IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

SEPARATION OF PLASTIC BOTTLES BASED ON ITS GRADE USING RFID TECHNOLOGY

[1]Cynthia Boby,[2]Joe Thomson K M,[3]Philomina Peter,[4]Sachin A J

[1]Student,[2]Student,[3]Student,[4]Student

[1] Department Of Electrical And Electronics

Rajagiri School Of Engineering And Technology, Ernakulam,India

Abstract: **The 21st century has witnessed a tremendous growth in urbanization. Rapid changes occur in all walks of life but unfortunately there has been no efficient and eco-friendly method to segregate and dispose of the waste products which have accumulated in our cities. This project aims at collection of plastic waste bottles thrown away by fast moving city dwellers at public places. The 'Reverse Vending Machine will be composed of three main parts: the vending machine, the control center, and the bottle acceptor unit. At the heart of the system is a microcontroller which directs the operation of the various input (sensors and keypad) and output (display and motors) devices attached to it. The machine accepts plastic bottles and credits these as points, which in turn, can be used to buy products. Through a plastic bottle inlet, the bottle acceptor unit. accepts plastic bottles. Rejected plastic bottles will be returned via the bottle acceptor dispensing area. RFID tag will be attached to each bottle, the tag contains information about grade of plastic, manufacturer details and cost. Based on the information read by the RFID tag the servomotor segregates different grades of plastic bottles into the respective bins.The plastic bottles thus collected can be used effectively for tarring of roads, in the production of gypsum boards etc. Grade1 and 2 plastic bottles can be sent to recycling stations. Thus the byproducts are successfully reused for different purposes.**

***Index Terms*–RFID, Reverse vending machine, Vending machine**

1 INTRODUCTION

Waste management is a worldwide concern to be looked upon. Huge cartloads of non-biodegradable waste have been dumped in open grounds for many years. Effective methods or processes to segregate different kinds of plastic waste has not yet been implemented. Tremendous increase in population and rapid growth in technology have led to severe waste management problems. The real problem, however, is the lack of a proper environment management system at a base level. Problems related to solid waste management exist beyond its disposal. There are many administrative, economic, and societal tribulations that must be addressed in relation to waste management. The scientific attempts to figure out all these complexities are usually attributed to waste management. Open dumping of plastic waste poses different kinds of hazardous health issues thus it is the need of the hour to promote real time plastic waste management for segregating and controlling the accumulation of plastic waste.

Plastic is a fabricated chemical compound that replaces worldly resources in all walks of life and has become a fundamental part of our society. There has been a significant increase in the consumption and production of plastic during the past few years. As time passes, the basic properties of plastic such as stability and durability has enhanced tremendously and hence these categories are now treated as identical for materials being unyielding to many environmental limitations. The main drawback is that these groups of plastic take up millions of years to decompose. Plastic waste bottles and wrappings heaved on land mostly enters into municipal drainage lines and creates clogging resulting in flood. Millions of mammals, birds, reptiles, and fish are disclosed to be killed every year by the ingestion of plastic bags. Most plastics affect aquatic wildlife either by intertwining creatures or by being eaten. While dumping plastic waste there is a chance for leakage chemicals which in turn pollutes the underground water table.

Recently many IoT based research has been put into place for the monitoring and collection of plastic waste. An IoT based smart bin which is provided with an ultrasonic sensor and Arduino microcontroller there is a separate Ethernet shield for transferring of data[1]. The paper imparts the evolution of smart wireless waste systems that employ the GSM technology for smart bins[2].An Arduino microcontroller was integrated with CCTV camera in order to keep track of the environment[3].RFID is a fast developing technology, RFID tag is attached to the smart bin and were various parameters were recorded[4].An object to object communication using local area network was tested where in the objects are placed 20 foot apart, here the data access is limited[5]. The bin identification in connection with the RFID tag is discussed. The tag contains information about the product and its management process.[6].

RFID tags are used to identify the grade of plastic and the manufacturer details are also included in the tag. The RFID reader recognizes the plastic bottle and gives command to the controller. The controller sends signals to the stepper motor and servo motor to operate so that plastic bottles are disposed in different bins according to its grade.The user gets credits for each plastic bottle deposited and can also purchase mineral water bottles from the same system using the RFID card balance.

The rest of the paper is organized as follows. Section 2 contains the block diagram and implementation of the prototype. The flow chart of the proposed system is described in section 3.Its implementation is reported in section 4. Finally, conclusions are drawn in section 5

2 IMPLEMENTATION

2.1. WORKING PRINCIPLE

The machine will be composed of three main parts: the vending machine, the control center, and the bottle acceptor unit. At the heart of the system is a microcontroller which directs the operation of the various input (sensors and keypad) and output (display and motors) devices attached to it. The machine accepts plastic bottles and credits these as points, which in turn, can be used to buy products. Through a plastic bottle inlet, the bottle acceptor unit. accepts plastic bottles. Rejected plastic bottles will be returned via the bottle acceptor dispensing area. RFID tag will be attached to each bottle, the tag contains information about grade of plastic, manufacturer details and cost. Based on the information read by the RFID tag the servomotor segregates different grades of plastic bottles into the respective bins. The plastic bottles thus collected can be used effectively for tarring of roads, in the production of gypsum boards etc. Grade 1 and 2 plastic bottles can be sent to recycling stations. Thus the byproducts are successfully reused for different purposes.

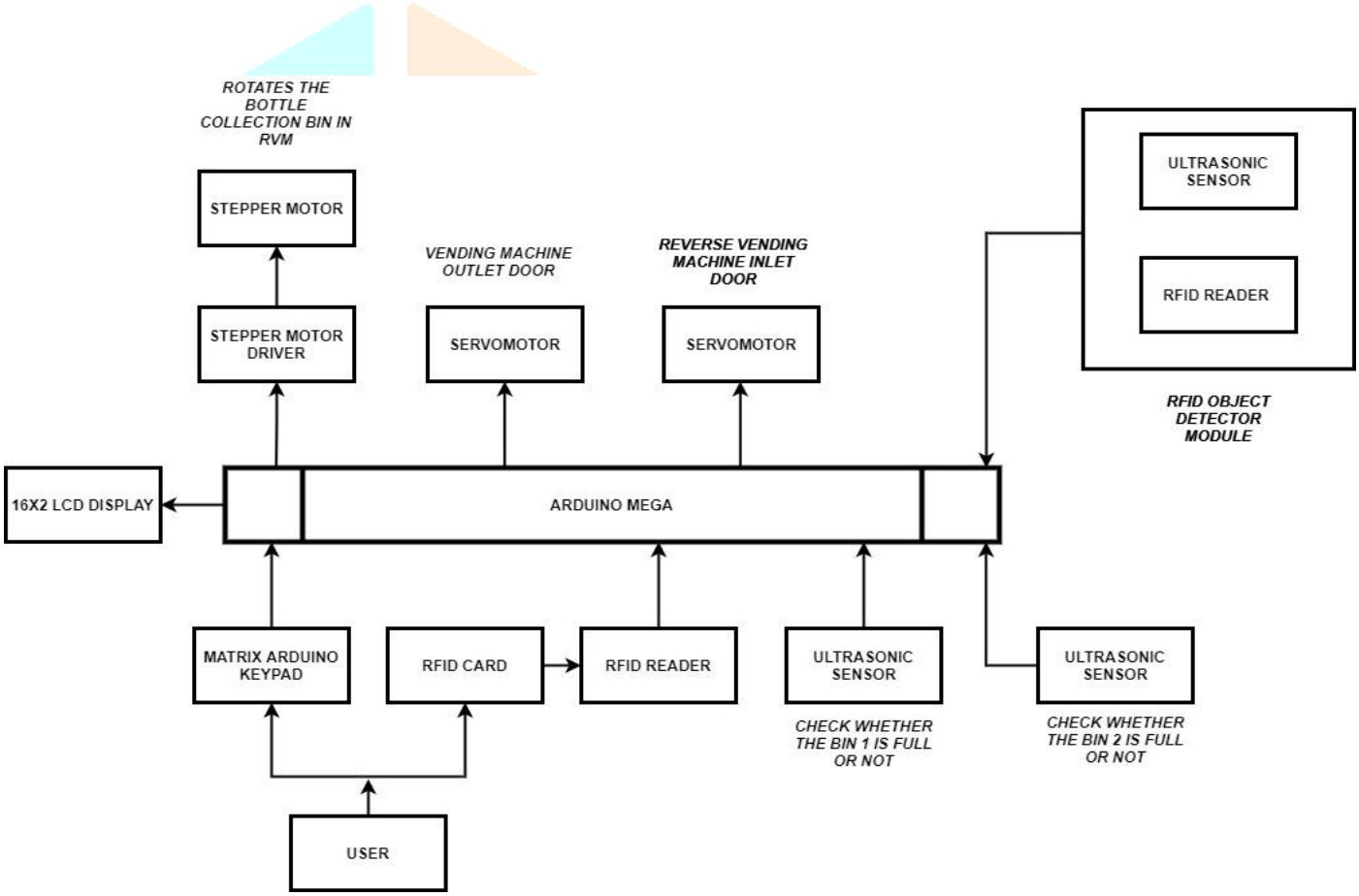

Fig.1 Block diagram of proposed system

2.2.MACHINE PROTOTYPE

The Fig .2 shows the prototype of 'Separation of plastic bottles based on its grade using RFID technology'. It will be composed of three main parts: the vending machine , the control center , and the bottle acceptor unit .The machine will have a display area LCD screen (1) which will also have a vending machine that contain funnel (8) and outlet (9) to serve as storage for the items to be sold through the outlet (9). Products purchased will be obtained through the vending machine dispenser.All processes will be controlled and ordered by the control center. The control center will contain the microcontroller unit and input/output peripherals such as LCD screen(1) and keypad(2) and the RFID reader(3) will be connected to it..

Through a bottle inlet, the bottle acceptor unit accepts plastic bottles. Rejected plastic bottles will be returned via the bottle acceptor dispensing area(4) . Inside the bottle acceptor unit, the ultrasonic sensor and RFID reader will be there .If the bottle is accepted the RFID reader detects whether the bottle is recycle or non recycle plastic based on the grade of the plastic bottle then the controller controls a stepper motor through a driver to rotate the bins(7) and (6) till the bin corresponding to the identified material.

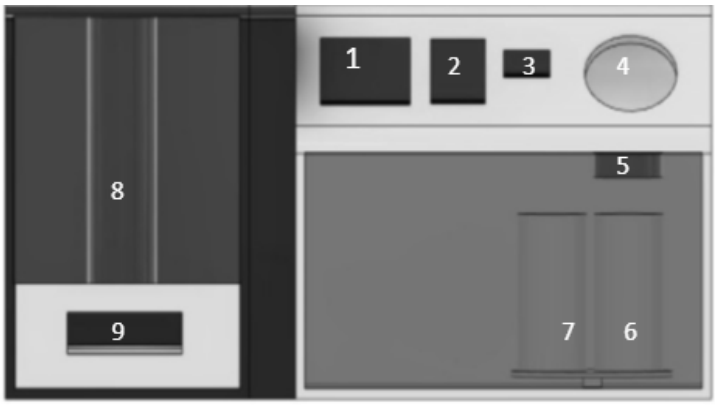

Fig.2The system design showing the major components of the system

2.3. HARDWARE COMPONENT

It consist of Arduino Mega 328P, Stepper Motor,ServoMotor,Ultrasonicsensor, RFID ,16*2 LCD Display,Power supply is 12v battery.

2.3.1 ARDUINO MEGA 328P

Fig.3 shows the Atmel 8-bitAVRRISC-based microcontroller combines 32 KB ISPflash memory with read-while-write capabilities, 1 KB EEPROM, 2 KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers [5].Arduino ATMEGA328P is the control center of this product .

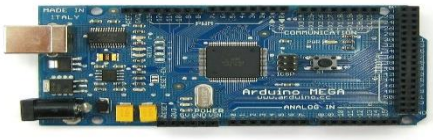

Fig 3.Arduino MEGA

2.3.2 STEPPER MOTOR

The 4.2Kg-cm, bipolar stepping motor with step angle:18,1.7A,12-24V DC as shown in Fig,4.a is used to rotate the bins. The TB660 stepper motor driver,8-50v,4.5a stepper motor driver, shown in Fig. 4.b, controls the stepper motor operation.

Fig.4.a Stepper motor

Fig.4.b Stepper motor driver

2.3.3 SERVO MOTOR

The MG995 plastic gear servo motor with 180 deg rotation with 4.8v-7.2v is used to open and close the funnel lid. A servomotor is arotary actuator orlinear actuator that allows for precise control of angular or linear position, velocity and acceleration as shown in Fig 5.

Fig.5 servo motor

2.3.4. ULTRASONIC SENSOR

The ultrasonic level sensors measure distance by using ultrasonic waves. The sensor emits an ultrasonic wave and the receiver receives the wave reflected back from the target. ultrasonic level sensors measure the distance to the target by measuring the time between the emission and reception. This is the HC-SR04 ultrasonic distance sensor as shown in Fig.6. This thrifty sensor provides 2cm to 400cm of non-contact measurement functionality with a ranging accuracy that can reach up to 3mm. Each HC-SR04 module includes an ultrasonic transmitter, a receiver and a control circuit [8]

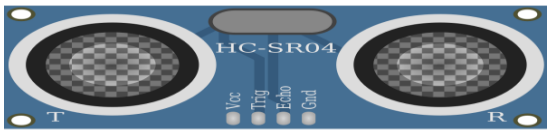

Fig.6 Ultrasonic Sensor

2.3.5 RFID

Radio frequency identification (RFID) refers to the technology consisting of tags and receivers and works on the radio frequency of radio waves. This technology is very much effective and less time consuming. The RFID has different frequencies of operation such as low frequency(125KHz or 134KHz),high frequency (13.56MHz)and ultra high frequency(860-960MHz). Here we use an RC522,13.56mHZ reader as show in Fig.7.a with ISO 14443. A 13.56MHZ RFID card is show in Fig7.b.

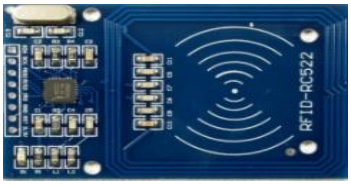

Fig.7.a. RC522,13.56Mhz RFID reader

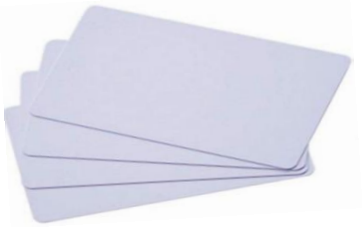

Fig 7.b 13.56MHz RFID card

2.3.6 16x2 LCD DISPLAY

16*2 Alphanumeric 16x2 LCD display module that shown in Fig.8, that can display alphabets and numbers. Display of operating Voltage is 4.7V to 5.3V,1mA is used.

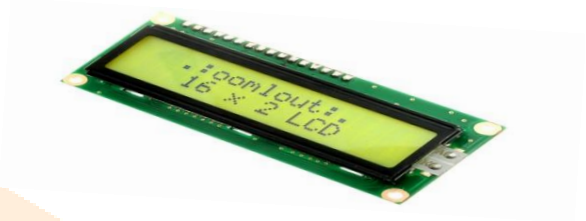

Fig 8. 16x2 LCD Display

3 FLOW CHART

The Fig.9.a and 9.b shows the flow of operation in the separation of plastic bottles based on its grade using RFID technology. The process starts from the detection of an RFID card indicating that a user is trying to access the machine. Upon verification of the user, the machine will show messages through an LCD screen asking for the desired course. If the user wants to deposit bottles, the machine will be ready to take the input order. The plastic bottles will be verified using the RFID reader and ultrasonic sensor .If the input is rejected, the machine discards the input and continues to ask for plastic bottles until the accepting phase is terminated. After the deposition of plastic bottles, the corresponding value of the inputted plastic bottles will be shown and added to the total value stored in the RFID card and the sum will be displayed through the LCD screen. The machine will then ask if the user would like to make a purchase. If the user wants to purchase the bottle, the machine will be ready to take orders. Upon totalling the value of the ordered goods, the machine checks if the account has enough credits to pay for the order. If not, the machine will cancel the order and then again be ready to accept additional plastic bottles. If the account has enough credits, the machine will deduct the cost from the total credits stored and will output the ordered goods. The machine would then again ask if the user would like to make a purchase. If not, the machine terminates operation. The user also has the option to check the amount of points available in the card

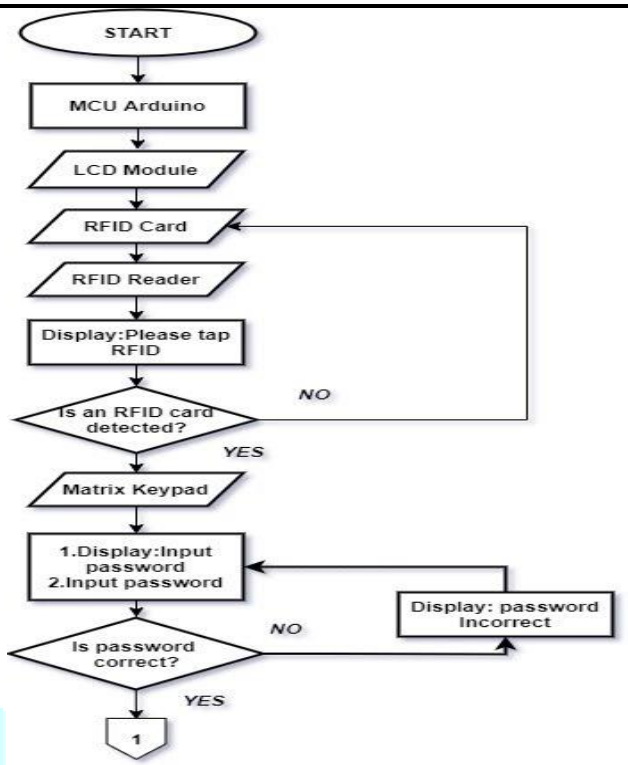

Fig 9.a Flow chart of proposed system

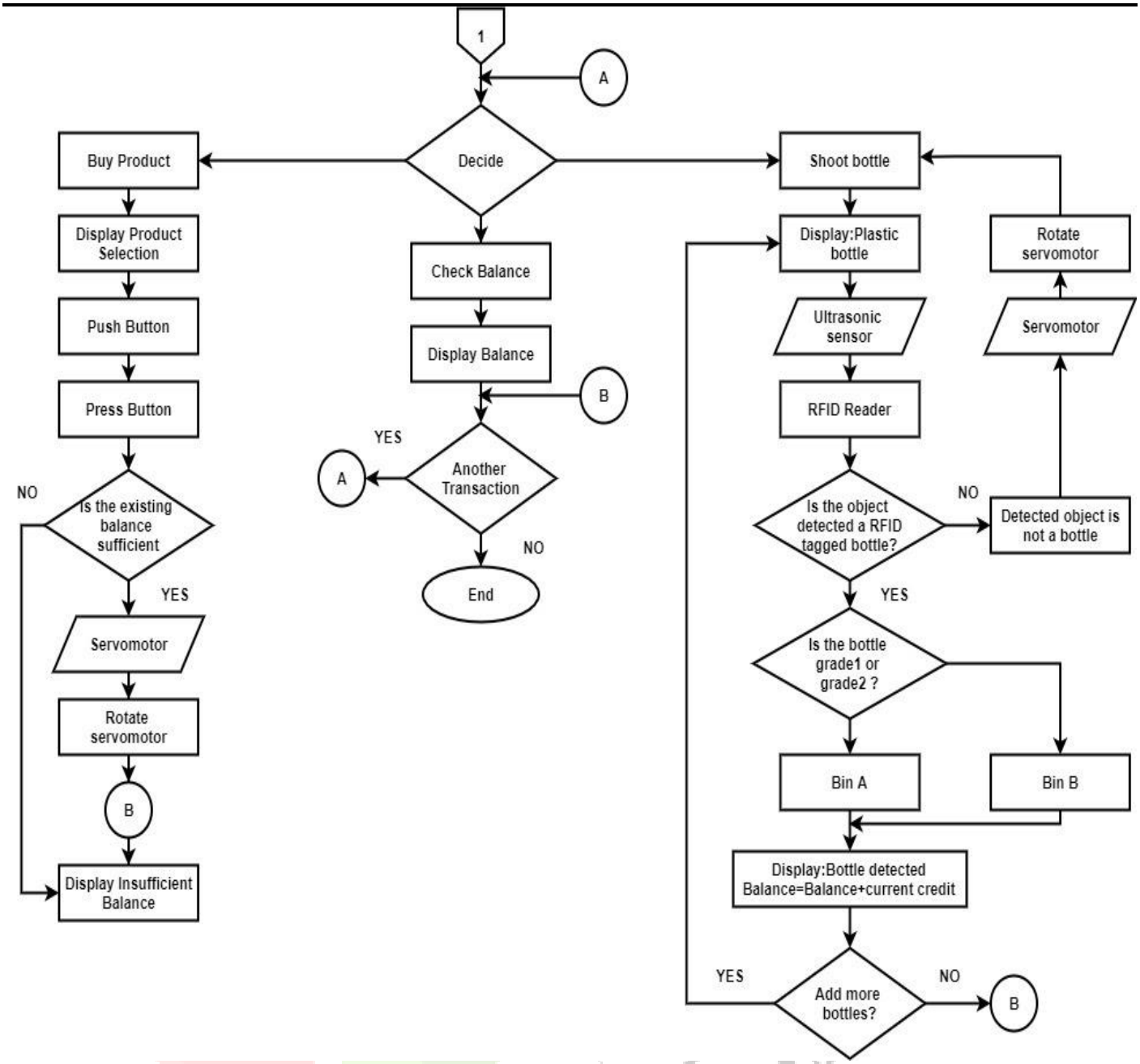

Fig 9.b Flow chart of proposed system

4 SIMULATION

The proposed circuit includes two processes. A Reverse Vending Machine for the disposal of Grade 1 and Grade 2 plastic bottle waste and a Vending Machine for buying new water bottles. Whenever a RFID card taps on the RFID reader in the machine ,the customer after entering his user ID and password can fetch the available card balance as shown in Fig 10 .And the user can choose either to dispose or buy a bottle from the machine which is shown in Fig 11. A 16x2 LCD display unit and keypad is used to view and enter the details associated with the card.

If the user choose the option to deposit the bottle and inserted the RFID tagged bottle through the vent, which consists of a ultrasonic sensor and a RFID Reader. The RFID reader reads the data within the RFID tag and the machine determines whether it is Grade1 or Grade2 plastic. The tag in the bottle is programmed to have the details of plastic grade and the amount that is to be credited to the customer. The ultrasonic sensor in the vent detects the bottle and opens the bottom lid of the vent. Two bins are used to store Grade1 and Grade2 plastic. A Servomotor(for opening the lid of the vent) and a Stepper motor(for rotating the bins) is used for the proper disposal of bottles to separate bins.

If the detected rfid bottle is Grade 1, the Servo motor rotates 180 degrees(the vent lid opens)and the Stepper motor remains idle and the bottle drops into the default bin which is shown in the Fig 12.Later the Servo returns to initial position.After disposing the bottle, certain amount of money will be credited to the customer account and is updated as new balance as shown in the Fig 13 .

If the detected bottle is of Grade 2, the Stepper has a rotation of 180 degrees for the other bin to be in position for collecting the bottle and the servo motor rotates(vent lid open) to drop the bottle and come back to initial position(vent lid closed and bin 2 back to initial position). Another two Ultrasonic sensor are used to check whether the bins are full or not.

For buying the bottle, the bottles are stacked one by one on top inside a pipe which consists of a Servomotor at the bottom end(to open the lid). Whenever the user wants to buy a bottle the Servo is rotated and the bottle is dropped down into a flat surface. From there the user can collect the water bottle. An additional Ultrasonic sensor is used to check whether the bottle availability is empty or not.

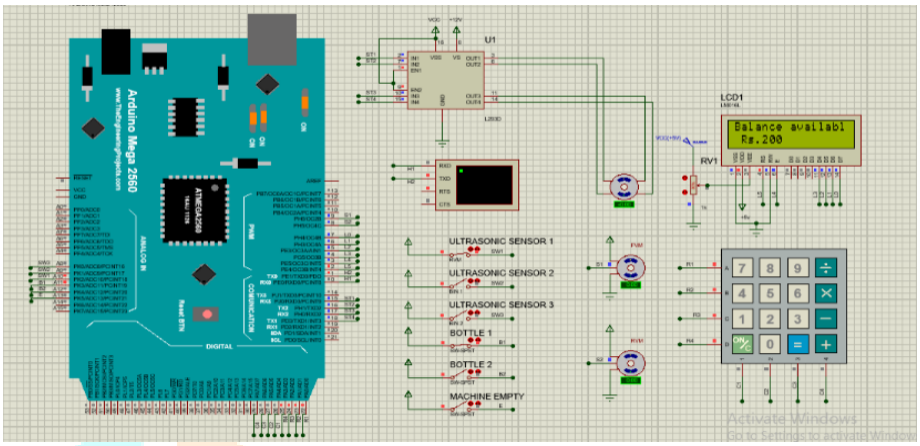

Fig 10 .Simulation diagram shows the RFID card balance

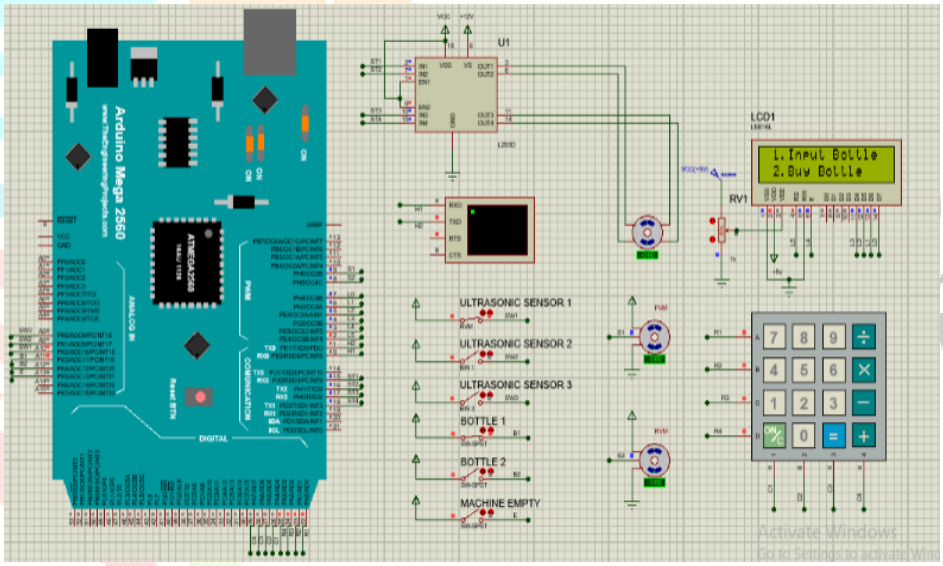

Fig 11Simulation diagram shows the option selected by the user

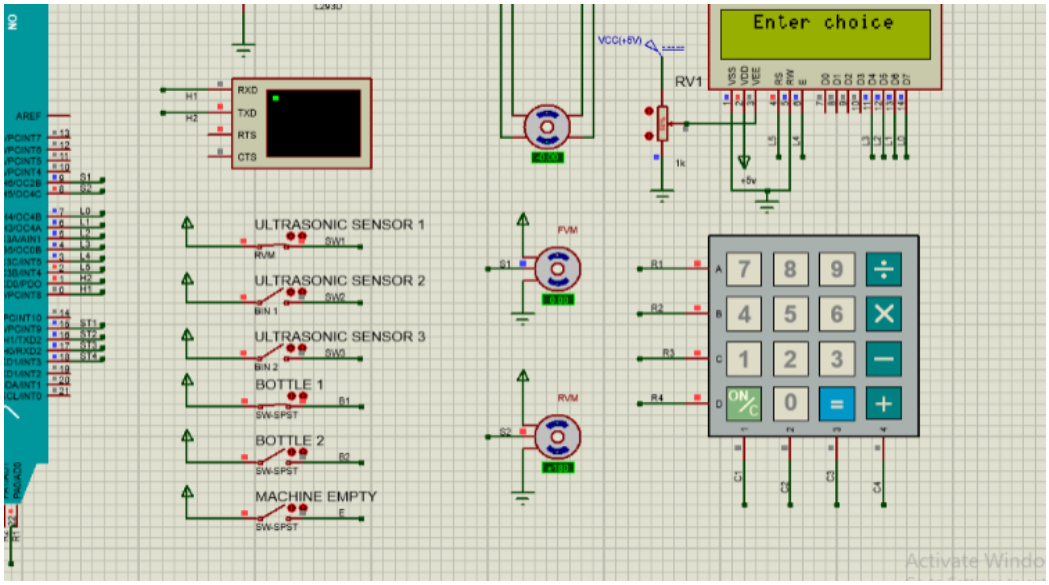

Fig.12.Simulation diagram shows the servomotor rotation for Grade 1 plastic

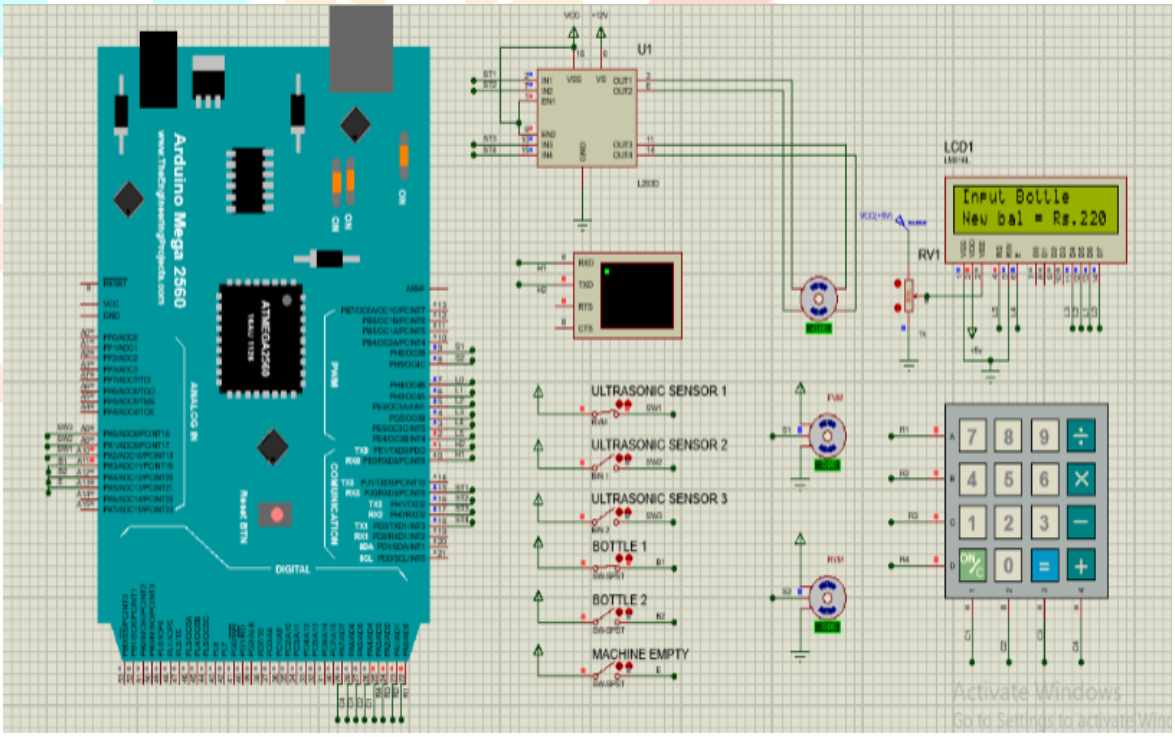

Fig.13. Simulation diagram shows the new card balance

SWITCHES	STATE	REMARKS
ULTRASONIC SENSOR 1(RVM)	ON OFF	bottle detected and RVM lid opens bottle not detected lid remain closed
ULTRASONIC SENSOR 2(BIN 1)	ON OFF	Detected that the bin 1 is full Detected that the bin 1 is not full
ULTRASONIC SENSOR 3(BIN 2)	ON OFF	Detected that the bin 2 is full Detected that the bin 2 is not full
BOTTLE 1 (PHYSICAL CONDITION)	ON	Bottle 1 contain RFID tag having the details of the grade and amount to be credited
BOTTLE 2(PHYSICAL CONDITION)	ON	Bottle 1 contain RFID tag having the details of the grade and amount to be credited
EMPTY MACHINE(PHYSICAL CONDITION)	ON OFF	Indicate that there is no bottle in vending machine Indicate the presence of bottle

Table 1. Different switching operation of the entire simulation

5 CONCLUSION

This paper presented the design and implementation of a drop and tap reverse vending machine which is capable of separating grade 1 and grade 2 plastic . The machine accepts plastic bottles and credits these as points, which in turn, can be used to buy products. Through a plastic bottle inlet, the bottle acceptor unit. accepts plastic bottles. Rejected plastic bottles will be returned via the bottle acceptor dispensing area. RFID tag will be attached to each bottle, the tag contains information about grade of plastic, manufacturer details and cost. Based on the information read by the RFID tag the servomotor segregates different grades of plastic bottles into the respective bins. The plastic bottles thus collected can be used effectively for tarring of roads, in the production of gypsum boards etc. Grade 1 and 2 plastic bottles can be sent to recycling stations. Thus the byproducts are successfully reused for different purposes. Testing showed the effectiveness of the sorting system.

REFERENCES

[1] Murugaanandam. S, Ganapathy. V and Balaji. R, "Efficient IOT Based Smart Bin for Clean Environment", International Conference on communication and Signal Processing, April 3-5, 2018, India

[2] Thakker, S.akker, S. and Narayanamoorthi, R,"Smart and wireless waste management",Innovations in Information, Embedded and Communication Systems (ICIIECS), International Conference, March 2015

[3] Chatterjee, S. & Kar, A.K. (2015). Smart Cities in Developing Economies: A Literature Review and Policy Insights. IEEE International Conference on Advances in Computing, Communications and Informatics. Kochi, India, pp. 2335 – 2340

[4] L. Catarinucci, R. Colella, S. I. Consalvo, L. Patrono, C. Rollo and I. Sergi, "IoT-Aware Waste Management System Based on Cloud Service and Ultra-Low-Power RFID Sensor-Tags," in IEEE Sensors Journal, vol. 20, no. 24, pp. 14873-14881, 15 Dec.15, 2020

[5]Saadia Kulsoom Faisal Karim, Naeem Ahmed And Abdul Aziz, "IoT Based Smart Garbage Monitoring & Collection System Using WeMos & Ultrasonic Sensors" iCoMET 2019.

[6] Yann Glouche, Paul Couderc. "A Smart Waste Management with Self-Describing objects." Leister, Wolfgang and Jeung, Hoyoung and Koskelainen, Petri. The Second International Conference on Smart Systems, Devices and Technologies (SMART'13), Jun 2013, Rome, Italy. 2013

[7] Wisdom Gen P.Dumpayan, Matthew Lawrence M. De Mesa, Nathalie Danielle F. Yucor, Eden T. Gbion, Jacqueline D. Reynoso, Gabriel Rodnei M. Geslani ,"Two-way Powered Microcontroller-based Plastic Bottles 'Drop-and-Tap' Reverse Vending Machine with Stored Value System Using Radio Frequency Identification (RFID) Scanner Technology "IEEE,25 January 2018

[8]"What is an ultrasonic / level sensor?" *https://www.keyence.co.in/*, May 26,2021

[9] D. Hoornweg et al., "WHAT A WASTE A Global Review of Solid Waste Management", Urban Development & Local Government Unit World Bank, Washington, DC., No.15, March 2012

[10] Nishigandha Kothari, "Waste to Wealth", NSWAI, New Delhi, July 2013.

[11] H. Ellsbury. "Plastic Water Bottles Impose Health and Environmental Risks." Internet: https://www.banthebottle.net/articles/plastic-water- bottles-impose-health-and-environmental-risks/, August 23, 2012.