a priority for a moving robot that must avoid obstacles and prevent collisions. We propose an efficient real- time avoidance system by which robots can avoid obstacles while moving as directed by automatic navigation. The distance information collected from sensors 1, 2, and 3 is used for the ultrasonic sensing system. Using the information about the robot's surroundings collected from these sen- sors as input, the proposed fuzzy logic controller generates instructions by which the robot can avoid obstacles.

Conclusion

The current study, with fuzzy control as its core, proposes control methods for intelligent behaviors such as obstacle avoidance, wall following, and attack. The system integrates three control methods within an inclusive structure that can be used for further development of bionic behavior controllers for intelligent robots.

In this study, the controller platform is established to determine whether the surrounding environment is suitable for walking through the most basic bio-current signal and discrete event control through the most primitive and consis- tent simulation of the organism. In the robot's reflex move- ment which is directly used for environmental interaction, this method can let the six-legged robot know the front path of obstacles and quickly take action to avoid unnecessary collision; the future can use GPS, gyroscope, pressure sensors, temperature and humidity sensors, and infrared sensors, increasing fusion sensing in the system, so that, overall, it is more perfect.

In the system of signal transmission, we use the simplest 8-bit transmission to significantly reduce the chip computing, reduce system load, as far as possible in a short time to resolve and control the system, so that the signal from the main system to the subcontroller can be immediately transferred. This method allows the system time to deal with not only other major messages to judge, but also the least information for the most effective signal processing, and to be closer to the simulation of biological movement structure.

In the study of the structure of the robot, the behavior can be smoother, real-time to achieve effective steering behavior, dodge behavior; these have a high degree of evolution, func- tional verification, and system analysis; we have established three situations, dodge obstacles, to avoid the dead end and walking in a wall of space; the results show that the proposed fuzzy logic controller is able to successfully guide the robot behavior with the autonomous model.

References

1. M. S. Ayas, I. H. Altas, and E. Sahin, “An optimized fuzzy logic controller for a parallel mechanism rehabilitation robot,” in Proceedings of the IEEE International Conference on Fuzzy Systems (FUZZ-IEEE ’15), pp. 1–6, IEEE, August 2015.
2. Y. C. Chou, K. J. Huang, W. S. Yu, and P. C. Lin, “Model-based development of leaping in a hexapod robot,” IEEE Transactions on Robotics, vol. 31, no. 1, pp. 40–54, 2015.
3. Y. Zhai, P. Gao, Y. Sun et al., “Gait planning for a multi-motion mode wheel-legged hexapod robot,” in Proceedings of the IEEE International Conference on Robotics and Biomimetics (ROBIO ’16), pp. 449–454, December 2016.
4. L. Zhang, D. Li, F. Yang, and C. Liu, “Development and attitude control of a Hexapod bionic-Robot,” in Proceedings of the IEEE International Conference on Robotics and Biomimetics (ROBIO 16), pp. 77–82, December 2016.
5. E. Passos and L. Almeida, “Simulations results of an insect robot,” in Proceedings of the International Conference on Neural Networks (IJCNN ’93), vol. 2, pp. 1837–1840, Nagoya, Japan, 1993.
6. L.-C. Liao, K.-Y. Huang, and B.-C. Tseng, “Design and imple- mentation of a quadruped robot insect,” in Proceedings of the 12th IEEE International Conference on Mechatronics and Automation (ICMA ’15), pp. 269–273, August 2015.
7. W. A. Lewinger, H. M. Reekie, and B. Webb, “A hexapod robot modeled on the stick insect, Carausius morosus,” in Proceedings of the 15th International Conference on Advanced Robotics (ICAR ’11), pp. 541–548, June 2011.
8. G. J. Klir and B. Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall, Upper Saddle River, NJ, USA, 1995.
9. L. A. Zadeh, “Fuzzy sets,” Information and Control, vol. 8, no. 3, pp. 338–353, 1965.
10. M. V. Bobyr, S. A. Kulabukhov, and N. A. Milostnaya, “Fuzzy control system of robot angular attitude,” in Proceedings of the 2nd International Conference on Industrial Engineering, Applications and Manufacturing (ICIEAM ’16), pp. 1–6, Chelyabinsk, Russia, May 2016.
11. J. J. Buckley, “Theory of the fuzzy controller: an introduction,” Fuzzy Sets and Systems, vol. 51, no. 3, pp. 249–258, 1992.