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DESIGN AND IMPLEMENTATION OF IOT BASED GARBAGE COLLECTING ROBOT

T. Lakshmibai

A.P/EIE, Sri Chandrasekarendra Saraswathi Viswa MahaVidyalaya, (SCSVMV), Kanchipuram.

Abstract: The world today faces a major garbage crisis and the product of rapid economic growth overcrowding, poor urban planning, corrosive corruption and political interruption the present tried and tested methods of garbage collection have so far been proven ineffective. And the world today is looking for a smarter way to overcome the garbage collection problems. This paper presents the Robotic Garbage collection for footpaths using an Arduino microcontroller. The Robot movement is controlled by Arduino programming. In the proposed method, the robot is design to collect garbage at footpaths, public places (parks, schools and colleges), beaches. The robots is built in such a way that, at the start it will move its arm to the down wards direction and when it encounters an obstacles, it will react depending on the conditions written in the program. The bot proceeds with further motion according to the program instructions to pick up the garbage, new advanced services based on the interplay between robots and things, are being conceived in assisting humans. As robots are used to help mankind in various environments, the robots and the internet of things are combined to achieve more than people think.

Index Terms **- Garbage, Arduino UNO, Servo Motor, Bluetooth Module, Inductive Sensor, Robot, Lead Acid Battery**

I. INTRODUCTION

Nowadays, waste management is a big issue globally and it needs serious attention. There is no proper management of waste and garbage in rural and urban areas, which may cause a threat to health security, hygiene, human safety and wildlife safety. Presently, the manual garbage collection system exists in most places, where human intervention is involved. Manual garbage collection and waste management is a good source to generate employment, but there are some issues associated with it, like sometimes there is the unavailability of manual labour for days, such as in maintaining railway tracks. There is a big concern about human safety.

The rate of increasing population in our country has increased rapidly and also, there is an increase in garbage, which has increased environmental issues. These days robots are used in various work fields across the globe. They are used mainly in industries and manufacturing stations, but coming to garbage collection man power is doing almost all of the work. using robots in this particular field can bring great change in many ways. Humans can get infected while working in any toxic place which may lead to casualty. As everybody knows these days during covid-19 garbage collection became a severe burden to frontline workers due to the spreading of the virus. Therefore, an idea raised in the mind is IOT based garbage collection robot which picks the waste and detects the nature of the picked material using a metal detecting sensor and separates the metallic and non-metallic waste. The metallic waste which is separated will be sent to recycling and the non-metallic waste will be disposed of safely. This saves humans from any danger that may occur in the garbage collecting process and as well as generating extra revenue can be done by metal recycling.

II PROPOSED SYSTEM

The proposed model concept is represented that the robot is operated using an android mobile phone or a laptop. The WIFI module is interfaced with Arduino to control the robot using a mobile from far away. Using ultrasonic sensors, obstacles or wastes are detected and the data is sent to an Arduino for processing. The trash is picked up by the robotic arm and the motion of the robotic arm is controlled by 4 servo motors. A metal sensor is used to detect whether the collected garbage is metal or non-metal. Using motor drivers, the rotational speed of motors is controlled for the movement of the robot as per requirement. The battery inside the robot provides the power needed for all the operations.

III DIAGRAMS OF THE WORKING MODEL

BLOCK DIAGRAM

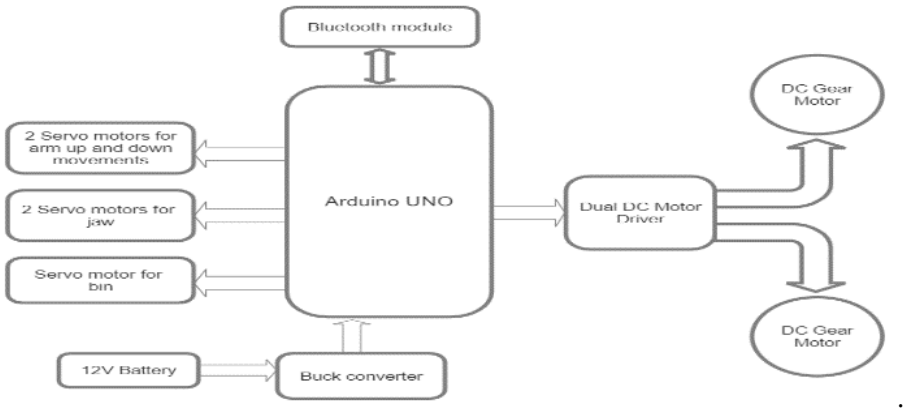

Fig.1. Block Diagram

CIRCUIT DIAGRAM

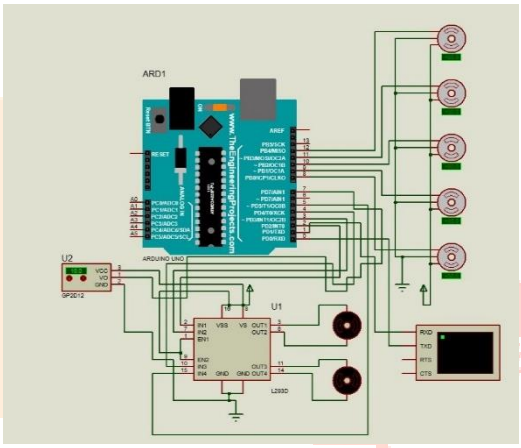

Fig. 2. Circuit Diagram

IV TOOLS REQUIRED

Hardware Requirements

1. Arduino UNO
2. MG996R Servo Motor
3. 12V DC Gear Motor
4. HC-05 Bluetooth Module
5. Inductive Sensor
6. L293D Motor Driver
7. Esp32- Camera Module
8. Lead Acid Battery
9. USB-TTL-CP2102
10. Jumper Wires
11. Bread board

Software Requirements

Arduino is a single-board microcontroller. The Arduino provides an integrated development environment (IDE) based on Processing language

Arduino UNO

Programming in Arduino

Arduino programs are written in the Arduino Integrated Development Environment (IDE). The Arduino programming language is based on a very simple hardware programming language called processing, which is similar to the C language. After the sketch is written in the Arduino IDE, it should be uploaded on the Arduino board for execution.

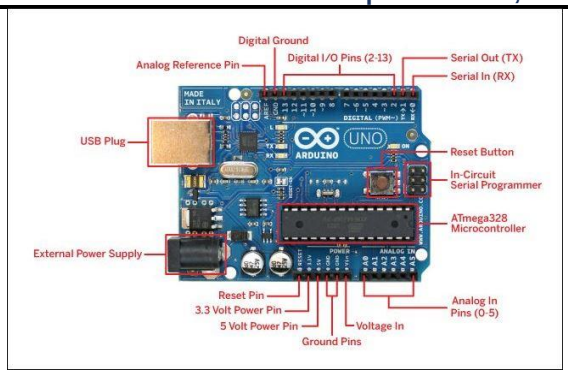

Fig. 3. Arduino UNO

Every Arduino sketch has two main parts to the program:

void setup () – Sets things up that have to be done once and then don't happen again.

void loop () – Contains the instructions that get repeated over and over until the board is turned off.

POWER SUPPLY

The Arduino board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

Inductive Proximity Sensor

An inductive proximity sensor can detect metal targets approaching the sensor, without physical contact with the target. Inductive proximity sensors are used for the non-contact detection of metallic objects. They find their application in detecting metallic objects in industrial automation environments. This includes objects made of iron, copper and aluminium. Inductive proximity sensors enable the detection, without contact with metal objects at distances of up to 30mm. Their range of applications is very extensive and includes the monitoring of machine parts (cams, mechanical stops etc). Monitoring the flow of metal parts, and counting.

Fig. 4. Inductive Proximity Sensor

HC-05 Bluetooth Module

It is used for many applications, like wireless headsets, game controllers, wireless mouses, wireless keyboards and many more consumer applications. It has a range of up to <100m which depends upon transmitter and receiver, atmosphere, geographic & urban conditions. It is IEEE 802.15.1 standardized protocol, through which one can build a wireless Personal Area Network (PAN). It uses FREQUENCY-HOPPING SPREAD SPECTRUM (FHSS) radio technology to send data over the air. It uses serial communication to communicate with devices. It communicates with the microcontroller using a serial port (USART). HC-05 is a Bluetooth module which is designed for wireless communication. This module can be used in a master or slave configuration.

Fig.5a. HC-05 Bluetooth Module

Fig. 5b: HC-05 Bluetooth Module Pin Description

HC-05 Bluetooth Module Pin Description

Bluetooth serial modules allow all serial-enabled devices to communicate with each other using Bluetooth. It has 6 pins,

1) Key/EN: It is used to bring the Bluetooth module into AT commands mode. If the Key/EN pin is set to high, then this module will work in command mode. Otherwise, by default, it is in data mode. The default baud rate of HC-05 in command mode is 38400bps and 9600 in data mode.

HC-05 module has two modes:

- **Data mode:** Exchange of data between devices.
- **Command mode:** It uses AT commands which are used to change the setting of HC-05. To send these commands to the module serial (USART) port is used

2) VCC: Connect 5 V or 3.3 V to this Pin.

3) GND: Ground Pin of the module.

4) TXD: Transmit Serial data (wirelessly received data by Bluetooth module transmitted out serially on TXD pin)

5) RXD: Receive data serially (received data will be transmitted wirelessly by Bluetooth module).

6) State: It tells whether the module is connected or not.

MG996R Servo Motor

Fig.6. MG996R Servo Motor

The MG996R is a metal gear servo motor with a maximum stall torque of 11 kg/cm. Like other RC servos. The motor rotates from 0 to 180 degrees based on the duty cycle of the PWM wave supplied to its signal pin.

MG996R Servo Motor Features:

- •The operating voltage is +5V typically
- •Current: 2.5A (6V)
- •Stall Torque: 9.4 kg/cm (at 4.8V)
- •Maximum Stall Torque: 11 kg/cm (6V)
- •The operating speed is 0.17 s/60°
- •Gear Type: Metal
- •Rotation: 0°-180°
- •Weight of motor: 55gm
- •The package includes gear horns and screw

L283D Motor Driver

A motor driver is an integrated circuit chip which is usually used to control motors in autonomous robots. The motor driver acts as an interface between the Arduino and the motors. The most commonly used motor driver ICs are from the L293D series, such as L293D, L293NE, etc. These ICs are designed to control 2 DC motors simultaneously.

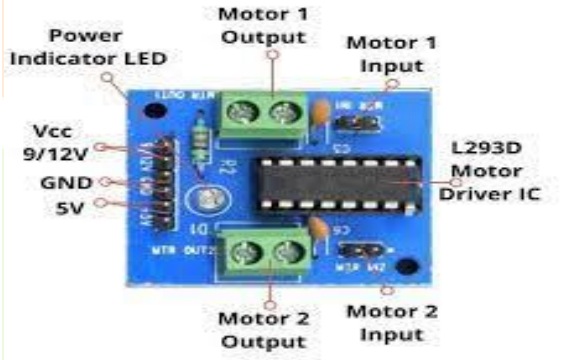

Fig.7. L283D Motor Driver

DC motor

Fig. 8. DC motor

A **DC motor** is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic to periodically change the direction of current in part of the motor.

A set of four 12V DC motors are used in our robot with each can deliver a speed of 300rpm. The four motors are connected to the motor driver to control the motor rotation. Using these motors, we can generate the required amount of torque for the robot.

Esp32 Cam Module

The ESP32 CAM Wi-Fi Module Bluetooth with OV2640 Camera Module 2MP for Face Recognition has a very competitive small-size camera module that can operate independently as a minimum system with a footprint of only 40 x 27 mm; a deep sleep current of 6mA and is widely used in various IoT applications. It is suitable for home smart devices, industrial wireless control, wireless monitoring and other IoT applications.

Fig. 9. ESP32 -Cam Module

This module adopts a DIP package and can be directly inserted into the backplane to realize rapid production of products, providing customers with a high-reliability connection mode, which is convenient for application in various IoT hardware terminals.

ESP integrates Wi-Fi, traditional Bluetooth, and BLE Beacon, with 2 high-performance 32-bit LX6 CPUs, and 7-stage pipeline architecture. It has a main frequency adjustment range of 80MHz to 240MHz, an on-chip sensor, a Hall sensor, a temperature sensor, etc.

USB TO TTL Module

CH340 chips are a series of USB bus adapters, that provides serial, parallel or IrDA interfaces over a USB bus (only serial interface). The CH340G integrated circuit provides common MODEM signals to allow adding a UART device to a computer or converting existing UART devices to a USB interface. It's a small USB to TTL serial tool, using the CH340G chip. It is used to connect serial device to your PC via a USB port.

Fig. 10. USB TO TTL Module

Features:

1. It Provides a virtual serial port over a USB 2.0 port
2. Full-speed 2.0 USB interface
3. Based on the 340G chip.
4. Supports operating systems: Windows / Linux / Mac OSX
5. Supports baud rates from 50 bps up to 2 Mbps..
6. Supports CH341 driver Dual 3.3V and 5V power output, work with 3.3V and 5V target devices. 3.3V and 5.0V outputs are available to power your project directly from this module.
7. Rail voltage: 1. 5V mode 4.5 - 5.5V
   2. 3.3V mode 3.3 - 3.8V
8. Operating current type. 12 mA up to 30mA
9. Clock-frequency type. 12 MHz
10. Power-on reset time type. 20 ms up to 50 ms
11. USB A Connector (male)Three indication LEDs (from top to bottom): "Power", "TxD", and "RxD".
12. The transmitter baud rate error is less than 0.3%
13. Receiver baud rate tolerance of < 2%.

METHODOLOGY:

The proposed model concept is represented that the robot is operated using an android mobile phone or a laptop. The WIFI module is interfaced with Arduino to control the robot using a mobile from far away. Using ultrasonic sensors, obstacles or wastes are detected and the data is sent to an Arduino for processing. The trash is picked up by the robotic arm and the motion of the robotic arm is controlled by 4 servo motors. A metal sensor is used to detect whether the collected garbage is metal or non-metal. Using motor drivers, the rotational speed of motors is controlled for the movement of the robot as per requirement. The battery inside the robot provides the power needed for all the operations.

DESCRIPTION OF THE WORKING MODEL

- The working robot is operated using an android mobile phone or a laptop. So, robot locomotion and trash pickup are operated through a mobile application. For the vision of a robot, a camera is placed in the robot.
- The collected trash is transferred to a trash bin attached to the robot platform. Using this cam module configuration, the operator will be able to distinguish between big objects(walls) and the objects which may able to pick up.
- Big objects are considered obstacles by the operator and are avoided. Other objects are considered trash and are picked up by the robotic arm.

HARDWARE IMPLEMENTATION

Fig.12. Proposed Hardware model

CONCLUSION

This proposed method is designed to fulfil the task of collecting garbage from certain places and then disposing of it at a single place from where the garbage will be taken for disposal. The IoT Based Garbage Collection Robot which detects and collects paper and plastic items and processes them. So, this reduces the requirement for manual clearance of plastic waste. The work of garbage pickup is a physically demanding task and worse, overexposes the workers to occupational hazards. This system was designed to bring fulfillment to the task of garbage collection from designated pickup points, sorting according to garbage type, and then its disposal at a single temporary dump site from which the waste will then be collected for permanent disposal or a recycling process. Finally, this system is initialized to aid the smart city concept and swatch Bharat Abhiyan.

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