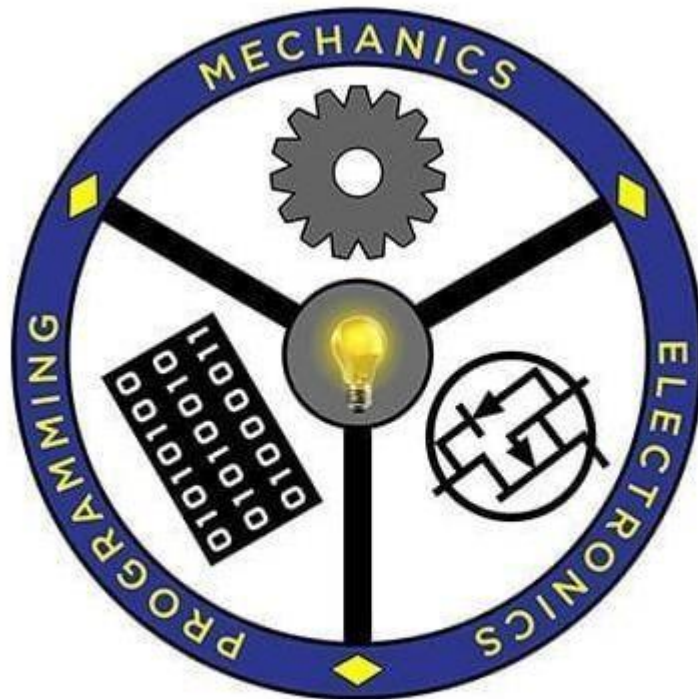ProjectReporton
AUTOMATICSEGREGATIONOFWASTE MATERIALS

SubmissiontoTHEROBOTICSCLUB -SNISTasapartof INDUCTION'23

TEAMNO- 07

THEROBOTICSCLUB-SNIST

SREENIDHIINSTITUTEOFSCIENCEANDTECHNOLOGY

(AUTONOMOUS)

(Affiliated to JNTU University, Hyderabad)

Yamnampet,Ghatkesar,Hyderabad–501301.

2023

CERTIFICATE

This is the project work titled 'UpakshyaViraha' by 'M Manikanth Reddy, R. Surya Prakash AsiniparthiLivruth, K. Vivek Reddy, SrinathItham, BarlaSaiAnjanna Reddy, SravyaChavali, P. PhaniAnirudh, Yahswika, RitikaAnshu Reddy Vemalla' under the mentorship of 'SunkuGiridharShanmukhand KovidhAddhish G'andisarecordoftheproject workcarriedoutbythemduringtheyear2022-2023as part of INDUCTION under the guidance and supervision of

Mr. DP NagaAjayKumar &
Ms.PTapaswini
TechnicalHeads

Mr.TBharatKumar The
President of
THEROBOTICSCLUB

Dr.A.PURUSHOTHAM
Faculty Advisor
MechanicalDepartment

DECLARATION

Theproject workreportedinthepresent thesistitled**"UpakshyaViraha"**isarecordofworkdoneby Team 07 in **THE ROBOTICS CLUB** as a part of **INDUCTION-2023.**

No part of the thesis is copied from books/ journals/ Internet and wherever the portion is taken,thesamehasbeendulyreferredinthetext.Thereportisbasedontheprojectworkdoneentirelyby TEAM (team number) and not copied from any other source.

ACKNOWLEDGMENT

Contents   Pg.No

ABSTRACT

"UPAKSHAYA VIRAHA"

Automatic Waste Segregation System

THEPROBLEM:

The nation and world is facing a huge problem today of disposal, segregation and recycling of solid waste, and improper management of these wastes are hazardous and dangerous to human health and ecological system. There is a rapid increase in capacity and categories of solid waste as a result of urbanization, constant economic growth, and industrialization. Global Waste Management Market reported that the amount of waste generated worldwide produced is 2.02 billion tones. "Wastes are not always waste if it is segregated as it was". To properly manage the waste it has to be handled,segregated, transported and disposed so as to reduce the risks to the public lives and sustainable environmental. The economic value of waste is best comprehended when it is segregated. Currentlythere is no such system employed of segregation of glass, plastic and metallic wastes at industrial level.

THETEAMSAPPROACHTOTHEPROBLEM:-

This paper proposes an automation of waste material segregation in scrap industry. This method is easy and simple solution of segregation of three types of wastes glass, metal and plastic. It is designed to sort the trash into metallic waste, plastic waste and glass waste ready to be processed separately for the next process of operation. The method uses inductive sensors metallic items, and capacitive sensors to distinguish between and dry waste. Experimental results show that the segregation of waste into metallic, plastic and glass waste has been successfully implemented using the automation of material segregation (AMS) method.

BLOCKDIAGRAM:
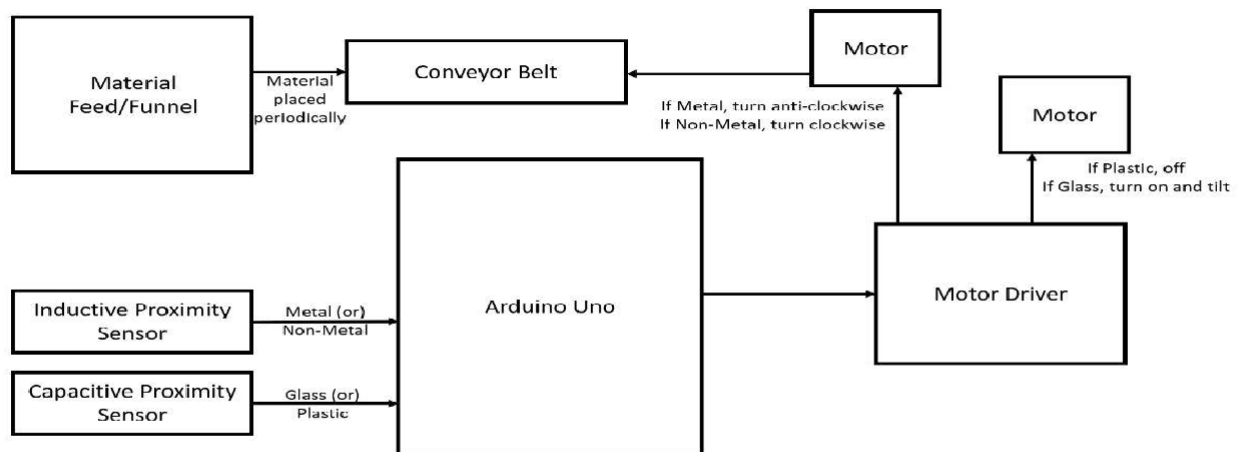
TITLEOFTHEPROJECT:-AutomaticSegregationofWasteMaterials What do

you feel is the most innovative part ofthe problem?

Previously, waste segregation has been a manual and labor-intensive process, requiring individuals to sort the waste and separate it into different categories. Innovative waste segregation systems may incorporate sensor technologies, to detect and analyze the composition of waste. These sensors can provide additional information beyond visual capture, enabling more accurate identification and sorting. The Sensor technology can be used to detect the type of material and it's chemical composition and perform the further following steps or process.

Automatic Conveyor Belts can be used to segregate the waste material put onto it, and help the waste to travel and reach the appropriate place, where it has to be dumped, after the sensing process for further tasks which can be performed. These robotic systems can be used to handle large quantities of waste efficiently and with the correct precision. These achievements are very important and useful in waste management for a happy, healthy and clean environment, sustain good surroundings and also for a pollution-free nature, keeping in view of the coming future.

IEEE FORMAT

Automatic Segregation of Waste Materials

[1]M.ManikanthReddy, [2]AsiniparthiLivruth, [3]K.VivekReddy, [4]SrinathItham, [5]BarlaSaiAnjannaReddy,
[6]SravyaChavali, [7]P.PhaniAnirudh, [8]Yashwika, [9]RitikaAnshuReddyVemalla

[1,2,3,4,5,6,7,8,9]TheRoboticsClub

SreenidhiInstituteofScienceandTechnology

Hyderabad, Telangana, India

mudusumanikanthreddy@gmail.com[1], alivruth@gmail.com[2], kallam.vivekreddi23@gmail.com[3],
srinathitham2020@gmail.com[4], saianjanna261@gmail.com[5], sravyachavali03@gmail.com[6],
phanianirudhp14@gmail.com[7], yashwikareddy08@gmail.com[8], ritikaanshureddy@gmail.com[9]

Abstract—**Around the globe, solid waste generation is increasing day by day and the improper management of this waste is hazardous to human health and the ecological system. The world faces a problem of disposal, segregation and recycling of solid waste. The increasing population, urbanisation and industrialisation resulted in an increase in the generation of solid waste. Wastes are not always waste if they are segregated, transported and disposed of. The economic value of waste is best comprehended when it is segregated. Waste segregation will lead to the reduction of risks to public lives and a sustainable environment. Currently, there is no such system employed of the segregation of glass, plastic and metallic wastes at the industrial level. To segregate the waste material, the team propounds an automatic segregating bot consisting of sensors, conveyor belts, shaft motors, servo motors, motor drivers and microcontrollers. The inductive and capacitive sensors identify the type of material and the different materials are dumped into separate bins respectively, through the conveyor belt, the whole process is controlled by the microcontroller.**

Index Terms—**Automation, segregation, solid waste, waste management.**

I. INTRODUCTION

The primary motive of this project is to aid the proper management of waste material in the scrap industry. The waste generation around the world was estimated to generate 2.24 billion tonnes of solid waste, amounting to 0.79 kilograms per person per day and it is expected to increase by 73 percent from 2020 levels to 3.88 billion tonnes in 2050. So it is necessary to manage the waste through recycling of solid waste. For this the segregation of waste is needed to be done, this paper proposes an automation of waste material segregation in the scrap industry. This gives the solution of segregation of three types of waste: glass, plastic and metal. It is designed to sort the trash into metallic waste, plastic waste and glass waste ready to be processed separately for the next $p_2r_2o_2cess$. Automatic waste segregation will lessen the human interaction with waste materials and it reduces the threat through proper management of solid waste.

II. LITERATURE SURVEY

Waste segregation can be defined as the process of identifying, classifying, dividing and sorting garbage and waste products in an effort to reduce, reuse and recycle materials. In order to segregate waste appropriately, it is important to correctly identify the type of waste that is generated. For the purposes of waste segregation at source, waste is identified and classified into the following categories depending on its biological, physical and chemical properties: Dry Waste, Wet Waste, Sanitary Waste, Hazardous Household Waste, etc. When waste is unsegregated, it may get contaminated with different types of waste being stored together. Waste Segregation is always stepped one for all types of waste management solutions that may be implemented either on an individual level or community level.

III. SYSTEM ARCHITECTURE

A. Existing System

The separation of waste has been assisted by many robots, including Dr. A. Prashant Gupta and Brintha Therese, who proposed using Raspberry Pi to create a Robotic Arm with Real-Time Image Processing, which can either be automated or can be operated manually. Jash Shah and Sagar Kamat presented an artificial intelligence-based system for identifying, removing, and sorting items on a moving conveyor. The majority of the top-performing object detection networks today use CNN (convolutional neural networks). Recycling and organic materials must be categorised using advanced approaches since the yare challenging to categorize. A worldwide strategy is required for industrial applications in addition to the gathering of datasets. The study proposes an optimal waste categorization method that is more accurate and efficient.

B. Proposed System

Waste plays a significant role in our society. Separating it into its own categories helps in effective recycling. For the process of separation, automatic segregation of waste bots is employed. It comprises sensors, a microcontroller, four motors and a motor driver to control them.

When the waste is dumped into the funnel, a single object is allowed fall on the conveyor belt. Firstly the object passes through the inductive proximity sensor. If the sensor detects a frequency which matches a metallic one the conveyor belt rotates in the opposite direction and falls in therespective bin else the belt moves forward and stops at the Capacitive proximity sensor. This sensor detects whether it's plastic or glass. If it is plastic, with the help of rack and pinion the
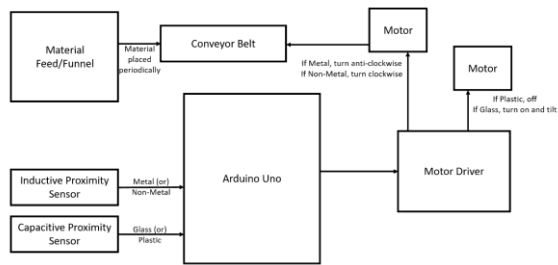
Fig.1.Workflow

object will be pushed in the opposite direction which thenfalls into the bin else the belt will be moved forward till the object is made to fall into the glass bin.

IV. ARCHITECTURE

A. Hardware

1) Arduino Uno: The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button

Fig.2.ArduinoUnoATmega328P

The ATmega328 has 32 KB of flash memory for storing code (of which 0,5 KB is used for the bootloader). It also has2 KB of SRAM and 1 KB of EEPROM.

*2) MotordriverL298N:*ThisL298NMotorDriverModule is a high-power motor driver module for driving DC and StepperMotors.This moduleconsistsofan L298motor driver

/2/2

Fig.3.MotorDriverL298N

IC, a 78M05 5V regulator, resistors, a capacitor, Power LED, 5Vjumper.L298NModulecancontrolupto4or2DCmotors with directional and speed control.

*3) Inductiveproximitysensor:*Aninductiveproximitysen- sor is a sensing device that detects metal targets using elec-tromagnetic energy and without contact.

Thesensingrangeofaninductiveproximitysensorchanges basedonthetypeofmetalbeingdetected.Theydetectobjects

Fig.4.Inductiveproximitysensor

and typically give a 0–10 VDC output based on the distance betweenthetargetandthesensor.Inductiveproximitysensors enable the detection, without contact, of metal objects at distances of up to 60 mm.

*4) Capacitiveproximitysensor:*CapacitiveProximitySen- sorscandetectnon-metalobjects,suchasliquids,plastics,and glass. Theydetect theirtargets throughchanges incapacitance

Fig.5.Capacitiveproximitysensor

between the sensor and target material. They usually have a larger sensing distance than their inductive counterparts, andit typically falls between 5 and 40 millimetres

*5) Centershaftmotor:*ThesemotorsaresimpleDCMo- tors featuring gears for the shaft for obtaining the optimal performance characteristics. Nut and threads on shaft to easily connect and internal threaded shaft for easily connecting it to the wheel.

Fig.6.Centershaftmotor

TheyareknownasCenterShaftDCGearedMotorsbe-causetheirshaftextendsthroughthecentreoftheirgearbox

assembly. These standard-size DC Motors are very easy to use.

6) Side shaft motor: A side shaft motor has a high performance. Many can be made to run in the opposite direction

Fig.7.SideShaftMotor

by switching leads where they attach to the motor. DC geared motor with metal gearbox used for high torque application and other automation purposes.

7) Servomotor: A servo motor is a self-contained electrical device that moves parts of a machine with high efficiency and great precision. In simpler terms, a servo motor is a BLDC motor with a sensor for positional feedback. This allows the output shaft to be moved to a particular angle, position, and velocity that a regular motor cannot do.

Fig.8.ServoMotorSG90

A servo motor is controlled by controlling its position using Pulse Width Modulation Technique. The width of the pulse applied to the motor is varied and sent for a fixed amount of time. Servo Motor generally requires a DC supply of 4.8 V to 6 V.

8) Jumper wires: Jumper wires are tiny metal connectors used to close or open a circuit part. They have two or more connection points, which regulate an electrical circuit board. Their function is to configure the settings for computer

Fig.9.JumperWires

peripherals, like the motherboard. Jumper wires come in three versions: Male-to-male jumper, Male-to-female jumper, and Female-to-female jumper.

9) Vectorboard: A vectorboard is a solderable board used to prototype electrical circuits. All boards have provisions for I/O connectors. Components on this board can be soldered
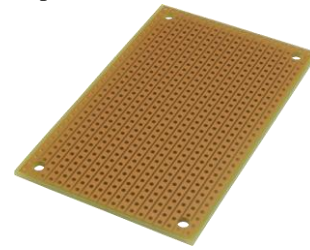

Fig.10.Vectorboard

together to provide electrical connections to make up multiple circuits.

10) Rack and Pinion: Racks and pinions are power-transmission components primarily used for converting rotary to linear motion and vice versa.
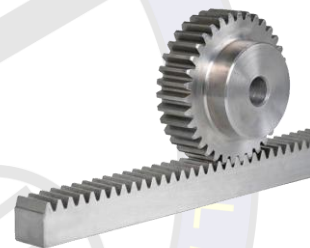
Fig.11.RackandPinion

Rack and pinion combinations are often used as part of a simple linear actuator, where the rotation of a shaft powered by hand or by a motor is converted to linear motion.

B. Software

1) Arduino IDE: Arduino Integrated Development Environment is an open-source application software created by Arduino.

Fig.12.ArduinoIDE

The microcontrollers can be programmed using the C and C++ programming languages, using a standard API which is also known as the Arduino Programming Language. The

boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced with various expansion boards.

2) Fusion 360: Fusion 360 has built-in capabilities to do 3Dmodelling,sheetmetal,simulationanddocumentation. Itcanmanagemanufacturingprocessessuchasmachining,
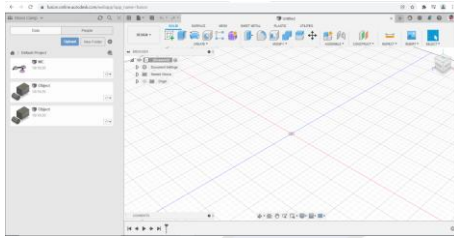

Fig.13.Fusion360

milling, turning and additive manufacturing. It also has electronic design automation (EDA) features, such as schema design, PCB design and component management. You canuse it also for rendering, animation, generative design and a number of advanced simulation tasks (FEA).

3) Fritzing: This software allows a designer, artist, researcher, or hobbyist to document their Arduino-based prototype and create a PCB layout for manufacturing using the ProcessingprogramminglanguageandtheArduinomicrocontroller.

Fig.14.Fritzing

This website allows users to exchange drafts and experiences, reduce manufacturing costs, and share experiences.

V. WORKING MECHANISM

Theworkingmechanismoftheproductismostlycontrolled by the microcontroller Arduino Uno.

It begins after the user manually dumps the waste materials(metal,$_{/2}$g$_2$lass and plastics) in the funnel. The Servo Motor SG90 which is directly controlled by Arduino Uno opens and closesthefunnelmakingthematerialsslideontotheConveyor Belt one after the other.

In segregating process Inductive Proximity Sensor, Capacitive Proximity Sensor, Motor Driver L298N are linked to the Arduino Uno as shown in Fig. 1.

ThematerialontheConveyorBeltisfirstexaminedby theInductiveProximitySensorandtheresultissentto

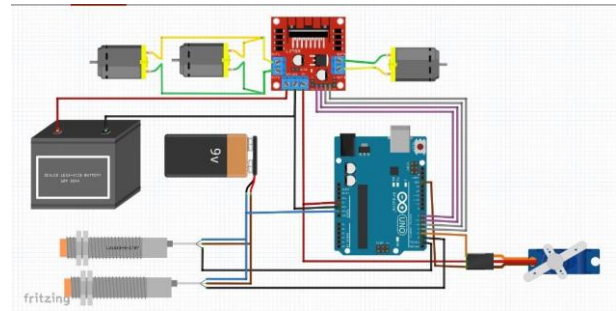
Fig.15.Circuitdiagram

theArduino Uno which commands the motor driver L298N accordingly, if the result is positive the belt is run in an anticlockwise direction by the side shaft motor which is instructedbytheL298Nand thematerialisdumpedinthe bin placed at the back of the belt. If the result is negative the material is moved forward to be examined by the Capacitive ProximitySensorandagaintheresultissenttomicrocontroller Arduino, Motor Driver L298N gets commanded for eachresult respectively. If the material is plastic, then the motor driver runs the central shaft motor first with rack and pinion arrangementandtheplasticispushedintothebininfront.Ifit isaglassmaterialthenConveyorBeltrunsforwardanddumps it into the bin at the end. All the connections 0f componentsof the product are shown in Fig. 15.
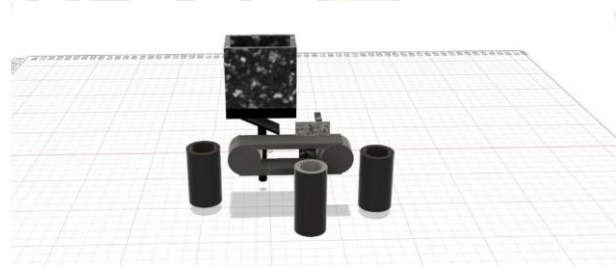

Fig.16.CADDesignofPrototype

VI. ALGORITHM

A. ALGORITHMFORPRODUCTFUNCTIONING

- Thewastematerialsaredumpedintothefunnel.
- ServoMotorSG90opensandclosesthefunnel.
- Inductive proximity sensor examines the material slid ontotheconveyorbeltandtheresultissenttotheArduino Uno ATmega328P.
- Arduino Uno gives commands to Motor driver L298N according to respective results.
- Result is positive then by the command from Arduino motor driver L298N instructs Side Shaft Motor to turn anti-clockwise making the Conveyor Belt to dump metal into Bin 1.
- If negative, the Conveyor Belt carries material to the range of the Capacitive Proximity Sensor to be examined and the result is sent to the microcontroller.

- If the material is plastic, commanded by the microcontroller motor driver instructs Central Shaft Motor such that the plastic is pushed into Bin 2 by rack and pinion setup.
- Ifthematerialisglass,themotordriverinstructstheSide Shaft Motor making a belt to carry the glass material to be dumped into Bin 3.
- Thebinsareemptiedonceinawhileaftertheyarefilled.

VII. FUTURE ENHANCEMENTS

The model built by our team is an elementary prototype. It canbeimproveduponforhigherdegreeofgarbagesegregation and disposal purposes.

Basedonitsfunctionality,therobotcanbealteredto detect and sort liquid and dry waste, biodegradable and non-biodegradable waste, as well as hazardous and radioactive material. It can be used in factories, industries, public places suchasparks,gardens,mallsetctosortgarbageefficientlyfor a cleaner, greener planet.

VIII. CONCLUSION

Toconclude,thehumaneffortofsegregationwillbereduced with the help of our robot. Thereby increasing hygiene in society and keeping the environment clean. The advantage is making a smart city through its work. Waste management is one of the most important challenges that a city faces

The discarded waste can then be processed to recover materials productively and metamorphose them into energyasusablefuels.Thiscanbefurtherdevelopedwiththehelp of machine learning and artificial intelligence to make a humanoid waste segregation robot.

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SOURCECODE:

```
#include<Servo.h>

Servo Myservo;int
motor_l1=4;
intmotor_l2=5;
intmotor_r1=6;
intmotor_r2=7;
intpos;
bools;
constintindsens  =  2;
constintcapsens  =  8;
intindvalue,capvalue;

voidsetup()
{
  Myservo.attach(3);

  pinMode(indsens, INPUT);
  pinMode(capsens, INPUT);
  pinMode(motor_l1,OUTPUT);
  pinMode(motor_l2,OUTPUT);
  pinMode(motor_r1,OUTPUT);
  pinMode(motor_r2,OUTPUT);
  Serial.begin(9600);
}

voidloop()
{

  //openbin
```

```
for(pos=0;pos<=70;pos++)
 {
  Myservo.write(pos);
  delay(15);
 }

//close bin
for(pos=70;pos>=0;pos--)
 {
  Myservo.write(pos);
  delay(15);
 }

//metal
indvalue=digitalRead(indsens);
if(indvalue==LOW)
 {
  //clockwise
  clockwise();
 }
else
 {
  //anti-clockwise
  anti_clockwise();
 }

//plastic
capvalue=digitalRead(capsens);
if(capvalue==HIGH)
{
```

```
    //clockwise
    clockwise();
 }
 else
 {
    //stopbelt,centre-shafton
    csforward();

    delay(3000);

    //centre-shaftreturnstoposition csbackward();
 }
}
voidclockwise()
{
 digitalWrite(motor_l1, HIGH);
 digitalWrite(motor_l2, LOW);
 digitalWrite(motor_r1,LOW);
 digitalWrite(motor_r2,LOW);
}
voidanti_clockwise()
{
 digitalWrite(motor_l1, LOW);
 digitalWrite(motor_l2, HIGH);
 digitalWrite(motor_r1,LOW);
 digitalWrite(motor_r2,LOW);
}
voidcsforward()
{
```

```
  digitalWrite(motor_l1,  LOW);

  digitalWrite(motor_l2,  LOW);

  digitalWrite(motor_r1,  HIGH);

  digitalWrite(motor_r2, LOW);

}

voidcsbackward()

{

  digitalWrite(motor_l1,  LOW);

  digitalWrite(motor_l2,  LOW);

  digitalWrite(motor_r1,  LOW);

  digitalWrite(motor_r2,HIGH);

}
```