

Human Follower Robotic Device for Real-Time Application

Arunima K. Ramesh¹ and Jemy Jose Kakkassery²

¹⁻²Vidya Academy of Science and Technology/ECE, Thrissur, India

Email: arunimakramesh97@gmail.com, jemy.j.k@vidyaacademy.ac.in

Abstract—Nowadays, there are many robotic devices developed for automation and navigation purposes. Robotics is an emerging field, which reduces the manual work. Many types of robotic navigation techniques are available in the world. The proposed system is an autonomous robotic device, which aims to follow a specific human. It can follow human movement automatically. It doesn't need to be encouraged or withdrawn. It is a user friendly system, as interference between the user and device is minimal. Secured delivery of the materials can be achieved by the proposed system. Manual effort of driving device and carrying materials can be minimized using this system. Microcontroller, sensors and motors are incorporated in this system. Wireless communication and sensor technology are used to trace specific human (owner). Obstacle detection is also enabled in the proposed device. Microcontroller is used for interfacing between hardware and software.

Index Terms— Accelerometer, wireless communication, navigation.

I. INTRODUCTION

Nowadays, robots are considered an important component in the society. This is due to the replacement of humans by robots in basic tasks. However, designing efficient navigation strategies for an autonomous mobile robots and considering their safety are among the most important topics in developing an autonomous robotics. The ability to detect and track specific people is considered a key prerequisite for serving these kind of robots. With the emerging technology, all forms of existing known and used technologies are converted into more convenient and easy to use form, often resulting into the use of autonomous components. Human effort of driving a device is considered to account. It has been a major task for human to drive the device. Following a specific person is the main problem. Hence, for this purpose the proposed system have been developed. This system can follow specific human autonomously and can carry the required weight accordingly.

A. Survey on Existing Systems

Different existing methods to follow humans are by using ultrasonic sensor, bluetooth and image processing. In first method ultrasonic sensor will be incorporated to the mobile device. This method detects human or object in a specific range and follows accordingly. The major drawback is that, it will follow anything which comes under that region. Bluetooth controlled robotic device resembles like a remote controlled system as directions of robots need to be controlled by the device. An Android app need to be installed on user's mobile phone and in which wireless communication can be enabled between user and the device. Upon giving the direction the device can be moved accordingly. Controlling the device is a hectic task in this method. By using image processing

technique specific human can be followed according to the detection of gesture or some other predefined features. But this method is complex as several analysis are required.

B. Proposed System

The proposed system is an autonomous device which aims at following specific human. It can follow human movement automatically. Interference between the user and device is minimal. Delivery of the materials from one place to another can be achieved by the proposed system. Manual effort of driving device and carrying materials can be minimized using this system. The device's direction can be controlled by an accelerometer sensor. The accelerometer reads the status of x, y and z directions and can control movement of the device. The proposed robotic system can be divided into two parts:

- A. Transmitter section - Controlling part which is present in user's hand.
- B. Receiver section - Attached in trolley system.

The controlling part sends status of the x, y and z of the accelerometer sensor to the trolley part with help of the RF data modem. Whereas the trolley part read controlling part's data through RF Data modem. Then analyze data status and continue after processing. Trolley part continuously monitors, whether there is an obstacle present in front of the trolley with the help of ultrasonic sensor. The device consist of microcontroller - Atmega328, RF data modem, accelerometer, DC motor and ultrasonic sensor. Microcontroller is used for interfng between hardware and software. Block diagram of transmitter and receiver section is shown in Fig. 1 and Fig. 2.

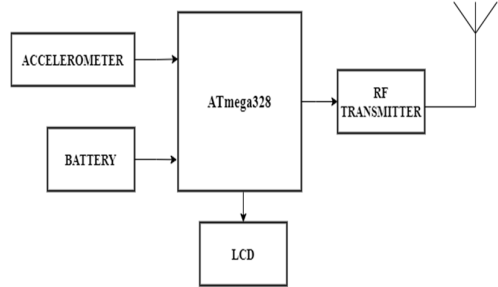


Fig. 1. Block diagram - Transmitter section

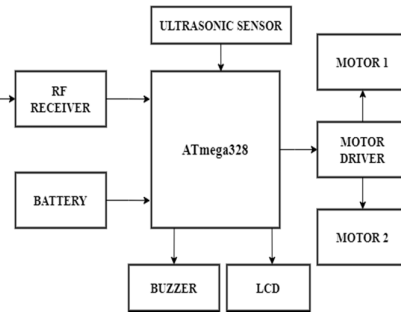


Fig. 2. Block diagram - Receiver section

II. RELATED WORKS

Aicha Moulay and Fatima Laoufi [1] proposed a system in which FPGA-Based Car-Like Robot Path Follower with Obstacle Avoidance is possible. In this system, design and enhancement of an System on Programmable Chip (SoPC) based autonomous path following along with obstacle avoidance using infrared sensors and ultrasonic sensor possible. The Line follower robot is a autonomous machine that can detect and follow the line drawn on the floor using infrared sensors which are installed under the robot . The path is pre-defined as a black line on a white surface as a high contrasted colour. This robot has an ultrasonic sensor to avoid an obstacle, either from the right or left and will stop if an obstacle is detected in the path or if the path is ended. The digital controller is designed and implemented on the basis of both the integrated circuits and the Field Programmable Gate Array (FPGA).

Tresna Dewi and Yudi Wijanarko [2] proposed a novel approach as Fuzzy Logic Controller Design for Leader-Follower Robot Navigation to follow specific person. Mobile robots are used everywhere in the society, starting from industries to domestics. Navigation is always an issue for this type of robot, to ensure it can finish its task safely. One of the ways is to give a 'brain' for autonomous navigating robot. The Fuzzy logic controller is a good way for the 'brain', as it does not need accurate mathematical modelling of the system. Utilizing the inputs from sensors is enough to design an effective controller. Here, an FLC design for leader-follower robot is enabled. This FLC design is the enhancement of FLC application in a single two differential-driven type of mobile robot. The relation between leader and follower robot is modelled as a linear spring-damper system. Simulation gives the feasibility and advantage of the proposed method several environment setting, and this paper also shows that the method can be easily incorporated to one leader and more than one follower.

Tsung-Han Tsai and Chia-Hsiang Yao [3] developed a real-time tracking algorithm for human following purpose. The ability to detect and track specific people is considered a main criteria for serving mobile robots. This design presents a tracking system using a binocular camera, which is capable of tracking a specific human

being in both indoor and outdoor environments. The proposed tracker system detects the target with the combination of human detection, colour histogram, and block matching algorithm (BMA). If the colour of the object is similar, the position of the object is determined by the predictor of the Kalman filter. Finally, the mobile robot is monitored based on the depth information of the target object. The effectiveness of the system is verified by human experiments which is carried out in indoor and outdoor environments. A block matching algorithm is performed before the detection process.

Hongying Zhang [4] introduced a system in which topology optimized multimaterial soft fingers for applications on grippers, rehabilitation and artificial hands is developed. Multimaterial soft robots, composed of integrated soft actuators and a harder body, which shows great potential to exert higher weights. The multimaterial design drawbacks is mathematically made under the framework of topology optimization which includes the whole structure and material distribution are obtained simultaneously. Here, a multimaterial pneumatic soft finger, modeled as a compliant mechanism, is altered to achieve maximal bend deflection and is further customized to practically applicable on grippers, rehabilitation and an artificial hand. These optimized multimaterial soft fingers are made by combining the methods like molding and 3D printing technique. Experimental results how that the soft gripper can examine a huge variety of objects with different varieties of shapes (from M4 screws to complicated sunglasses), size and weights (up to 168g), the rehabilitation finger can facilitate human safely mainly in two modes, and the artificial hand can perform various gestures. This represents a significant move toward high-performance soft robots.

III. METHODOLOGY

The system uses a modular architecture with co-designed hardware and software to support autonomous operation, efficiency, controllability and flexibility. Each module, designed to accomplish specific pre-defined tasks. The proposed system interfacing block diagram of transmitter and receiver section is shown in Fig. 3. and Fig. 4. The block diagram consists of a microcontroller, ultrasonic sensor, LCD display battery, accelerometer sensor, RF modem, motor driver and motor. The design of the proposed model consist of two different stages:

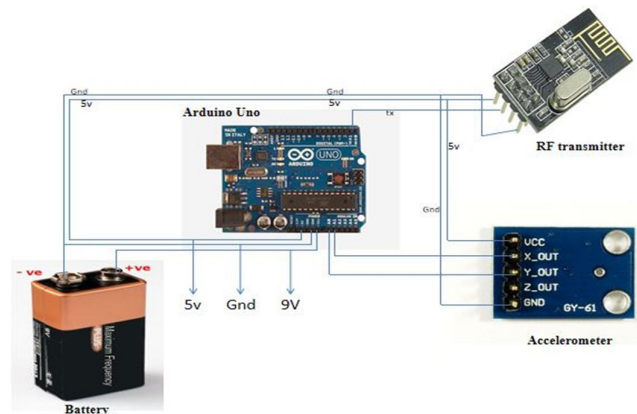


Fig. 3. Transmitter section-Controlling part which is present in user's hand

A. Transmitter section-Controlling part which is present in user's hand. It comprises of accelerometer, microcontroller, RF transmitter, battery and LCD display. The accelerometer is an inertial measurement sensor which is used for controlling the receiver device. The status of the x, y and z of the accelerometer sensor is transmitted wirelessly to the trolley part with help of the RF data modem. The direction of movement of accelerometer tilting upward, downward, right and left will correspondingly read by the receiver part through RF data modem. Then data status is analysed and is processed correspondingly like moving forward, backward, left and right.

B. Receiver section-Attached in trolley. It comprises of microcontroller, RF receiver, motor, motor driver, ultrasonic sensor, buzzer, battery, and LCD display. Human following in required direction is possible in accordance with the data received from the transmitter section. Obstacle detection and activation of buzzer is also possible in the proposed device. By using this device 12kg of weight can be carried from one place to another.

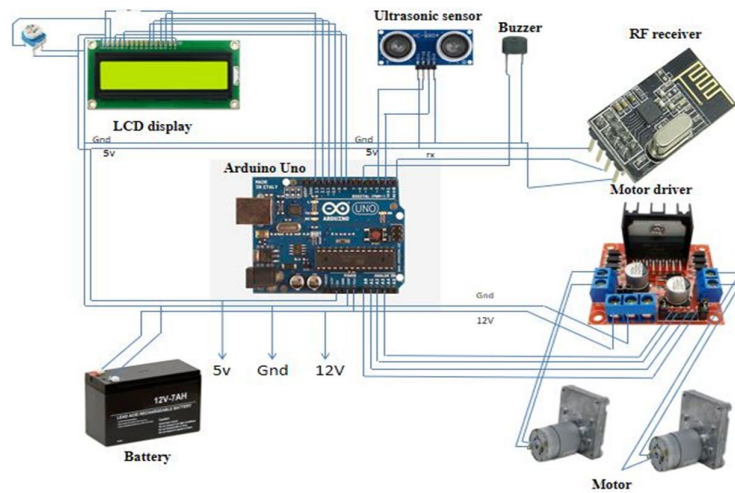


Fig. 4. Receiver section- Attached in trolley

The working of the whole model is explained using the flow chart is shown in Fig. 5.

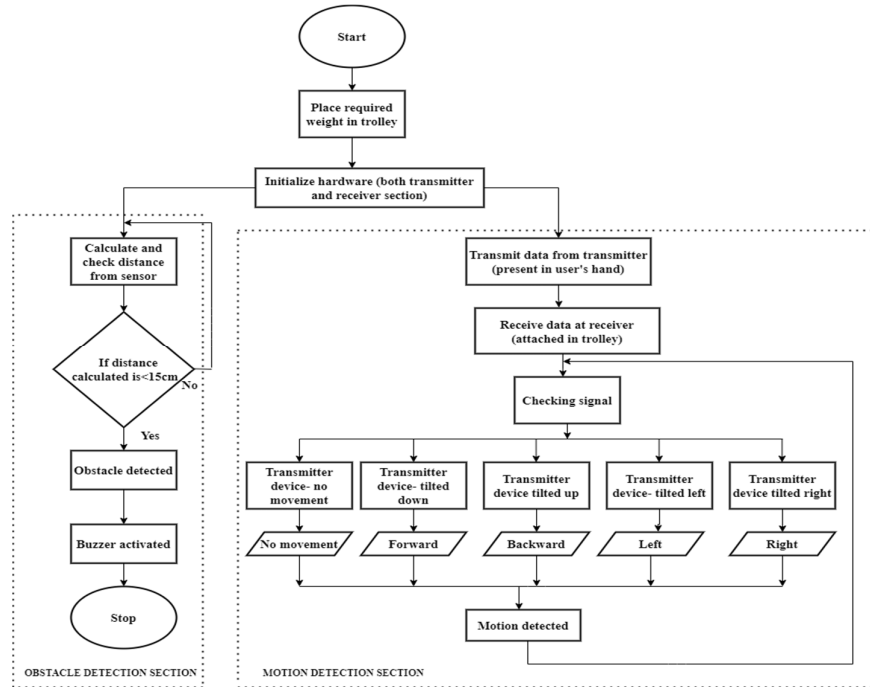


Fig. 5. Flowchart

The steps involved are shown below:

1. The required weight is placed in trolley.
2. Transmitter and receiver section are initialized.
3. Obstacle detection section - When an obstacle is detected in specific range, the buzzer is activated and the system stop accordingly.

Motion detection section - In this system, two sections are implemented; transmitter and receiver section. Transmitter section is the controlling part which is present in user's hand and receiver section is attached in trolley. With the aid of wireless communication, data is transmitted from transmitter to receiver. According to the tilting of transmitter device in upward, downward, left and right correspondingly the trolley will move in forward, backward, left and right direction.

IV. RESULT AND DISCUSSION

Transmitter section comprises of accelerometer sensor, arduino uno, RF transmitter and battery is shown in Fig. 6.

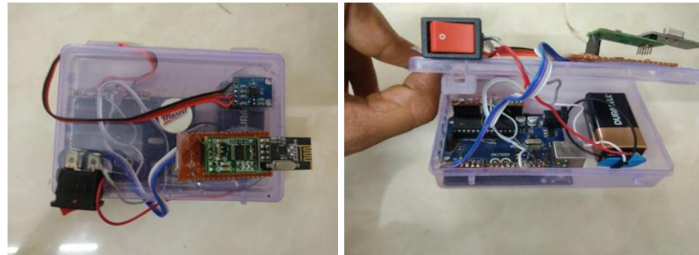


Fig. 6. Transmitter section - present in user's hand

Receiver section consist of arduino uno, ultrasonic sensor, RF receiver, motor, motor driver and battery which is shown in Fig. 7.



Fig. 7. Receiver section - attached in trolley

According to the tilt in direction of accelerometer corresponding movement can be achieved in motor and obstacle detection is possible with the use of ultrasonic sensor. Main element of human follower robotic system is motor. Hence, the controlling of motor should be done by proper analysis. By using this device 12kg of weight can be carried from one place to another. Here, the proposed system is intended to rotate in forward, backward, left and right direction in accordance to the tilt in transmitter device. Ultrasonic sensor is the main device used for distance measurement. It detects obstacle and activates buzzer accordingly.

V. CONCLUSIONS AND FUTURE SCOPE

The Autonomous robot for human following purpose is established here. Manual effort of driving the device can be replaced by the proposed system. In this system, two sections are implemented; transmitter and receiver section. Transmitter section is the controlling part which is present in user's hand and receiver section is attached in trolley. With the aid of wireless communication, data is transmitted from transmitter to receiver. According to the tilting of transmitter device in upward, downward, left and right correspondingly the trolley will move in forward, backward, left and right direction. Obstacle detection and activation of buzzer is also enabled. Hence, by the proposed device specific humans can be followed with ease. Revolving around this topic, future work in the aspect of the device itself includes the refinement of the mechanical parts. The proposed system works on flat surface, by advancement in future, climbing steps using the autonomous robot can be incorporated.

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REFERENCES

- [1] Aicha Moulay and Fatima Laoufifi "FPGA-Based Car-Like Robot Path Follower with Obstacle Avoidance,"2020, IEEE vol. 04, pp. 487-506, 2020.
- [2] Tresna Dewi and Yudi Wijanarko,"Fuzzy Logic Controller Design for LeaderFollower Robot Navigation," 2018,IEEE/RSJ International Conference on, 2008, pp. 3501-3506.
- [3] Tsung-Han Tsai and Chia-Hsiang Yao," A Real-time Tracking Algorithm for Human Following Mobile Robot",2018,IEEE,vol. 17, pp. 455-466, 2005.
- [4] Hongying Zhang, "Topology Optimized Multimaterial Soft Fingers for Applications on Grippers, Rehabilitation and Artificial Hands," 2018, IEEE Sens.J., pp. 1-1, Feb. 2018.
- [5] B. Blasberg and M. Greenberg, "Temporomandibular Disorders," Burket's oral medicine diagnosis and treatment., pp. 271-306, 2003.
- [6] Anja Jackowski, "Head Motion and Head Gesture Based Robot Control: A Usability Study", IEEE Transactions On Neural Systems And Rehabilitation Engineering vol. 35, no. 5, pp. 266-274, 2018.
- [7] Feiyu Chen, "Wrist Cam: A Wearable Sensor for Hand Trajectory Gesture Recognition and Intelligent Human-Robot Interaction",IEEE, vol. 25, no. 2, pp. 265-270, Feb.2019.
- [8] Wentao Dong, Lin Yang and Giancarlo Fortino. "Stretchable Human Machine Interface Based on Smart Glove Embedded With PDMS-CB Strain Sensors.", IEEE Sens.J., vol. 20, NO. 14, JULY 15, 2020.
- [9] B. G. Lee, and S. M. Lee, "Smart Wearable Hand Device for Sign Language Interpretation System with Sensors Fusion",IEEE Trans. Human-Mach. Syst., vol. 44, no. 2, pp. 293-299, Apr. 2019.
- [10] Geng Yang, "An Iot-Enabled Stroke Rehabilitation System Based On Smart Wearable Armband And Machine Learning", IEEE Engineering in Medicine and Biology Society. Annual Conference, pp. 4267-4270, 2019.
- [11] R. Gravina, P. Alinia, H. Ghasemzadeh et al., "Multi-Sensor Fusion in Body Sensor Networks: State-of-the-art and research challenges", Inform. Fusion, vol. 35, pp. 68-80, Oct. 2017.
- [12] F. Chen, J. Deng, Z. Pang et al., "Finger Angle-Based Hand Gesture Recognition for Smart Infrastructure Using Wearable Wrist-Worn Camera",Appl. Sci., vol. 8, no. 3, pp. 369, Mar. 2018.
- [13] D. Xu, Y. L. Chen, C. Lin et al., "Real-time dynamic gesture recognition system based on depth perception for robot navigation", in IEEE-ROBIO, 2012, pp. 689-694.
- [14] R. D. Vatavu, "User-defined gestures for free-hand TV control" in EuroITV, pp. 45-48.
- [15] J. Tang, H. Cheng, Y. Zhao et al., "Structured dynamic time warping for continuous hand trajectory gesture recognition", Pattern Recog., vol. 80, pp. 21- 31.