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Automated Restaurant Food Service Management system using a Line Follower Robot

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ABSTRACT
This paper describes the concept of an application of a line follower robot as food service system (a line follower based food service system in a restaurant). Autonomous systems are gradually increasing day by day in our modern life. A Line follower robot is a good example of an autonomous system. A line follower robot moves by tracking a line of white color line on a black surface or vice versa. The tracking is done by using an array of IR sensor. Using this principle, a line follower robot can be applied as an autonomous food service system in a restaurant.

Keywords: Automated restaurant, food service management, line following robot, IR sensors

1. Introduction
A line follower robot is an autonomous robot that can move by tracking a line of white color on a black surface or vice versa. The idea of the project is to applying this principle of line following, the robot can be used as a food service system in a restaurant. The robot delivers food from the kitchen to the destination table number. The destination table no is input by key pressing. After receiving the food the robot automatically return to the kitchen for the next service. An entrepreneur can apply this concept in a small restaurant business to serve the customer as a smart way.

2. Problem detection
Since the concept of the project is to apply the system for food service and maintaining the service in a proper way in a small restaurant business, focusing on an entrepreneur who can't bear the cost of service man. Though Honda company has been established a humanoid servicing robot. It is now under research. But a humanoid robot is very costly to apply.

3. Related work
Some related application of line following robot are [1] 'Line following robot for library inventory management system' published in Emerging Trends in Robotics and Communication Technologies (INTERACT) 2010 International Conference, [2] 'Development and Applications of Line following Robot Based Health Care management system' published in International Journal of Advanced Research in Computer Engineering and Technology (IJARCET) Volume 2, Issue 8, August 2013

4. Design concept of the robot
The robot is based on line follower. An Array of infra-red sensors is used for tracking the line. The sensor array is placed at front of the body. An Arduino Mega2560 is used as control part of the robot. It processes the data from sensors and sends to the motors that move the body. A 12v Rechargeable battery is used for the power source of the robot. A proposed 3D view of the robot is shown in Fig.1

Fig.1 A 3D Model of the Robot

A movable tray is used to move forward when the robot reaches at the destination table no and move backward when the food is received. Fig.2 shows the actual robot body.

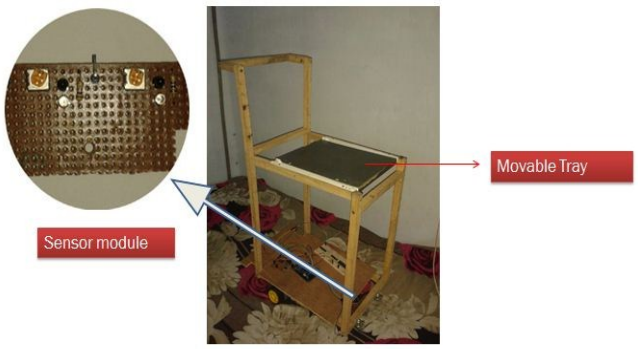

Fig.2 Actual Robot Body

4.1 Mechanical Construction
The whole body of the robot is placed on a chassis. The chassis contains the sensor module at the front, two wheel casters act like steering, and two DC gear motors with

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wheel at back to move the body. The chassis metal is stainless steel. Since stainless steel has Modulus of elasticity about 200 GN/m^2, the chassis is able to carry weight of the whole body without any deformation. The Fig.3 shows the mechanical construction of chassis. The body material is used as wood for light weight and consideration of low cost. Any other light weight material such as aluminum can be used but then cost will be high.

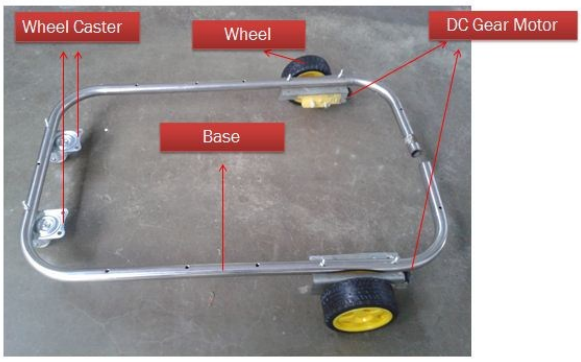

Fig.3 Chassis Construction

5. Design concept of the restaurant Layout or Track of the line.

The track for the robot is designed such a way that the robot can serve the food within a short time. In the line there is some indicating line which indicates where to stop the robot according to the corresponding table no. The tables are arranged with number beside the line. The Fig.4 shows the track line for the robot and table arrangement.

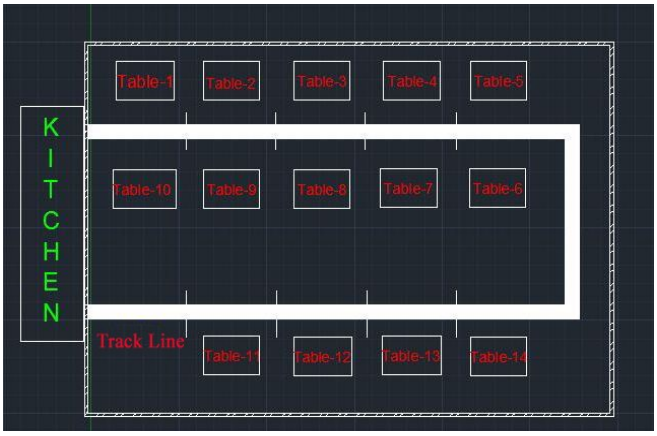

Fig.4Track for the robot

6. Control part of the robot

An Arduino mega2560 prototype board is used to control the robot. This is a micro-controller board based on ATmega2560 with 256KB Flash memory (of which 8KB is used by boot-loader), 8KB of SRAM, 54 digital I/O pins (of which 14 provide PWM output), 16 ADC, clock speed of 16 MHz and so many features from the data-sheet. The board operating on 5v DC, but recommended voltage is 7v to 20v. The controller board processes the data from the sensor array, and sends the control to the two DC motors. Fig.5 shows the control board

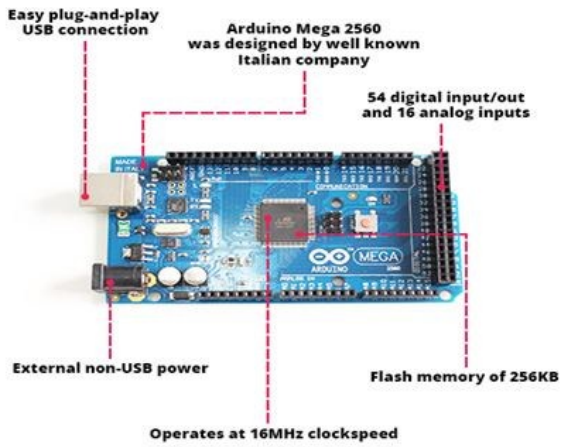

Fig.5 Arduino Mega2560 board

6.1 The Sensor module

The sensor module is used to trace the line. The sensor module is based on Infra-red light. The module contains 5 pairs of infra-red light emitter and receiver. The Fig.6 shows the sensor module.

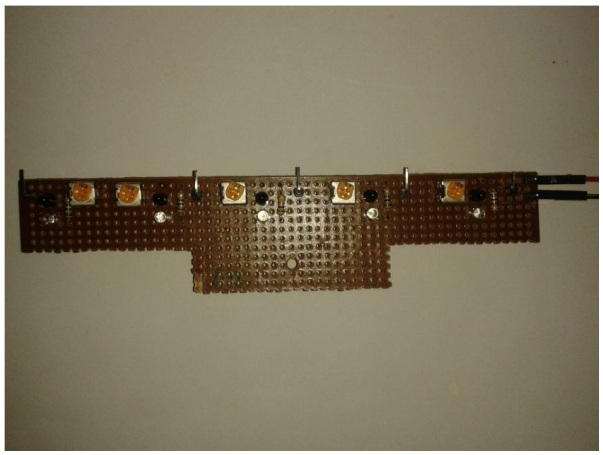

Fig.6 IR sensor module

The working principle of the sensor is shown in the Fig.7

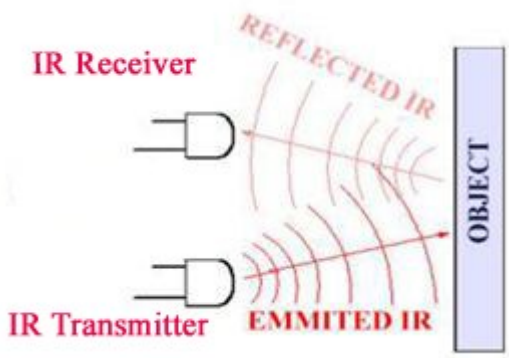

Fig.7 working method of sensor

The output voltage ranges of the sensors are 0v to 5v. This data is sent to the controller board to process.

6.2 Motor driver

Since the DC motor consume more current, a driver circuit is needed to provide the amount of current. The driver is L293D integrated circuit. It accepts the standard TTL logic levels and drives inductive loads (such as relays, DC motor, solenoid etc.) The device is a switching power transistor. It draws 600mA output current per channel, and operating through 5v to 36v. a several pin configuration of the driver is shown in Fig.8

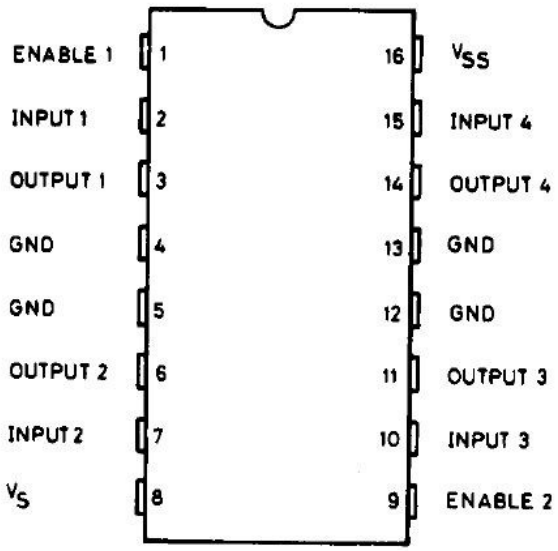

Fig.8 L293D motor driver.

7. Control Diagram of the robot

The overall control of the robot is shown in the Fig.9 in a block diagram.

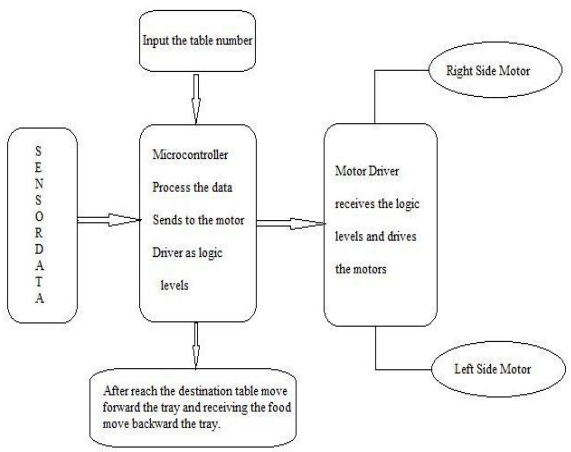

Fig.9 Control block diagram of the robot.

The robot takes the input table no. the sensors sense the track and send data as voltage input to the micro-controller. The micro-controller processes the data as digital logic and sends the data to the motor driver to drive the motors. After reaching the destination table the robot stops. The tray on the robot moves forward by using a servo motor. It moves backward when the food is received.

8. Differential Drive of motor

The differential drives mechanism help the robot to run at different speed of wheel while turning. Different input to the pin of motor driver creates differential drive. The table below shows the different voltage level at the pin of motor driver to create differential drive mechanism.

Table 1 differential drive mechanism

EN	IN1	IN2	Turn
HIGH	LOW	HIGH	CW
HIGH	HIGH	LOW	CCW
HIGH	LOW	LOW	STOP
HIGH	HIGH	HIGH	STOP
LOW	IGNOR	IGNOR	STOP

9. Performance

The performance of the robot depends on tracking of the line. The robot is able to trace the line very smoothly and moves fast. Since the objective of the service robot is to serve very short time, from this point of view the robot fulfills this requirement.

10. Discussion

Power supply is main fact to the performance of the robot. Less power drives the robot slow. The inductive loads (such as motor) consume more power. So use of rechargeable battery is very effective so that the battery can be charged fully before every run of the robot.

11. Future work

Since the robot can only reach the food and return for the next service but there is no scope of cleaning the table. So in future development of the robot it is focused on how to clean the table using an autonomous system.

11. Conclusion

The service robot is used in many fields such that from the industrial level to domestic service. There are many foods serving robot but their initial cost and maintenance cost are high. The overall cost of this project is considerable. Automation makes the life easier and reducing the time. This autonomous robot is also reducing the time and makes proper utilization of technology.

NOMENCLUTURE

MCU	: Micro-controller Unit
DC	: Direct Current
ADC	: Analog to Digital Converter
CW	: clock wise
CCW	: counter clock wise
EN	: Enable Pin of Motor Driver
GND	: Ground
I/O	: Input or Output
IN1	: Input pin 1 of motor Driver
IN2	: Input pin 2 of motor Driver
KB	: Kilo Byte
MHz	: Mega Hertz

PWM	: Pulse Width Modulation
SRAM	: Static Random Access Memory
TTL	: Transistor-Transistor Logic
V_s	: Supply voltage, V
V_{ss}	: Logic supply voltage, V

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