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IoT Based Robotic Arm for Waste Segregation System using Renewable Energy Sources

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ABSTRACT

Robotic arm for waste separation is proposed for segregating the wastes as metal, dry and wet wastes so as to reduce the recyclable wastes going into the waste dumping areas. This paper proposes such a system which is easy to use. The whole process is done in two steps. Firstly, the waste is detected by IR sensor and picked up by the robot arm. Secondly, the waste picked is sensed on the waste segregation system to segregate the wastes as wet and metal waste by means of moisture and induction proximity sensors respectively otherwise it is considered as dry waste. The waste is then dumped into the appropriate bin. The proposed system utilizes Arduino mega 2560 microcontroller programmed in embedded C using Arduino IDE software and is powered using SOLAR power using PV panel. The redundant supply is given through battery. To monitor the system and to detect the type of waste Internet of Things (IoT) is implemented using Wi-Fi and GSM. An ultrasonic sensor indicates the level of waste in the bin and when the bin is full the information is sent to the concerned person via SMS via GSM module.

KEYWORDS: Arduino mega 2560 microcontroller, GSM, IR sensor, Metal sensor, Ultrasonic sensor, Moisture sensor, Robotic arm, TCP/UDP test tool

1. INTRODUCTION

The effective ways of reducing dumped waste is segregation and recycling of the waste. People are not implementing the guidelines given by the government in disposing the waste properly and they are throwing about 5.8% of metals, 3.5% of glass, 1.6% of plastic, 12.9% of papers, 1.8% of textiles and 53.7% of biodegradables which amounts to 79.3% of waste which can be recycled and remaining 20.7% only has to be dumped into landfills. A solution to this is to use an automated waste segregation system. This project consists of an automatic waste segregation system which is cheap and easy to use. It can be used for segregation of households so that the segregated waste can be directly sent for processing. This system segregates metal, dry and wet wastes by using appropriate sensors and the experimental results shows a successful segregation of the wastes using automated segregation system. The system consists of IR sensor to detect the waste. Once it is detected the robotic arm picks the waste and places it on the plate and is segregated by automated waste segregator as wet waste or metal waste if it is sensed by moisture sensor or metal sensor respectively otherwise it is considered as dry waste. Then the waste is dumped into the appropriate bin which is achieved by means of bin

movement. An ultrasonic sensor is used to check the level of waste in the dustbin and the information when the dustbin is full is given to the concerned authority via SMS via GSM module.

2. OBJECTIVES

Using automated waste segregator so that human interference can be reduced. To control the pollution of the environment. To alert the waste management system. To reduce the recyclable wastes going into the

3. METHODOLOGY

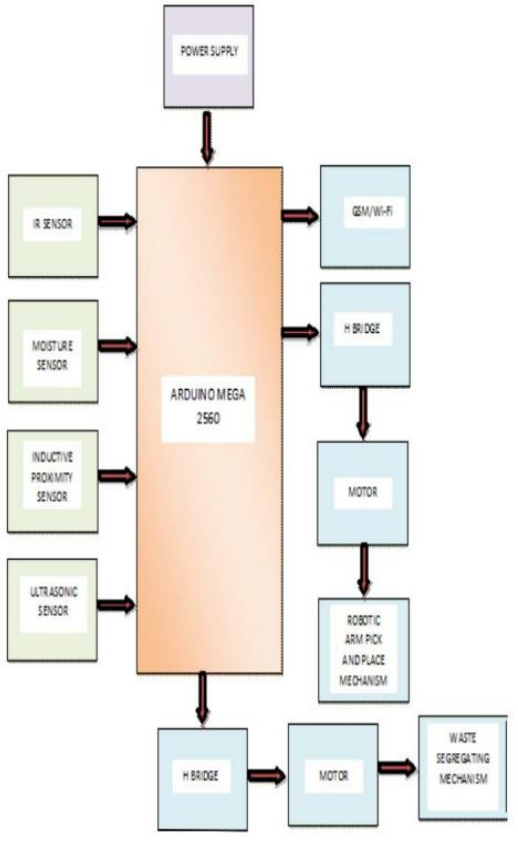


Figure 1 – Block Diagram

The block diagram of the proposed work is shown in the figure 1. The whole process is carried out in two steps. One is picking and placing of the waste by means of robotic arm, this requires IR sensor for detection of waste, motors for the working of the robotic arm, H-bridge to achieve the required direction of the motor. The second step of the process is segregating mechanism. It requires moisture sensor and induction proximity sensor to sort out wet and metal wastes respectively. If these two sensors cannot detect any waste then the waste is dry waste. The coding is done in such a way there will be rotation of the bin depending on the waste detected by the sensors. Ultrasonic sensor is used to know whether the bin is full or not. GSM module is used to send an alert message to the concerned person, the information about the full level of waste in the bin. The whole process is controlled by Arduino mega 2560 microcontroller

4. IMPLEMENTATION

Microcontroller: The Arduino Mega 2560 is a microcontroller board and it is based on the ATmega2560. It has 54 digital input or output pins out of which 14 can be used as PWM outputs and has16 analog input pins. Power to the board can be given using USB connection or with an external power supply.

Voltage Regulator: The voltage regulator L7805/12 is used to obtain a constant voltage. The proposed work requires 5 V and 12 V supply. It works on the principle of bridge rectifier and provides a regulated output of 5V and a nonregulated output of 12V.

Infrared obstacle detection sensor: The Infrared obstacle detection sensor is a proximity sensor consisting of a transmitter and a receiver. The transmitter transmits IR rays and when it is hit by the waste, some radiations are reflected back and are received by the receiver.

Moisture sensor: The moisture sensor measures the moisture content in the waste. The waste placed on the plate if contains moisture content then it conducts more electricity when in contact with the sensor.

Ultrasonic sensor: Ultrasonic sensor is a distance measuring sensor. This sensor consists of a transmitter which transmits the sound wave at 40kHZ and when it is hit by the waste, thesignals are received by the receiver which makes the echo pin to remain high.

Inductive proximity sensor: The inductive proximity sensor is used to detect the conducting metal target. It has four components coil, oscillator, trigger circuit and output circuit. The oscillator generates the fluctuating magnetic field around the coil. When the metal waste is present in this field, eddy circuit is generated in the metallic waste. As a result, it reduces the oscillator strength and triggers an output when the oscillator strength reduces to a sufficient level.

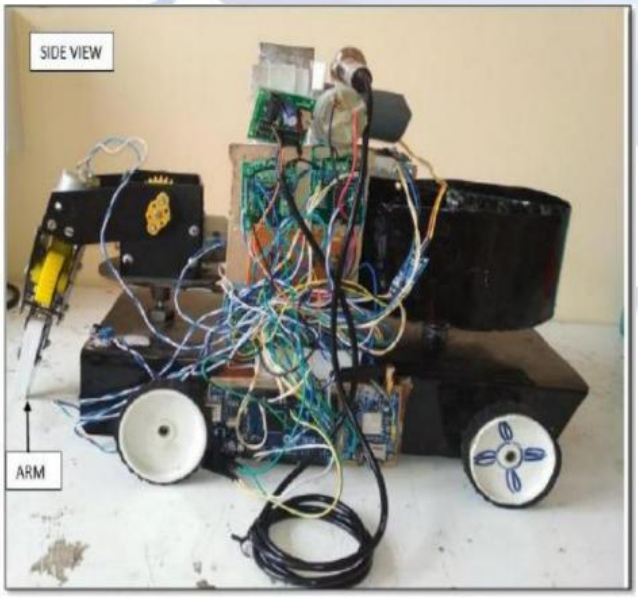
DC motor: DC motor is a device used to convert electrical energy into mechanical energy. L293D motor driver.

L293D motor driver: It is an H-bridge which enables the motor rotation in either direction. It consists of four switching elements. They are high side left S1, high side right S3, lowside right S4 and low side left S2. High side switches are called sourcing currents and low side switches are called sinking currents. If both the switches on one side of the bridge are turned on, it creates a short circuit between the battery positive and battery negative terminals. When terminals are short circuited motor comes to sudden stop and it runs free to stop when detached from the circuit.

GSM module: Global system for mobile communications (GSM) is a standard developed by the European telecommunications standard institute (ETSI) to describe the protocols for second generation (2G) digital cellular networks used by the mobile devices such as mobile phones and tablets. The GPRS/GSM shield provides a way to use the GSM phone network to receive the data from a remote location.

Wi-Fi module: Wi-Fi is a technology that makes use of radio waves to provide network connectivity. ESP8266 is the Wi-Fi module usedour proposed system. The module is a selfcontained SOC and it has integrated TCP/IP protocol stack. This module comes with preprogrammed AT command set.

5. EXPERIMENTAL SETUP



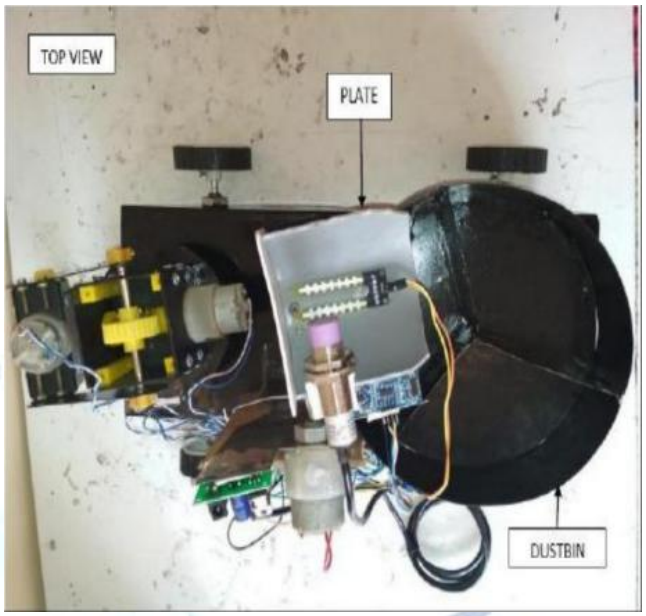


Figure 2 - Experimental setup of the waste segregation system

The experimental set up of the proposed work is shown in the figure 2. It shows the waste segregation system in top view and side view. It consists of robotic arm and the waste segregation system

6. RESULTS AND DISCUSSION

The proposed system provides a robotic solution for the segregation of dry, wet and metal wastes using sensors. IR sensor placed in front of the system detects the waste for each movement of the robot 20 times. It works on 5V. Frequency varies from 430THZ to 300GHZ. Accuracy is about ±0.5cm. It gives a digital LOW output when the waste is detected.

Figure3 - SMS received by the concerned person

A 1 second movement is equal to a distance of 5cm. The movement of the robot, rotation of the motor and time taken for the rotation is shown in the table 1.

Table1: Robot movement

FUNCTION	ROTATION OF MOTOR	SECONDS
FORWARD	2 Rotation + 180°	5
STOP	-	1
LEFT	2 Rotation + 180°	5
STOP	-	1

The waste is checked by the sensors placed on the plate. Once checked for the type of waste there will be rotation of the dustbin with respect to the type of waste. The movement of the bin with respect to the waste is shown in the table 2. After a delay the bin is rotated back to its predefined position.

FUNCTION	ROTATION OF MOTOR	SECONDS
DUSTBIN_ROTATE_WET (bin M_7 rotates)	150°	2.5
STOP	-	3
DUSTBIN_ROTATE_WET_1 (bin M_7 rotates back)	150°	2.5
STOP	-	3
DUSTBIN_ROTATE_METAL (bin M_7 rotates)	270°	4.5
STOP	-	3
DUSTBIN_ROTATE_METAL_1 (bin M_7 rotates back)	270°	4.5
STOP	-	3

For each movement of the bin, it is stopped for 3 seconds during which the waste is placed by the plate into the bin. The movement of the plate is shown in the table 3. For dry waste there will be no movement of the bin.

Table 3: Plate movement

FUNCTION	ROTATION OF MOTOR	SECONDS
WASTE_DROP (M_6 rotates anticlockwise)	180°	1
STOP	-	1
WASTE_DROP (M_6 rotates clockwise)	180°	1
STOP	-	1

TCP/UDP test tool is an application tool used to monitor the type of waste detected. It requires Wi-Fi for its working. Here program is done in such a way the distance measured by the ultrasonic sensor, and the type of waste detected can be monitored. The figure 4 shows the type of waste monitored and distance measured by the ultrasonic sensor.

Figure 4 - TCP/UDP test tool display

7. CONCLUSION AND FUTURE SCOPE

The proposed prototype aims at segregating dry, wet and metal wastes using sensors and was successfully implemented using Infrared sensor, ultrasonic sensor, moisture sensor and inductive proximity sensor. According to the state of waste, it is segregated and dumped into the respective bin successfully, which is achieved by means of proper movement of the bin. The system can automatically send a message to the concerned person when the bin is full using GSM technology. The concerned authority can successfully monitor the state of sensor using TCP/UDP test tool. Manual collection of the waste is avoided and is made automated so that human interference can be reduced. In our proposed system implementation is done for a single dustbin. Many bins can be integrated and internet of things can be used. Automatic dumping mechanism can be provided if the bin is full. Different motion of the robotic system can be provided

depending on the architecture of the place where it has to be used.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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