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Human Following Robot Car

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Abstract

In this modern age of artificial intelligence, humanoid robotics is an emerging research field to advance the moving world. A new challenge of the 21st century is the implementation of the construction and use of robots that follow and help humans at all levels to increase the speed of human work. Due to its human-following capabilities, the human-following robot can help humans through its own intelligence in various situations. Which can greatly reduce the manual labor of people. In this paper we presented some results on the design of a human-following robot car and its capabilities in practice from the IR sensor, ultrasonic sensor and Arduino uno circuit board data. In the future, we will be able to showcase the importance of human-following robots to the world through the use of more sophisticated devices and sensors including cameras, GPS tracks, Bluetooth.

Keywords: Arduino Uno, IR sensor, ultrasonic sensor, Motor shield, obstacles detection, edge detection

1. Introduction

Human Following Robot Car, a state-of-the-art and innovative robot car that can autonomously follow humans within its sensing range with its own intelligence. Equipped with an ultrasonic sensor, an IR sensor, and an intelligent Arduino control system. This robot vehicle can detect and respond to human presence, enabling seamless and safe service. With its sophisticated design and precise maneuvering. The Human Following Robot Car presents a remarkable fusion of robotics and mobility. Human-following cars also offer a glimpse into the future of smart transportation and human-robot collaboration. If we look back a few years, we didn't need human-following robots. But in this advanced world, human-follower robots have now become indispensable. For example, we can say that the need for human-following robots to carry personal belongings in shopping malls, to carry medical equipment and medicine for doctors in hospitals, to carry passenger luggage at airports, and to transport dangerous goods is increasing day by day. The military sector also needs human-following robots to transport weapons to combatants. Human-following robots can be used for more and more demanding tasks in the future using more advanced technology. We can use cameras, tracking devices, and other sophisticated sensors to turn the robot into an intelligent human-following robot that will be the trend in the developed world.

2. System circuit diagram and components

A. Circuit diagram

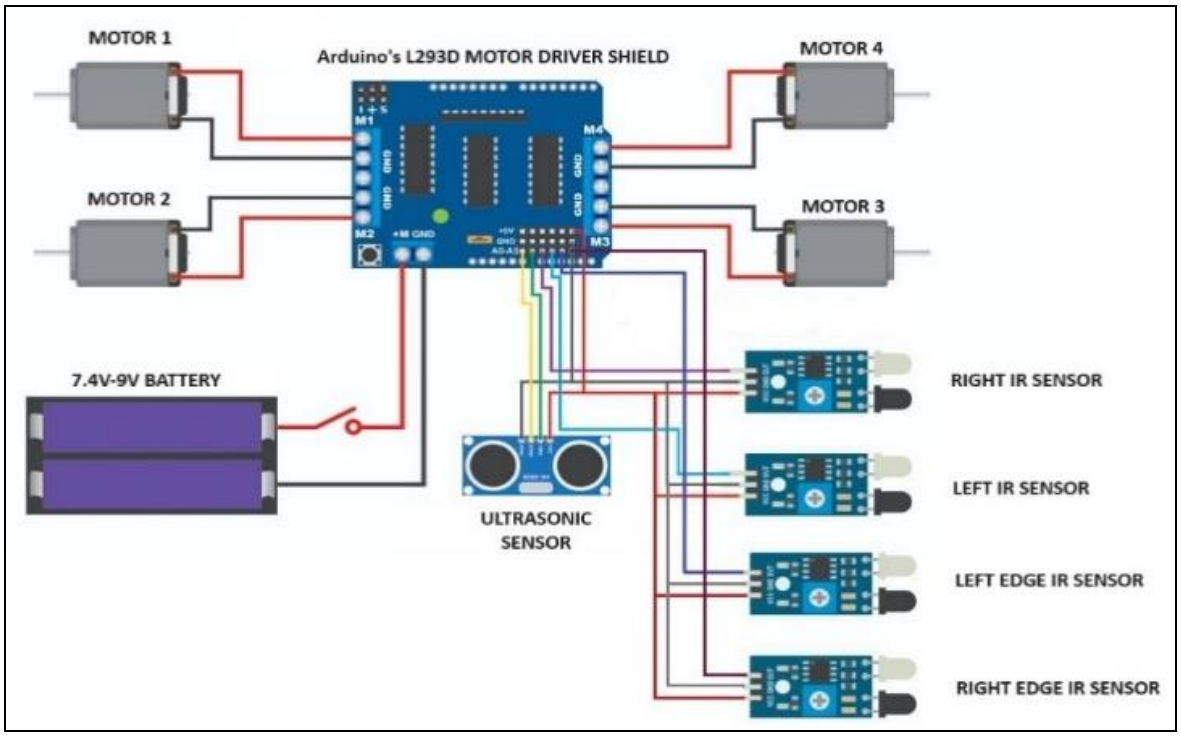

Fig 1: Circuit diagram

B. System Components

1. Core

Arduino Uno

Arduino Uno is an open source microcontroller board which is the brain of the robot. It has the AT mega 328 microprocessor which is a single chip microcontroller. It has specification of 2 kB of RAM,1 KB of ROM,32 KB of flash memory. Programming in the Arduino Uno carried out in the integrated development environment which called (IDE). The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Inte grated Development Environment), via a USB B cable. It can be powered by the USB cable or by an external battery [1].

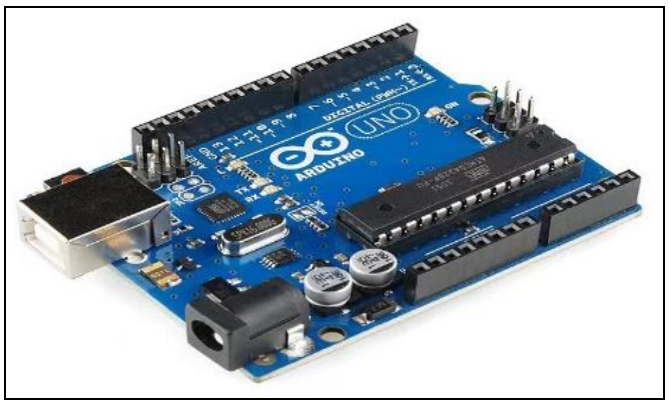

Fig 2: Arduino Uno

Arduino L298D Motor Driver Shield

L298D Motor Driver Shield is a motor driver shield which is designed to Work with L293D IC. The L298D motor driver Shield features a built-in microstepping driver that allows for precise control of the motor's speed and direction [2].

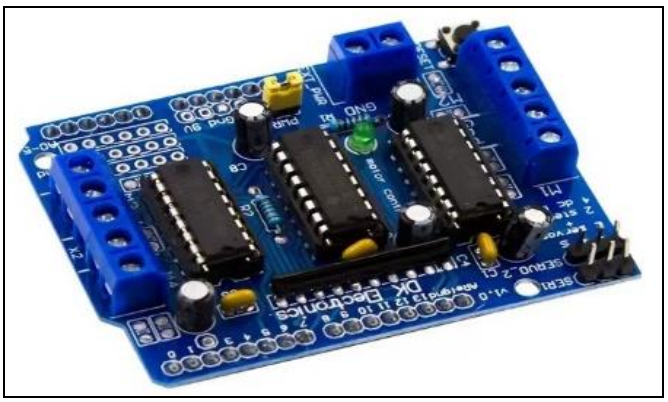

Fig 3: Arduino L298D Motor Driver Shield

2. Movement

TT Dc Motor

TT Dc motor is an electrical machine that's converts electric energy into mechanical energy. The motor is usually the important component in building a robot since it imparts motion to the robot. In this project we used 4 dc motor to drive the car [3].

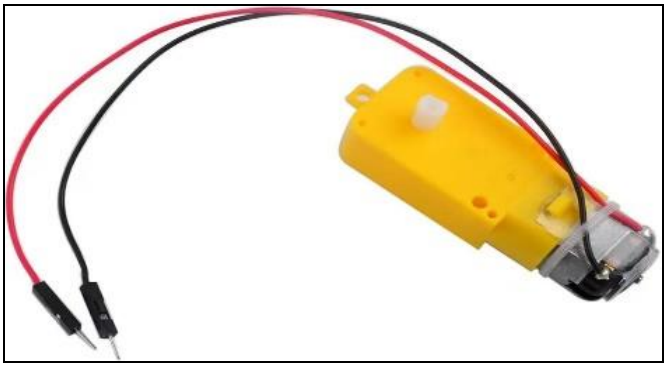

Fig 4: TT Dc Motor

3. Detection

IR Sensor

The IR sensor is an electronic device that gives off light to sense the objects present in its surroundings. In addition, an IR sensor detects the motion of a person as well as measures the heat of an object. However, all objects emit some kind of thermal radiation in the infrared spectrum. However, humans' eyes cannot see these radiations though they are able to be detected by an infrared sensor. The emitter itself is just an IR LED (Light Emitting Diode), while on the other hand, the detector is merely an IR photodiode [4].

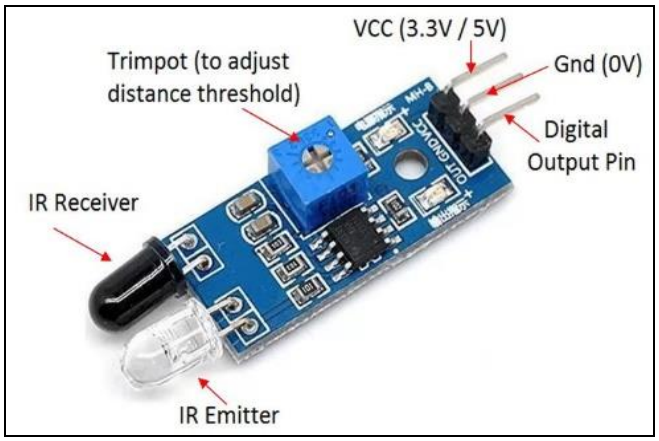

Fig 5: IR Sensor

Ultrasonic Sensor HCSR04

An ultrasonic sensor is an electronic device that measures the distance to an object using ultrasonic sound. The working principle of this module is simple, it sends an ultrasonic pulse out at 40kHz which travels through the air and if there is an obstacle or object, it will bounce back to the sensor. By calculating the travel time and the speed of sound, the distance can be calculated [5].

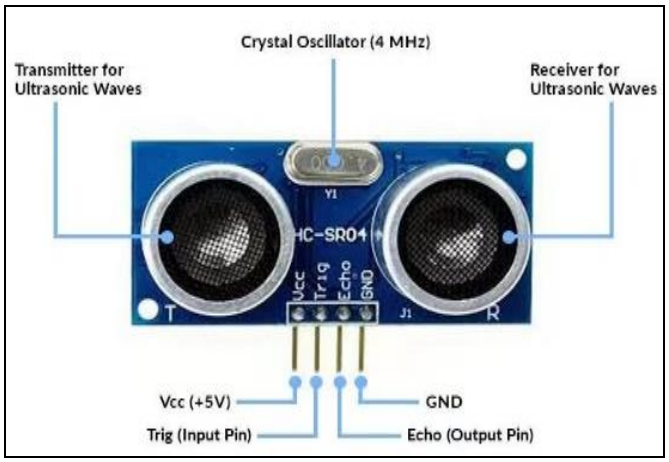

Fig 6: Ultrasonic Sensor HCSR04

4. Connection

Male and female jumper wire

These male-to-female jumper cables are used to join any development board with a female header pin to other development boards with a male connection. These are straightforward cables with connection pins on both ends that enable you to link two locations together.

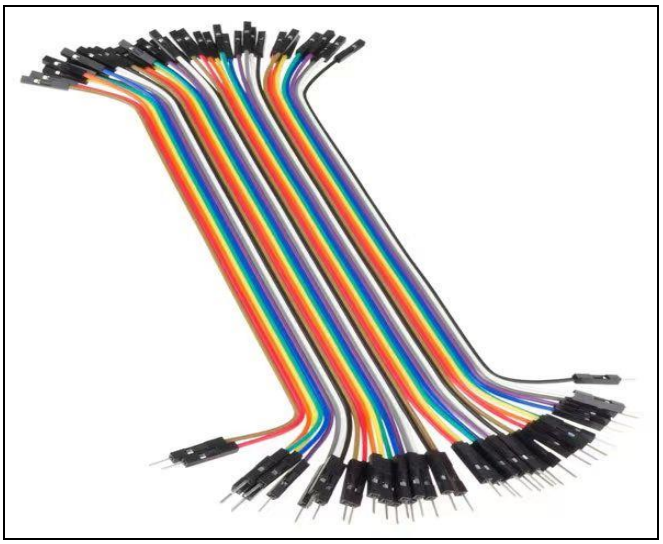

Fig 7: Male and female jumper wire

Battery Holder

To house and connect one or more 18650 Lithium-ion battery cells, a special compartment known as the 18650 Li-ion battery holder is needed. The circuit is established when spring-loaded or flexible contacts in these holders come into contact with the positive and negative poles of the batteries. The capacity outputs are achieved through connection of multiple cells in parallel or series whereas single cells can also be accommodated. A well-built holder should enable easy installation and removal of a battery, but must also secure against possible short circuits, reversing polarities, or leakage. Proper selection of a holder depends on several factors such as application field, battery chemistry, temperature exposure and safety rules.

Fig 8: Battery Holder

5. Power

18650 Li-on battery

18650 Li-on battery is a cylindrical rechargeable cells which is very common in many electronic devices and applications. They take 18mm of diameter and 65mm of length hence their name "18650". These batteries usually have a nominal voltage of 3.6-3.7V and capacities that range from 1200mAh to 3350mAh being common with between 2200-2600mAh. Lithium-ion chemistry has a high energy density making it possible for the use of 18650 cells as

power tools, laptops, electric vehicles, energy storage systems etc. Though its theoretical cycle life is about 1000 charges, parameters like aging and discharge rate affect their actual lifespan. Proper battery management systems are essential for safe operation in packs of high capacity.

Fig 9: 18650 Li-on Battery

3. Materilas and Methods

A human following robot has two stages.

1. Hardware

First, we have to build a frame or chassis as per the requirement. We use acrylic sheet for build this frame. We should carefully arrange the components in the chassis as per the circuit diagram. The L293D Motor Shield has been used to control DC motors and detect obstacles and edges. It's a kind of interface between Arduino and DC motors. It is capable of handling 4 DC motors. At the same time, this L293D Motor Shield can also power 2 servo motors. For this robot, we didn't use any servo motor. 4 Motors are connected to the M1, M2, M3, M4 slots of the motor shield. Then, the trig pin of the Ultrasonic Sensor is connected to A1, and the echo pin is connected to A0. For obstacle or human detection, the left IR sensor and right IR sensor are connected to A2 and A3. Additionally, 2 more IR sensors are used for edge detection. So, for edge detection, edge IR left and edge IR right are connected to A4 and A5. All the ground and VCC pins of the ultrasonic sensor and 4 IR sensors are attached to the ground and 5V pins of the motor shield respectively. The whole unit is powered through a 3.7V Lithium Polymer battery which is connected to the external power supply terminal of the motor shield. The motor shield requires an external power supply and thus for Arduino itself no additional power is needed.

2. Software

To ensure the hardware elements work properly and meet their specified duties, it is necessary to program them using software like Arduino IDE. At first, the microcontroller does not come with any programming and therefore software has to be used to upload the required program into it. These are three main parts of this process exchanging data so that they can be able to achieve a desired functionality. One includes data collection by the sensor module which then sends it for processing by the microcontroller. The incoming sensors' information is used by the controller to decide what should be done next and where should this information be stored in. The microcontroller receives processed data and uses it in order to activate or control motor operation within a motor control section. The preferred choice of utilizing Arduino UNO board leads to using Arduino IDE that writes programs on microcontrollers. It allows seamless interaction among these hardware components hence meeting their intended objectives effectively.

4. Results and Discussion

The performance of the human-following robot was meticulously evaluated through a series of experiments. We did experiment in the room by using serial monitor. Also we did experiment outside.

1st experiment

Fig 10: No movement

In the first experiment we put the robot car in the road and put nothing in its sensing range. In this experiment we see that our distance was 0. That's means the ultrasonic sensor has not detected anything within its range. In our project, the ultrasonic sensor can detect obstacles or human within its range of 1 to 15 cm. As a result we didn't see any movement of the robot car in the first experiment.

2nd experiment

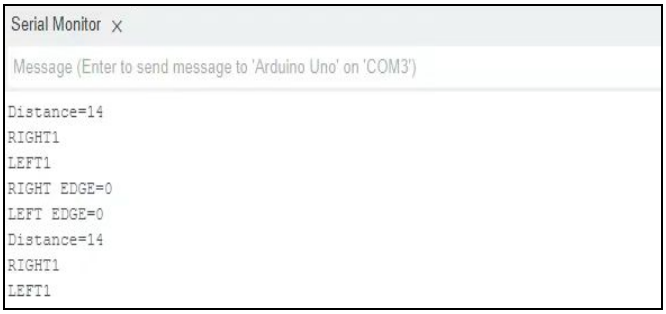

Fig 11: Move forward

In the 2nd experiment we put the robot car in the road and put our hands in its sensing range. In this experiment we saw that our distance was 14cm.That means the ultrasonic sensor has detected our hands within its range. In our project, the ultrasonic sensor can detect obstacles or human within its range of 1 to 15 cm. As a result we saw the robot car moving forward. Also there was no edge. So the robot car continued to move forward.

3rd experiment

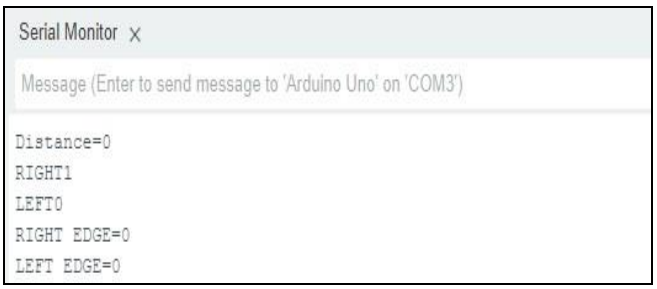

Fig 12: Turn right

In the 3rd experiment we put the robot car in the road and put our hands in front of right IR sensor. In this experiment we saw that our distance was 0 cm. That means the ultrasonic sensor has not detected our hands within its range. In our project, the ultrasonic sensor can detect obstacles or human within its range of 1 to 15 cm. For this reason the robot car did not move forward. The car took turn left because the right IR sensor has detected our hand and the sensor value was 1.

4th experiment

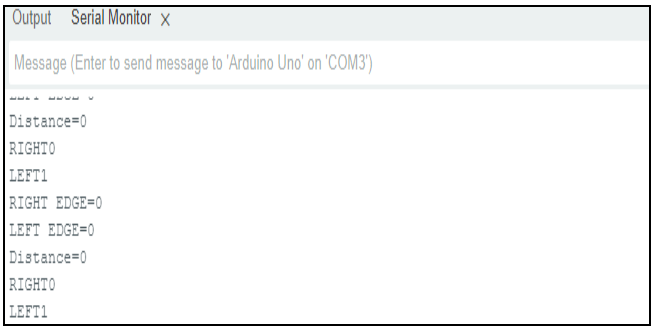

Fig 13: Turn left

In the 4th experiment we put the robot car in the road and put our hands in front of left IR sensor. In this experiment we saw that our distance was 0 cm. That means the ultrasonic sensor has not detected our hands within its range. In our project, the ultrasonic sensor can detect obstacles or human within its range of 1 to 15 cm. For this reason the robot car did not move forward. The car took turn right because the left IR sensor has detected our hand and the sensor value was 1.

5th experiment

Fig 14: Turn left

In the 5th experiment the robot car found an edge. That time the right IR edge sensor value was 1 and the left IR edge sensor value was 0. For this situation the car took turn left.

6th experiment

Fig 15: Turn right

In the 6th experiment the robot car found an edge. That time the right IR edge sensor value was 0 and the left IR edge sensor value was 1. For this situation the car took turn right.

7th experiment

Fig 16: Move backward

In the 7th experiment the robot car was moving forward. After some moment the robot car found an edge. That the robot car stopped and move backward. Because the left and right both IR edge sensors value was 1.

Results summery

Case-1(both edge IR value=0)				Case-2(edge IR value 0 or 1)			
Ultrasonic sensor value(distance cm)	Left IR sensor value	Right IR sensor value	Result	Ultrasonic sensor value(distance cm)	Left edge IR sensor value	Right edge IR sensor value	Result
0	1	1	No movement	1-15	1	1	Stop and move backward
1-15	0	0	Move forward	1-15	0	1	Turn left
1-15	0	1	Turn left	1-15	1	0	Turn right
1-15	1	0	Turn right	1-15	0	0	Move forward

Fig 17: Experiment result chart

After running a series of several tests of the sensors we were satisfied with the response of the robot car, as shown by the chart above. Therefore we concluded that our robot car is able to make correct decisions in different environments.

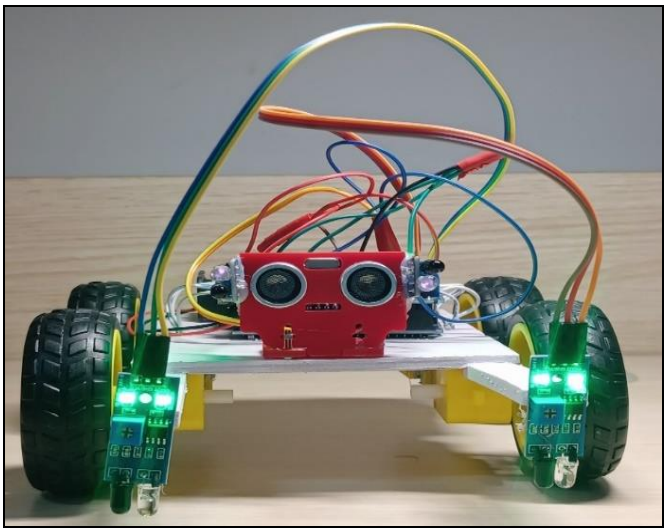

Fig 18: Human following car

5. Limitation

Our current design of a human succeeding robotic car equipped with one ultrasonic sensor and four infrared sensors faces considerable challenges in complex environments. Owing to the small size of the vehicle and the short distance between sensors, it may make incorrect judgments if multiple objects or people are within its sensing range. Since the ultrasonic sensor follows the human by measuring the distance through ultrasonic sound, sometimes it becomes difficult for the robot to accurately measure the distance due to unnecessary surrounding noise. The robot can overcome its limitations if we can change the design of the robot. It should be designed differently to overcome the limitations.

6. Application

We realize the need for human-following robots when we look at the environment and public life around us. With some modifications, the robot can also act as a human assistant. For example, we can use the robot to transport disabled, elderly people or patients. Besides, we can use the medical equipment of doctors and medicine transport in hospitals. In the supermarket we can use the robot as a salesman. May be used as an aide to fire fighters in hazardous operations. After all, we can use the robot as a load carrier at all levels including railway stations, airports, libraries.

7. Future work

The robot will have to undergo many changes in the future according to the human work style and needs. The robot can be equipped with cameras and wireless communication for military and rescue use. Also, the robot can be well prepared to survive in harsh environments. For use as a personal robot, the robot can be configured to follow specific individuals using cameras and artificial intelligence. As a video recording assistant, we can make structural and coding changes to the robot. Designing the robot can be modified to cope with adverse weather conditions. All in all we can say we can turn the robot into an intelligent humanoid robot according to the human needs.

8. Conclusion

This paper presents a successful prototype of a human-following robot. This robot not only follows people, but also has the ability to detect edges with its own intelligence. We made this robot for human benefits. We were able to develop an intelligent robot by experimenting with the robot in different environments and conditions and correcting our mistakes. By doing this project we faced many challenges in programming language with various sensors, electronic devices.

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