SMART DUSTBIN

ABSTRACT

As people are getting smarter so are the things. While the thought comes up for Smart cities there is a requirement for Smart waste management. The idea of Smart Dustbin is for the Smart buildings, Colleges, Hospitals and Bus stands. The Smart Dustbin thus thought is an improvement of normal dustbin by elevating it to be smart using sensors and logics. Smart dustbins is a new idea of implementation which makes a normal dustbin smart using ultrasonic sensors for garbage level detection and sending message to the user updating the status of the bin using GSM modem. As soon as the dustbin is full, it moves in the predefined path to reach the larger container with the help of Line follower robot.

Key words: IR sensor, Ultrasonic sensor, GSM, Arduino Board, Line follower

INTRODUCTION:

The Internet of Things, also called The Internet of Objects, refers to a wireless network between objects. Usually the network will be wireless and self-configuring, such as household appliances. Internet of Things refers to the concept that the Internet is no longer just a global network for people to communicate with one another using computers, but it is also a platform for devices to communicate electronically with the world around them.

The Internet of Things (IOT) is the network of physical objects—devices, vehicles, buildings and other items which are embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data. The Internet of Things allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit.

BACKGROUND RESEARCH: One important step in building a new Smart Dustbin was to know the existing systems for waste management. This section consists of some systems which were proposed for waste management from different researchers and students all over the world.

Existing system: In **'smart garbage management system'** system, the level of garbage in the dustbins is detected with the help of Sensor systems, and communicated to the authorized control room through GSM system. Microcontroller is used to interface the sensor system with GSM system. A GUI is also developed to monitor the desired information related to the garbage for

different selected locations. This will help to manage the garbage collection efficiently. Here in this system, Infrared (IR) sensor is used for garbage level detection. IR sensor radiates light which is invisible to the human eye because it is at infrared wavelengths, but it can be detected by electronic devices. GSM module is used for communication purpose, to send message to the control room when the container is full. Arduino board is used to interface the sensor and GSM module.

The IR sensor arrangement is act as level detector .The output of level detector is given to the microcontroller. The AT commands are used to facilitate the messaging service through the GSM Module. This program is burned in the microcontroller with the help of Arduino software (IDE). These messages consist of information of garbage levels of respective dustbins. Depending on the information sent to control room, the authority informs the concern person of the respective area about garbage level. Then the concerned person makes sure that the garbage of that particular area is collected by sending the cleaning vehicles.

Proposed system: Smart dustbins is a new idea of implementation which makes a normal dustbin smart using sensors for garbage level detection and sending message to the user updating the status of the bin. As soon as the dustbin is full it moves in the predefined path to reach the larger container with the help of motors and wheels. The system design and implementation are explained in detail in further in the paper.

SYSTEM ANALYSIS:

System analysis is the act, process or profession of studying an activity typically by mathematically means in order to define its goals or purposes and to discover operation and procedures for accomplishing them most efficiently.

Hardware Requirements: The hardware requirements for the system are as follows.

Ultrasonic Sensors: Knowing the distance you are away from an object is very important in robotics or even for tasks just as simple as driving.

Fig 1. Ultrasonic sensor

As shown in the Fig 1. Ultrasonic distance sensors use a sound transmitter and a receiver. An ultrasonic distance sensor

creates an ultrasonic pulse, often called a "ping", and then listens for reflections (echo) of the pulse. This pulse of sound is generally created electronically using a sonar projector consisting of a signal generator, power amplifier and electro-acoustic transducer/array. A beam former is usually employed to concentrate the acoustic power into a beam, which may be swept to cover the required search angles Fig 2.

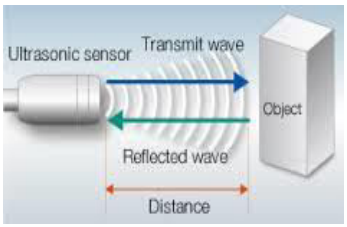

Fig 2 Ultrasonic sensor transmitting waves

To measure the distance to an object, the time from transmission of a pulse to reception is measured and converted into a range by knowing the speed of sound. This signal together with noise is then passed through various forms of signal processing, which for simple sensors may be just energy measurement. It is then presented to some form of decision device that calls the output either the required signal or noise. This decision device may be an operator with headphones or a display, or in some systems this function may be carried out by software. Further processes may be carried out to classify the target and localise it, as well as measuring its velocity. Some ultrasonic sensors have multiple beams to provide all-round cover while others only cover a narrow arc, although the beam may be rotated, relatively slowly, by mechanical scanning.

IR Sensor: IR transmitter and receiver LEDs have been around for a long time so the technology is already seen in mainstream society (i.e. water facets in bathrooms/toilets/hand dryers). The Sharp IR Range Finder works by the process of triangulation. A pulse of light (wavelength range of 850nm +/-70nm) is emitted and then reflected back (or not reflected at all). When the light returns it comes back at an angle that is dependent on the distance of the reflecting object. Triangulation works by detecting this reflected beam angle - by knowing the angle, distance can then be determined as shown below in fig 3.

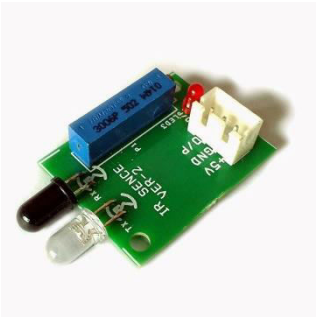

Fig 3, IR sensor

The IR range finder receiver has a special precision lens that transmits the reflected light onto an enclosed linear CCD array based on the triangulation angle. The CCD array then determines the angle and causes the rangefinder to then give a corresponding analog value that can be read by a microcontroller. Additional to this, the Sharp IR Range Finder circuitry applies a modulated frequency to the emitted IR beam. This ranging method is almost immune to interference from ambient light, and offers amazing indifference to the colour of the object being detected. In other words, the sensor is capable of detecting a black wall in full sunlight with almost zero noise.

GSM Modem: GSM Modem can accept any GSM network operator SIM card and act just like a mobile phone with its own unique phone number. Advantage of using this modem will be that you can use its RS232 port to communicate and develop embedded applications. Applications like SMS Control, data transfer, remote control and logging can be developed easily using gsm as shown below in fig 4.

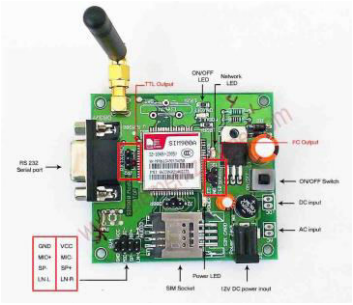

Fig 4. GSM modem

The modem can either be connected to PC serial port directly or to any microcontroller through MAX232. It can be used to send and receive SMS or make/receive voice calls. It can also be used in GPRS mode to connect to internet and do many applications for data logging and control. In GPRS mode you can also connect to any remote FTP server and upload files for data logging. This GSM modem is a highly flexible plug and play quad band **SIM900A** GSM modem for direct and easy integration to RS232 applications. Supports features like Voice, SMS, Data/Fax, GPRS and integrated TCP/IP stack.

DC motor: DC motors are widely used, inexpensive, small and powerful for their size. Reduction gearboxes are often required to reduce the speed and increase the torque output of the motor. Although recent developments in stepper motor technologies have come a long way, the benefits offered by smooth control and high levels of

acceleration with DC motors far outweigh any disadvantages. Several characteristics are important when selecting DC motors and these can be split into two specific categories. The first category is associated with the input ratings of the motor and specifies its electrical requirements, like operating voltage and current. The second category is related to the motor's output characteristics and specifies the physical limitations of the motor in terms of speed, torque and power. In case of geared motors another attribute that can be specified is the gear ratio. The higher the ratio, the stronger robot (more torque; less speed), the lower, the faster robot(less torque; more speed). Direction of rotation of a motor can be controlled by the direction of voltage applied across the terminals. Speed of the motor can be controlled by varying the voltage applied and in cases where only digital signals are available by using Pulse Width Modulation (PWM).

Arduino Board: As shown in Fig 5, the Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Mega 2560 board is compatible with most shields designed for the Uno and the former boards Duemilanove or Diecimila.

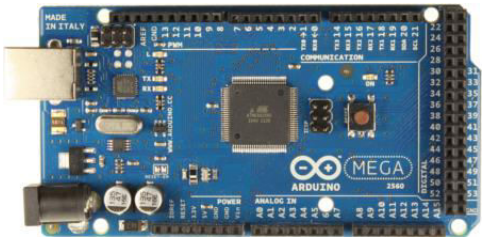

Fig 5, Arduino board

Table 1, briefs the summary of this microcontroller board

Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	54 (of which 15 provide PWM output)
Analog Input	16

Pins	
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz
Length	101.52 mm
Width	53.3 mm
Weight	37 g

Table 1, Features of Arduino board

L293D DUAL H-BRIDGE IC:

The L293D is a dual H-Bridge motor driver IC, so with one IC we can interface two DC motors which can be controlled in both clockwise and counter clockwise direction. As shown in Fig 6 L293D has output current of 600mA and peak output current of 1.2A per channel. Moreover for protection of circuit from back EMF output diodes are included within the IC. The output supply (Vs) has a wide range from 4.5V to 36V, which has made L293D a best choice for DC motor driver.

The Vss is the 5V power supply to the IC. The Vs is the supply voltage that is given directly to the motors i.e. if a 7.2V DC voltage is applied to this pin the same is applied to the two motors. The IC can be functionally divided into two channels: the left motor and the right motor channel. The output pins are connected to the motor. The enable pins take active high inputs. A logical high input to this pin enables the motor while a logical low input disables the motor. The input pins take logical inputs usually from a microcontroller for various operations of the concerned motor. The truth table below shows the working. Speed of the motors can be controlled by using Pulse Width Modulated (PWM) signals to the enable pins.

The pin diagram of the IC is shown in fig 6.

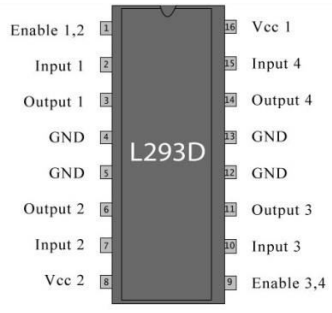

Fig 6, L293D IC

Software Requirements:

The software requirements specification is a description of a software system to be

developed. It lays out functional and non-functional requirements, the software requirements are

Arduino IDE: The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus as shown in fig 3.12. It connects to the Arduino and Genuine hardware to upload programs and communicate with them.

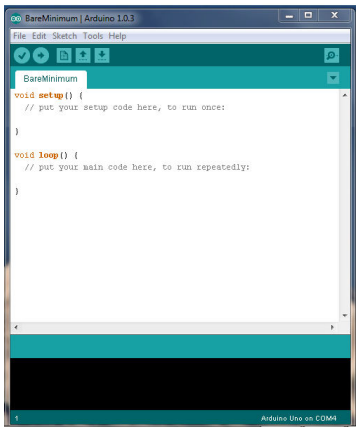

Fig 7, Arduino IDE

Writing Sketches: Programs written using Arduino Software (IDE) are called **sketches**. These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom right hand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

Arduino Language: Arduino Language is used for programming in Arduino IDE. The Arduino language is merely a set of C/C++ functions that can be called from your code. Your sketch undergoes minor changes (e.g. automatic generation of function prototypes) and then is passed directly to a C/C++ compiler (aver-g++).

DESIGN AND IMPLEMENTATION

The project can be divided into two modules, one is detection of garbage level and then the second module is motion of the dustbin to the container in the predefined path. This chapter contains the detailed explanation of the design and implementation of the project.

MODULE1: GARBAGE LEVEL MONITORING

Garbage level detection is the done by ultrasonic sensor (HC-SR04).The ultrasonic sensor is placed on top of the dustbin facing

the bottom. The sensor continuously emits the sonic waves, when the sonic waves hit the object and reflect back, the echo in the sensor senses the waves and calculates the distance of the object as shown in Fig 8.

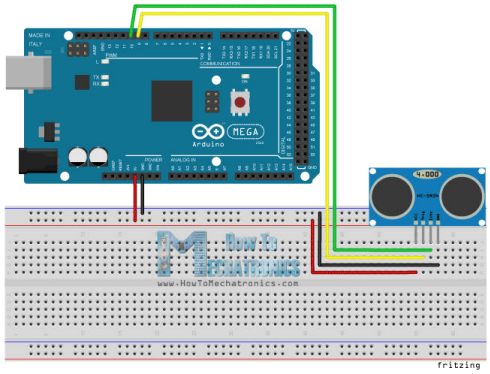

Fig 8, Connection of ultrasonic sensor with Arduino board

MODULE2: MOTION OF DUSTBIN TOWARDS THE CONTAINER

LINE Follower robot using IR sensor:

Line follower Robot is a machine which follows a line, either a black line or white line. Basically there are two types of line follower robots: one is black line follower which follows black line and second is white line follower which follows white line. Line follower actually senses the line and run over it.

Concepts of Line Follower: Concept of working of line follower is related to light. We use here the behaviour of light at black and white surface. When light fall on a white surface it is almost full reflected and in case of black surface light is completely absorbed. This behaviour of light is used in building a line follower robot.

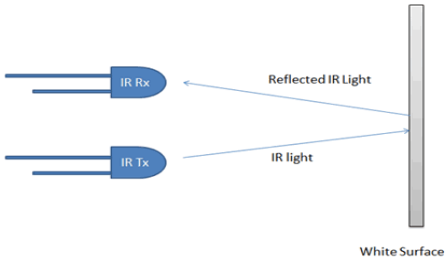

Fig 9, IR sensor on white surface

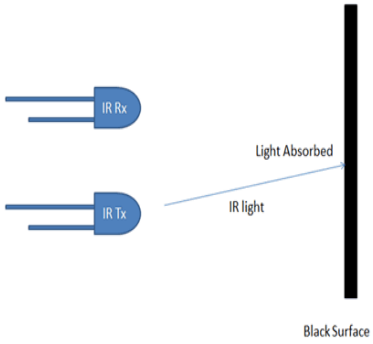

Fig 10, IR sensor on black surface

In Arduino based line follower robot we have used IR Transmitters and IR receivers also called photo diodes. They are used for sending and receiving light. IR transmits infrared lights. When infrared rays falls on white surface, it's reflected back and cached by photodiodes which generates some voltage changes as shown in fig 9. When IR light falls on a black surface, light is absorb by the black surface and no rays are reflected back,

thus photo diode does not receive any light or rays as shown in fig 10. Here in this line follower robot when sensor senses white surface then Arduino gets 1 as input and when senses black line Arduino gets 0 as input.

Circuit Explanation: The whole line follower robot can be divided into 3 sections: sensor section, control section and driver section.

Sensor section: IR diodes, potentiometer, Comparator (Op-Amp) and LED's. Potentiometer is used for setting reference voltage at comparator's one terminal and IR sensors are used to sense the line and provide a change in voltage at comparator's second terminal. Then comparator compares both voltages and generates a digital signal at output. Here in this **line follower circuit** we have used two comparator for two sensors. LM 358 is used as comparator. LM358 has inbuilt two low noise Op-amps.

Control Section: Arduino Pro Mini is used for controlling whole the process of line follower robot. The outputs of comparators are connected to digital pin number 2 and 3 of Arduino. Arduino read these signals and send commands to driver circuit to drive line follower.

Driver section: Driver section consists motor driver and two DC motors. Motor driver is used for driving motors because Arduino does not supply enough voltage and current to motor. So we add a motor driver circuit to get enough voltage and current for motor. Arduino sends commands to this motor driver and then it drive motors.

Working of Line Follower Robot using Arduino

Working of line follower is very interesting. Line follower robot senses black line by using sensor and then sends the signal to Arduino. Then Arduino drives the motor according to sensors' output as shown in fig 11

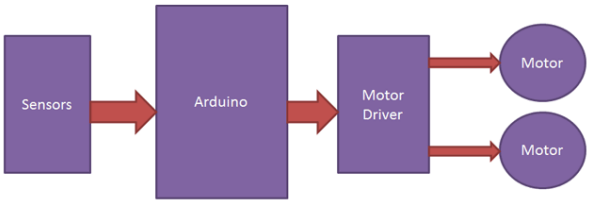

Fig 11. Working of line follower

Here in this project we are using two IR sensor modules namely left sensor and right sensor. When both left and right sensor senses white then robot move forward. As shown in fig 12.

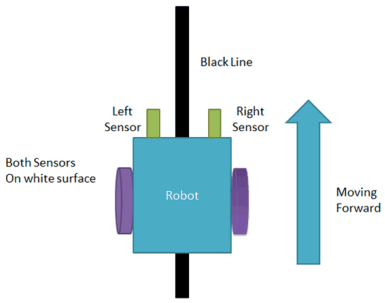

Fig 12, Robot moving straight.

If left sensor comes on black line then robot turn left side. As shown in fig 13

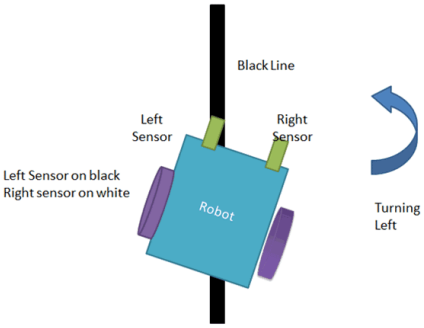

Fig 13, Robot taking left turn.

If right sensor sense black line then robot turn right side until both sensor comes at white surface. When white surface comes robot starts moving on forward again.

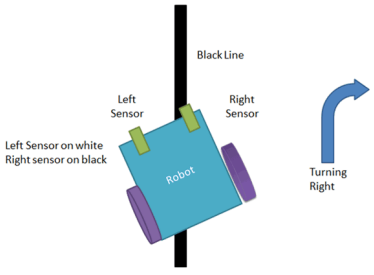

Fig 14, Robot turning right.

If both sensors comes on black line, robot stops.

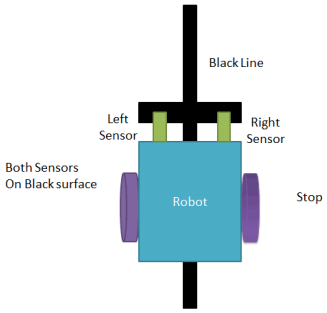

Fig 15, Robot stopping.

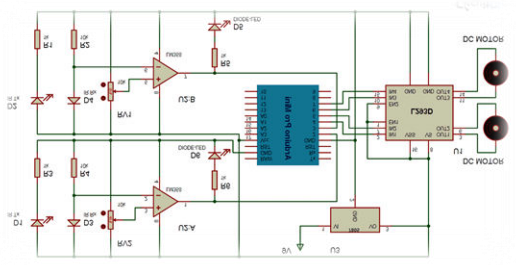

Fig 16, complete circuit diagram

Complete circuit diagram for Arduino based line follower robot is shown in the above fig 16. As you can see output of comparators is directly connected to Arduino digital pin number 2 and 3. And motor driver's input pin 2, 7, 10 and 15 is connected to Arduino's digital pin number 4, 5, 6 and 7 respectively. And one motor is connected at output pin of motor driver 3 and 6 and another motor is connected at pin 11 and 14.

PROTOTYPE: The working prototype of the model is shown below

Fig 17, Dustbin on the line follower

Fig 18, Smart dustbin tracking the path

FEASIBILITY: While the thought comes up for Smart cities there is a requirement for Smart waste management. The idea of Smart Dustbin is for the Smart buildings, Hospitals and Bus stands The Smart Dustbin thus thought is an improvement of normal dustbin by elevating it to be smart using sensors and logics.

CONCLUSION: Smart dustbins are the now the needs of Smart buildings. Smart waste monitoring and management is the keen idea of smart city planners. Smart dustbins is a new idea of implementation which makes a normal dustbin smart using sensors for garbage level detection and sending message to the user updating the status of the bin. As soon as the dustbin is full it moves in the predefined path to reach the larger container with the help of motors and wheels. The garbage is dumped to the container manually and the dustbin moves back in the same direction back to its initial place.

FUTURE SCOPE: There is a great scope for the modifications of the Smart Dustbin in future. The system can be improved by adding new functionalities. Dumping of the waste was manual in Smart dustbin this can be automated by fixing a robot arm or a tipper. The path tracking can be GPS enabled and the dustbins can be monitored through a GUI. The Smart dustbins can be well widely used in the Smart buildings of Smart cities.

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