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RESEARCH ARTICLE

Garbage collector robot

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Abstract

Aim/Objectives: The primary aim is to introduce a way in which garbage could be collected and disposed efficiently; To analyze the problem of garbage disposal at a school, restaurant, office, hotel, production plant or any other suitable location; To design and develop a system for solving the problem; To test and maintain the implemented system. **Method**: Our project is divided into two main parts. We are designing a system that collects garbage automatically through line. For which we are designing an arena so that the machine will follow the specific path and also manually by using Arduino and Bluetooth module. The machine can be controlled by software which will give command to the robotic jaw to collect the stationary waste. It also has the characteristic to get controlled by voice command which makes the robot to collect the garbage according to the given command. **Findings**: We have designed a semi-autonomous garbage collector robot which can do multiple functions. This robot has one robotic arm in which it can pick the garbage and dispense it in main basket attached to the robot. The camera placed on robot helps the administrator to remotely monitor the robot while collecting garbage. The prototype has an electronic mechanism by which the robot can dispense it collected garbage to the dispensing point. This robot has installed batteries in which there is no fuel or electricity required to complete the operation.

Keywords: Robot; garbage collector bins; automatic waste disposal; Pakistan

1 Introduction

Waste management is the big issue globally and it needs serious attention. There is no proper management of waste and garbage in rural and urban area in Pakistan, which may cause threat to health security, hygiene, human safety and wild life safety. Presently the manual garbage collection system exists in most places, where human intervention is involved. Manual garbage collection and waste management is the good source to generate employment but there are some issues associated with it, like some time there is unavailability of manual

labor for days such as in maintaining railway tracks. There is a big concern of human safety when harmful gases exist.

The autonomous or semi-autonomous garbage collection unit may have high manufacturing cost but less maintenance cost. Autonomous bots can be a far better option when it comes to abolishing the monotony of tasks, overcoming safety issues during manual labor and in reaching remote areas. In some cases, efficiency may also be better (1 robot can do the work of several men). The only drawback is that the production costs of the robots are high. Our aim is to substantially reduce the cost, so as to make the implementation on a large scale feasible, including implementation through government bodies [(1)].

In order to understand the need for a compact, cost effective and scalable system, and before diving in to provide our own solution, we need to first understand the existing research and work done in the field. There have been numerous prototypes of garbage collection systems, autonomous robots, and waste segregators. In this section, we depict a concise review performed on these existing pieces of work, encompassing mobile robots, garbage collectors and IoT based systems for similar use cases. In proposed a Garbage collection Robot on the beach using wireless communications. The primary objective of this research was to clean up waste materials on coastline beaches. The mobile robot system consists of a shovel to scoop up waste, a trash box to deposit the waste gathered, a solar cell(which can help use an alternate source of power), an IP Camera to relay live feed to the user and a Bluetooth module for wireless communication [(2)]. The controller used is a basic PIC Microcontroller, along with a LED Display. The UI and the robot controller are designed on Visual Basic. Motion is completely controlled by the user (not autonomous), with buttons being made for COM port connection, the four translational directions, as well as the vertical motion of the tray. It can pick up wastes big in size like plastic bottles, packets, etc. The robot is equipped with tank wheels, which make it suitable for use not only in the beach terrain, but also in other harsh environments. It is a manual, eco-friendly and cheap option [(3)].

In [(4)] presented a deep learning-based approach to waste collection. The system consists of a 5- DoF manipulator, a web camera, IMU, Odometer, GPS module, Ultrasonic rangefinder, and a garbage container. The terrains suitable for such application are plain grounds, lawns and parks. The working is split into localization, navigation and perception. Localization deals with determining the position and orientation of the robot relative to a reference frame. A regenerated map of the cleaning area is generated for localization and navigation. The navigation module is for path planning and obstacle avoiding. Using the pre-fed environment map, the robot must find an optimal, obstacle avoiding path to pick up all the garbage lying around within the confines of the local map. Perception deals with garbage classification and localization. Image recognition includes ground segmentation, contour extraction, object tracking, and then classification. The neural network used here is CNN. Once identified, the robot will translate such that the image is kept in one particular part of the image continually, and the arm will then take over and pick up the object at a certain distance if it is classified as waste. Robot moves under PID algorithm. If out of range, tries to come back in range. Good accuracy obtained, most for bottles (91.87%), least for waste papers (77.7%).

In [(5)] proposed a robot based indoor autonomous trash detection algorithm using Ultrasonic Sensors. The idea here was to eliminate the heavy image processing algorithms for waste classification. The object shape has been scanned by 2 horizontally moving ultrasonic sensors placed one on top of the other. The ultrasonic sensors map the dimension of the object by being mounted on a servo base which rotates horizontally. The upper ultrasonic sensor confirms the object size and decides whether it is a waste or not. It then moves towards the trash and picks it up using an arm. The robot also comes equipped with a trash bin. It differentiates between walls/furniture and trash based on object width as scanned by the lower ultrasonic sensor. Here, waste classification simply based on width and height of object. Cheap option, complexity saved, but accuracy compromised. Work has also been done in creating a house cleaning robot system using path indication and position estimation using a ceiling camera. The idea presented here is that the user should be allowed to select which zone he wants cleaned. The user selects that on his/her computer screen from an image taken by a web camera attached to the ceiling of the room. When he/she clicks the zone that need to be cleaned, the points clicked on the image have to be manually mapped to coordinates in the room, and this movement coordinate data is fed as an instruction to the robot. To detect the position, a LED mounted on the

robot is tracked by the camera. The desired application area here is homes, and other cramped places where sensor data might not be completely reliable. Odometer errors are neutralized by camera pre-determined optimal path calculations. This concept saves a lot of time, but isn't completely automated, and requires some degree of human intervention. This method is tough to implement when robot goes out of camera frame.

In[6] demonstrates the use of a different algorithm. The robot (Khepra robot with 2 wheels and a gripper) was first trained in simulation to learn what it must go using the evolutionary process, and then the final generation was deployed onto the hardware board. Each task of the robot (for example identifying waste, picking up waste, dumping waste, etc.) was assigned a fitness level or score. The algorithm parameters adjusted themselves to maximise the score as the generations (iterations) progressed. Sensor readings (8 IRs) were used to take inputs from the environment and study the interactions of the robot. Block diagram (Figure 1) shows the complete overview of project.

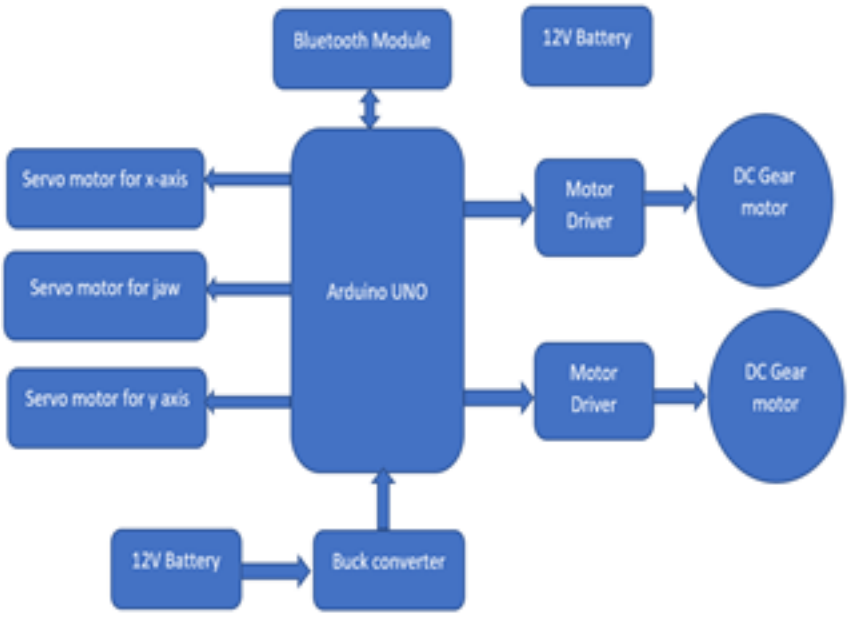

Fig 1. Block diagram of project

2 Implementation Method

The project is based on the low-cost solution; the system is completely user-friendly. The project consists of two main parts in which one is voice controlled and the other is semi-autonomous like button control.

We have used one Bluetooth module for wireless link between the robot and mobile. The mobile generates the voice command and send to the Arduino microcontroller via Bluetooth and microcontroller read the command and perform respective action. There is one robotic hand placed on robot which will pick the garbage and dispense it in the basket which is placed on robot.

The robot has two DC gear motors which specifications are as below:
Voltage = 24V maximum
Current at no load = 300mA
Current at full load = 1.2A
RPM without gear Box = 2800
RPM with gear box = 200 @ 24V
These gear motors are placed in a differential drive in both rear wheels. These motors mainly drive the robot. The

servo motors are used in robotic hand which move the robotic hand in 4 degree of freedom.

We have used Arduino based microcontroller in this project in which it has 14 digital pins and 6 analog pins. Arduino UNO has a microcontroller of ATMEL Family ATMEGA328 having instruction execution time is one machine cycle per instruction. The motor driver which we have used is L298N, L298N has two built in motor driver in one chip. To increase the current, we have connected two drivers parallel because our motor driver current consumption is more and one motor driver does not handle these motors properly. The schematic diagram of motor driver interfacing with Arduino is shown in Figure 2.

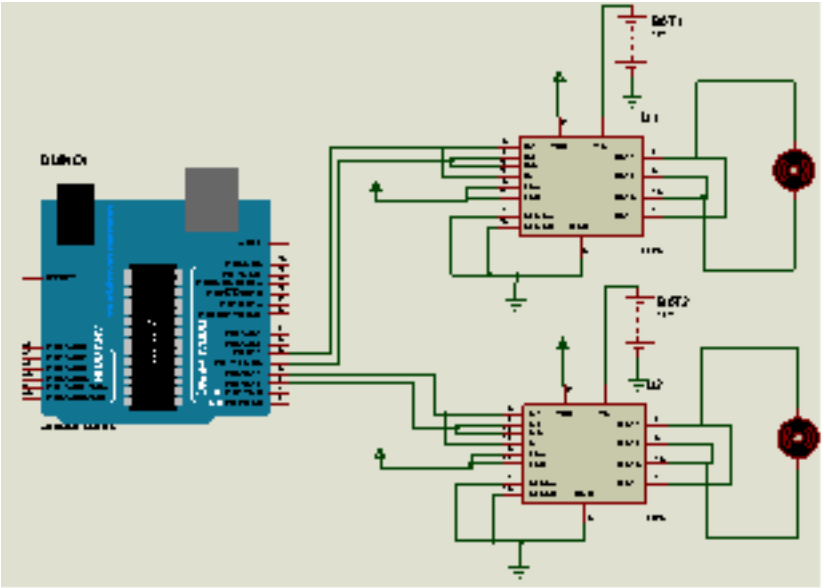

Fig 2. Schematic of Robot circuit

Figure 2 shows the schematic of motor driver circuit in which we have connected two motor drivers in parallel to increase the current, this driver can handle the current of 3A easily at 12V which id our requirement. The motor driver pin 1,8 and 15 is connected to ground to disable the current sensing capability because we no more required this pin. The Vs pin is connected to 12V of battery which will provide the power to motors.

The Bluetooth module is used for wireless communication and this link is of short range having a range of 25 meters. Wireless link is required to establish the connection between the mobile application and the robot. The microcontroller requires 5V for proper operation and above 5V it got damaged. So we have used one buck converter to convert 12V to 5V for microcontroller operation.[7,8]

2.1 Flow diagram

The flow diagram (Figure 3) explains the basic algorithm of project in which the programming code of project is based. This robot has one jaw mechanism for pick and place and two motors which are used for x and y direction movement. The x direction motor is used to place the garbage in respective basket and the y-axis motor is used to adjust the jaw height.

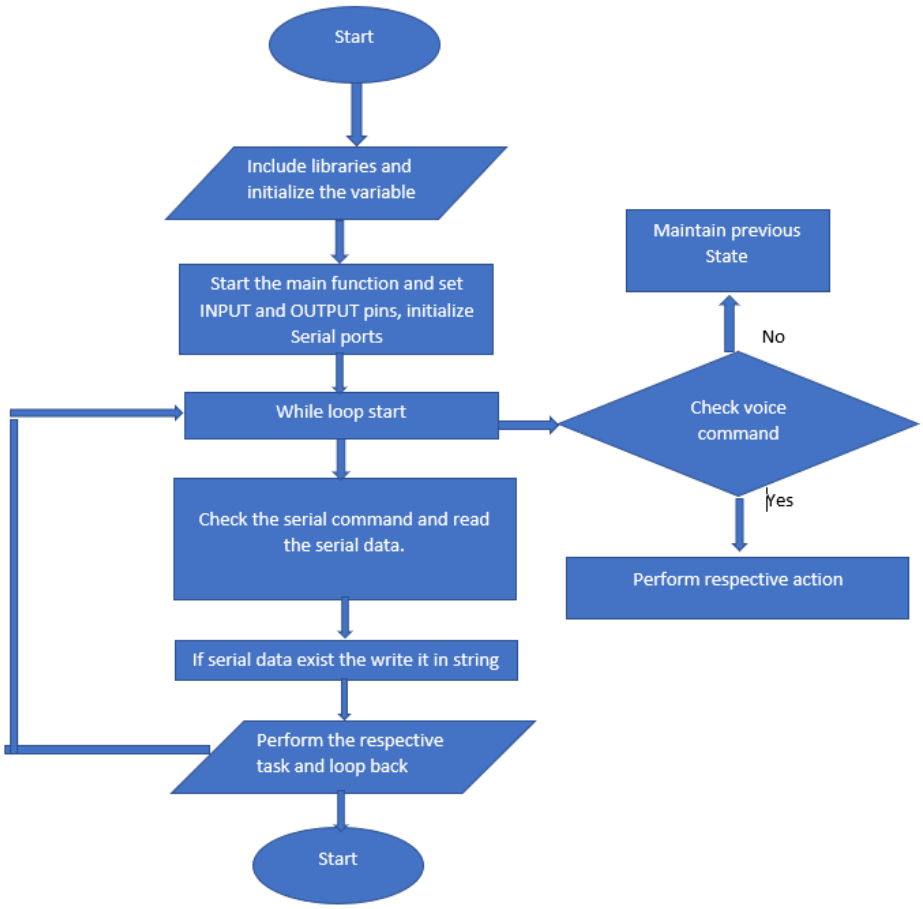

Fig 3. Flow chart of project

3 Result and Discussion

The simulation of project is completed on proteus software and then we have tested the hardware. The hardware is based on Arduino board. First of all, we have tested the DC gear motors with the respective motor driver circuit. The Arduino will provide the logic signal to the motor driver to turn ON and OFF. The commands are listed in Table 1

Table 1. Commands of basic operation of robot

SR. No	Command	M1a	M1b	M2a	M2b
1	Forwards	ON	OFF	ON	OFF
2	Backward	OFF	ON	OFF	ON
3	Left	ON	OFF	OFF	OFF
4	Right	OFF	OFF	ON	OFF
5	Stop	OFF	OFF	OFF	OFF
6					

The Table 1 shows the basic operation of robot in which two motors will drive the robot in forward as well as reverse direction.

4 Conclusion

We have designed a semi-autonomous garbage collector robot which can do multiple functions. The basic reason of completion of this task is to implement a well-organized way of garbage compilation and to trim down the production cost. Intelligently handling garbage waste can help for clean environment of Pakistan and to reduce environment pollution which is seriously felt in the ongoing COVID-19 pandemic situation.

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