PROJECT ID:

RBT2002

TITLE:

The ocean cleaner Robot

KEYWORDS:

Ocean cleaner robot

AGE OF STUDENT(S):

15

CONTENT

INTRODUCTION

The Marine - iosity robot is committed to cleaning the ocean in an efficient and quite affective procedure, with the help of a few electronic components, as we all know pollution affects the oceans around the world so much, marine life are at risk. Citizens living closer to coastline areas do not realise the harm they cause to the environment, however you cannot be sure if one will actually abide by the rules.

How the ocean cleaner robot will be able to help the environment?

This robot has to be able to pick up plastic in the ocean

Affects:

The marine life population will certainly increase and they will have a cleaner environment to live in.

This will get a message through to people to stop the release of waste products in the ocean

Purity of water will be very low with the amount of waste ending up in aquatic areas.

The purpose of carrying out Reasearch?

Research is so important to this project as it gives an estimated idea of what the robot is up against.

The purpose of this project is to collect plastic in order to prevent the decrease in population of marine life.

Research will give me a brief understanding oh how much ocean pollution occurs in a year and the amount of sea creatures that die in a year.

This will give me an idea of the size this robot should be in reality and the amount of plastic it should collect to achieve its goal and decrease the amount of plastic in the ocean.

BACKGROUNG INFORMATION

What is ocean pollution and how it affects the environment?

Marine debris is human-created waste that has deliberately or accidentally been released into the sea or ocean floating ocean debris tend to accumulate in coast line areas.

With the increasing use of plastic, human influence has become an issue as many types of plastics do not biodegrade, Waterborne plastic poses a serious threat to fish, seabirds, marine reptiles, and marine mammals, as well as to boats and coasts. Dumping, container spillages, litter washed into storm drains and waterways and wind-blown landfill waste all contribute to this problem.

Affects of ocean pollution:

- Depletion of oxygen content in the water
- Effect of toxic wastes on marine animals
- Failure in the reproductive system of marine animals
- Contamination of food chain
- Effect on human health
- Disruption to the cycle of coral reefs

- 100,000 marine creatures a year die from plastic entanglement and these are the ones found. Approximately 1 million sea birds also die from plastic.

BACKGROUNG INFORMATION CONTINUED

Why I used high density foam in the boat hulls?

A prime function of a boat is to provide buoyancy to its occupants. A boat should float on the surface, even if it is flooded, swamped or has capsized. Ideally the boat will stay upright, even if full of water, and will support its own weight plus the motors and occupants.

PROBLEM

The problem is that oceans are polluted quite often by south Africans living near the coastal areas, this problem affects, marine life as its population decreases rapidly everyday.

There are many contributing factors to ocean pollution IN south Africa such as:

- **The packaging of products** sold in shopping malls are harmful to the environment.
- Takes long for some waste matter to degrade.
- It has an appealing affect towards the marine life so they get desperate and mistaken the plastic to be a meal

AIM

The aim of this project is to build a robot affordable that it is able to remove plastic from the ocean so the marine life population does not decrease. It is designed to work on a simple process but produce phenomenal results.

DESIGN CRITERIA

SPECIFICATIONS	CONSTRAINTS
• The prototype must be cheaper than most cleaning up systems available on the market today. • The prototype must be user friendly and totally easy to operate and control. • The prototype must be easy to build but perform all functions allocated. • The prototype must be reliable in cleaning the ocean. • The prototype should work at a good speed that is fast but not putting too mauch straint on the machine.	• Trouble shooting with python programming as libraries constantly need to be updated to get the best performance out of the robot. • The robot should not cost a lot to build.

HYPOTHESIS

The hypothesis of my project is to test if a robot made with different electronic components can remove plastic from the ocean. It provides a cheap user friendly system with better efficiency that the robots on the market today. It should be reliable in the job its expected to perform.

ENGINEERING GOAL

The goal of this project was to design an affordable but reliable ocean clean up system for cleaning up purposes, it must be designed to to clean up the ocean so the marine life population do not decrease. it should be programmed with the computer programming language python and Arduino. They are both strong and widely used programming languages.

REQUIREMENTS

- The user will need knowledge on the python and Arduino programming language
- The user would need knowledge on 3d printing software
- The user would need knowledge on constructing code
- The user will need knowledge on SSH telnet client
- Internet connection
- Google maps
- Power supply

MATERIALS

The following are a brief description of electrical components used in making the ocean cleaner robot:

1x Arduino Romeo Ble V1.0- micro controller used to control motors, servos.

2x Motors- control the boat path and conveyer.

1x Servo- turn the boat.

8x Batteries- source of energy

30x male to female jumper leads - get energy from one part of the boat to another.

1x Raspberry pi 4- micro controller for controlling camera and GPS.

1x Raspberry pi camera- taking pictures and videos.

1x Raspberry pi GPS hat- to receive gps data from robot.

1m x 1m High dense foam- help robot to float.

10 x Super glue- stick components together.

1x Contact adhesive- stick foam to boat hull.

5 x Screws, nuts,bolts- join components together.

3 x 3D printing filament(PLA) – making 3d components.

2 x Coloured tape- to give the boat colour

VARIABLES

In this project, there are a few variables

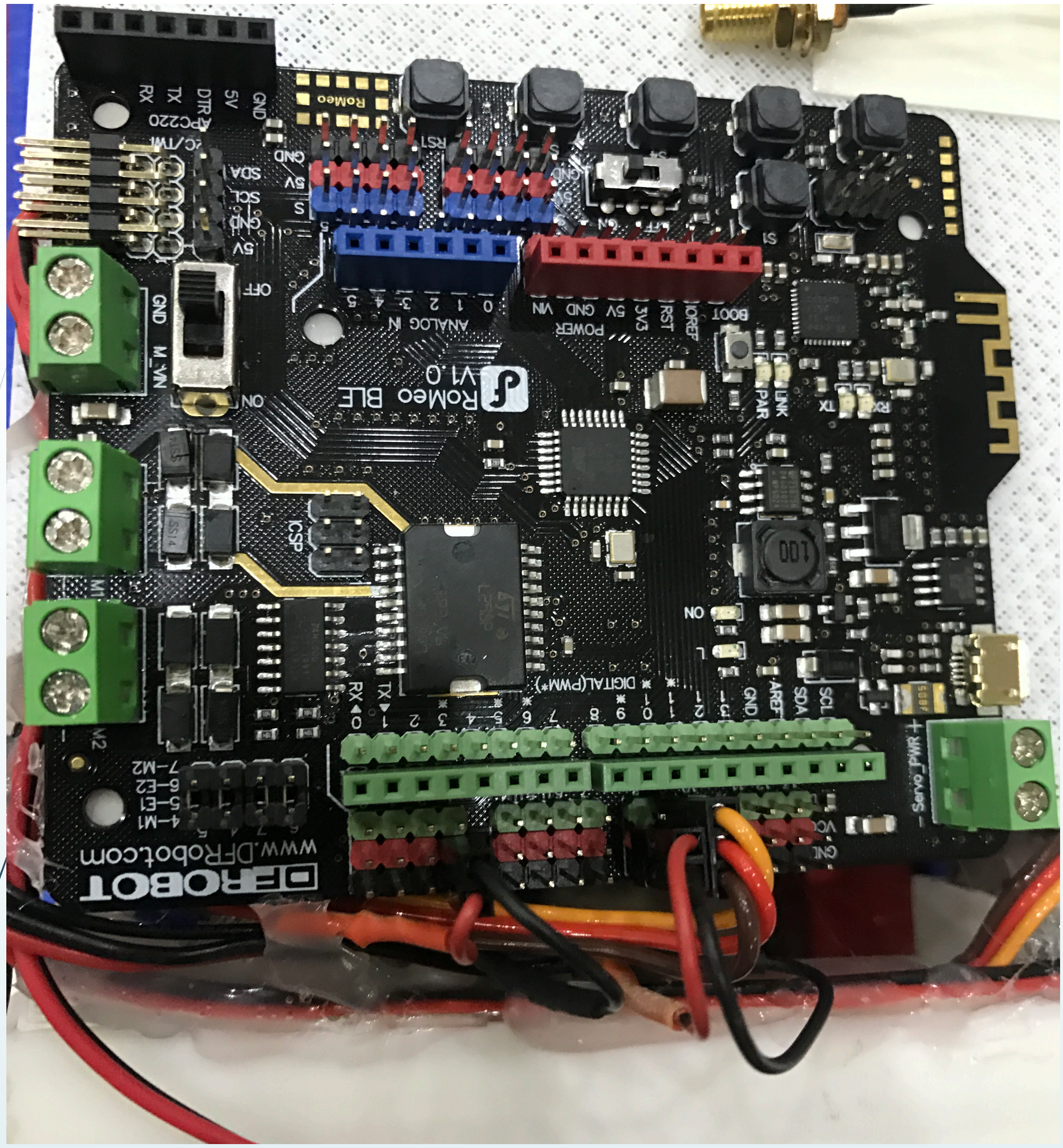
- ✓ INDEPENDANT VARIABLE- same source of energy.
- ✓ CONTROLLED VARIABLE- Area marine- iosity cover– speed of the procedure.
- ✓ DEPENDANT VARIABLE- amount of plastic removed from the ocean.

METHOD

- 3D print components.
- Cut foam to specified sizes.
- Assemble mountings and brackets. (brackets made from alluminium and industrial nylon.
- Assemble all mechanical components- conveyer, horizontal and vertical brackets, motors and servos, wirings, etc…
- Assemble all electrical components .
- Programming and tests .
- Test on waterways.
- Repairs if any leaks
- All codes for programming the robot is provided on the code page

<u>Circuit diagrams-raspberry pi</u>

Photo taken from www.waveshare.com



CONNECTIONS-ARDUINO ROMEO BLE

This photo was taken by finalist mum; MRS SINGH

CONNECTIONS-RASPBERRY PI 4

- ✓ Raspberry pi camera- camera port on Raspberry pi
- ✓ GPS module- USB to UART on raspberry pi
- ✓ Pi juice will be connected to raspberry pi via GPIO pins to give the microcontroller power

CODING-ARDUINO

Components used to carry out the process:

Romeo BLE v1.0

Initial power source

Laptop/pc

Motor

Servo

CODE

```
#include <Servo.h>
Servo myservo;  // create servo object to control a servo
int pos = 80;    // variable to store the servo position set
the position of rudder to 90 degrees

void setup() {
// INDO PROJECT PROGRAM  2019-12-22

  // PRODUCED BY THE RANDHIR SINGH

  Serial.begin(9600);
  myservo.attach(9);  // attaches the servo on pin 9 to
the servo object
  pinMode (8,OUTPUT); // attatch impeller diital output
  pinMode (3, OUTPUT);  // attatch conveyor motor digital
output
}
```

```
void loop() {
  for (pos = 80; pos <=80;); { // goes from 0 degrees to 80 degrees in this case the rudder position is straight
    myservo.write(pos);              // tell servo to go to position in variable 'pos' 90 degrees
    delay(500);                       // waits 1seconds for the servo to reach the position and reference


  }
   digitalWrite (8,HIGH);    // power impeller
   delay (10000);         // impeller run for 10 seconds



    digitalWrite (3, OUTPUT); // conveyor motor run contineously


  for (pos = 140; pos <= 140; pos += 10) { // goes from 0 degrees to 180 degrees
    myservo.write(pos);              // tell servo to go to position in variable 'pos' 90 degrees
    delay(500);                       // waits 5seconds for the servo to reach the position to make left turn
    return (80);


  }
   digitalWrite (8,HIGH);    // power impeller
   delay (10000);         // impeller run for 10 seconds



   for (pos = 40; pos >= 40; pos -= 10) { // goes from 180 degrees to 0 degrees
    myservo.write(pos);              // tell servo to go to position in variable 'pos'
    delay(500);           // waits 5 seconds for the servo to reach the position to make a right turn
    return (80);
    }
}
```

CODING-RASPBERRY PI

Components used to carry out the process:

Raspberry pi 4

Raspberry pi camera with fisheye lens

Raspberry pi GPS hat

Raspberry pi official power source

HDMI to Micro HDMI cable

Ethernet cable

Screen for display

Keyboard

Mouse

Power source for display

Sd card 16gb+

CODING-RASPBERRY PI continued

- Download the SD card formatter on pc, put the card in to pc and open SD card formatter , format the card.
- Next open up a web page on google https://www.raspberry pi.org/downloads
- Go to downloads and download the Raspbian operating system as zip file.
- Once downloaded get it out of zip file by extracting info into new folder.
- Thereafter put info onto sd card and eject the card.
- Put card into raspberry pi and connect power source for the pi and your screen
- Plug hdmi to screen
- The operating system will download and then the pi will reboot.
- Thereafter you will be logged onto your desktop ready to code.

CODING-RASPBERRY PI CAMERA VIA THE COMMAND LINE

Image

raspistill –o image.jpg- this command is used to take images on the raspberry pi.

raspistill- tells micro controller to take a picture

Image- what the micro controller is expected to do or name of image

Jpg- type of file

Video

raspivid -0 testvideo.h264 –t 60000- this command is used to take videos on the raspberry pi.

raspivid - tells micro controller to take a video

testvideo - name of video

h264- resolution

60000- delay how long should the video play for

CODING-RASPBERRY PI GPS

```
#!/usr/bin/python

import serial
import time
from decimal import *
from subprocess import call

def find(str, ch):
    for i, ltr in enumerate(str):
        if ltr == ch:
            yield i

# Enable Serial Communication
port = serial.Serial("/dev/ttyUSB0", baudrate=115200, timeout=1)
# Transmitting AT Commands to the Modem
# '\r\n' indicates the Enter key

port.write('AT'+'\r\n')
rcv = port.read(100)
print rcv
time.sleep(.1)
```

```
port.write('AT+CGNSPWR=1'+'\r\n')          # to power the GPS
rcv = port.read(100)
print rcv
time.sleep(.1)

port.write('AT+CGNSIPR=115200'+'\r\n') # Set the baud rate of GPS
rcv = port.read(100)
print rcv
time.sleep(.1)

port.write('AT+CGNSTST=1'+'\r\n')    # Send data received to UART
rcv = port.read(100)
print rcv
time.sleep(.1)

port.write('AT+CGNSINF'+'\r\n')      # Print the GPS information
rcv = port.read(200)
print rcv
time.sleep(.1)
ck=1
```

```
while ck==1:
    fd = port.read(200)      # Read the GPS data from UART
    #print fd
    time.sleep(.5)
    if '$GNRMC' in fd:       # To Extract Lattitude and
        ps=fd.find('$GNRMC')       # Longitude
        dif=len(fd)-ps
        if dif &gt; 50:
            data=fd[ps:(ps+50)]
            print data
            ds=data.find('A')       # Check GPS is valid
            if ds &gt; 0 and ds &lt; 20:
                p=list(find(data, ","))
                lat=data[(p[2]+1):p[3]]
                lon=data[(p[4]+1):p[5]]
```

GPS data calculation

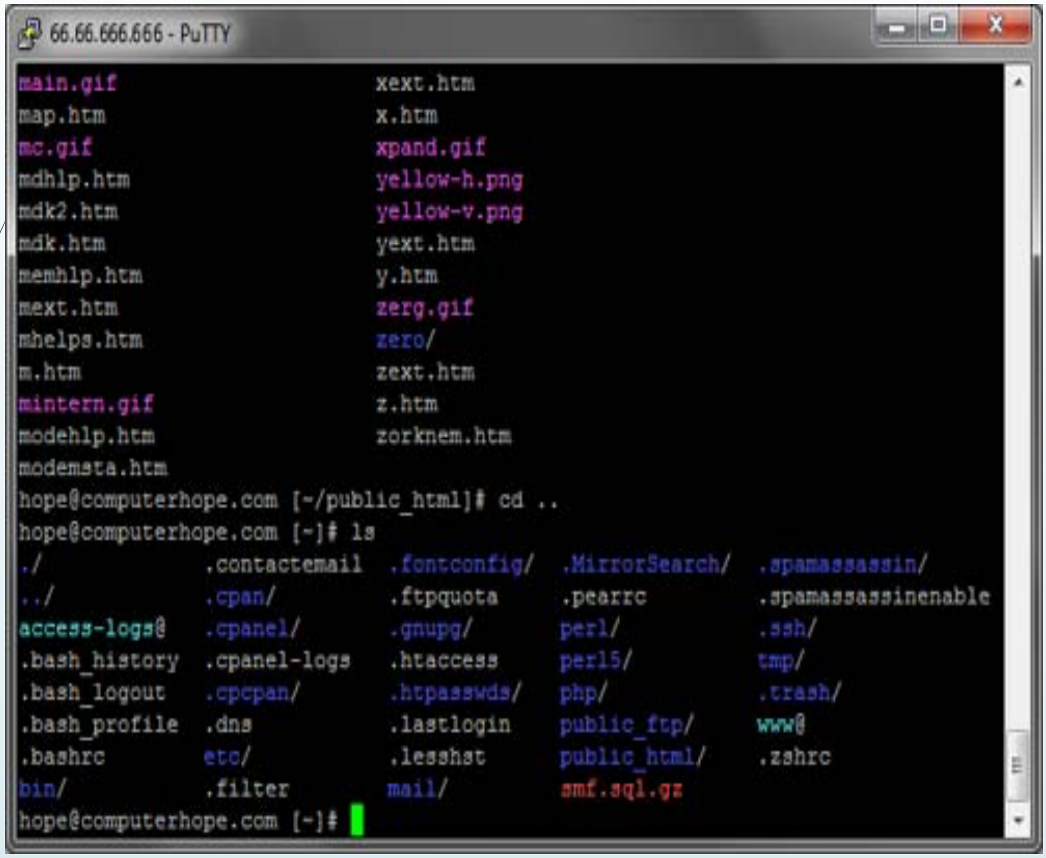
```
s1=lat[2:len(lat)]
        s1=Decimal(s1)
        s1=s1/60
        s11=int(lat[0:2])
        s1 = s11+s1

        s2=lon[3:len(lon)]
        s2=Decimal(s2)
        s2=s2/60
        s22=int(lon[0:3])
        s2 = s22+s2

        print s1
        print s2
```

ACCESSING THE RASPBERRY PI WIRELESSLY
putty

- PuTTy is a software terminal emulator for Windows and Linux. It provides a text user interface to remote computers running any of its supported protocols, including SSH and Telnet



information taken from:

https;//.computerhope.com

PROCESS IN OCEAN CLEANER ROBOT ARDUINO

1. Motor and servo is connected to digital pins on Arduino microcontroller.
2. Programming language sent to micro controller.
3. Motor and servo turned on .
4. Servo turns after certain delay.
5. Motor is turned on for a set period of time.

PROCESS IN OCEAN CLEANER ROBOT Rapberry pi

Raspberry pi

1. Camera and GPS module connected to its allocated port on pi.
2. Code is sent to the Raspberry pi micro controller
3. GPS data given in latitude and longitude.
4. SSH telnet client connection
5. Code on command line for camera
6. Camera takes video and pictures

COSTING TO BUILD A SCALED MODEL

Raspberry pi 4- R600

Raspberry pi camera with fisheye lens- R90

Raspberry pi GPS hat- R360

Arduino Romeo BLE v1.0-R400

Servo- R60

Motor- R70

High dense foam- R200

Super glue- R5

Contact adhesive- R50

Screws, nuts ,bolts- R100

3D printing filament(PLA) – R250

Coloured tape- R50

TOTAL= R 2235

COSTING TO BUILD THE ROBOT IN REALITY

According to my findings the ocean cleaner robot will need size to accumulate larger amounts of plastic, sizes can vary from a average sized boat to a large cargo ship size, but obviously for the robot to work more efficiently the larger robot would be the better choice although to make a larger robot it is more costly. The estimated price of this boat including all electronic parts is about billion USD which is quiet expensive.

Building smaller robots will be a better option but building multiple of these robots is the best choice as it can cover more surface area on the ocean.

3D PRINTING PROCESS WITH THE CREALITY CR10-MAX

What is needed to construct a 3D print?

3D printer

3D printing filament

Sd card

Sd card reader

Laptop/pc

Drawing software such as fushion 360

Slicing software for printer(CURA)

3D PRINTING PROCESS WITH THE CREALITY CR10-MAX

- Make drawings of a model you want to print on any drawing software that can save files as STL.
- Once model is drawn save as STL file and thereafter open with the slicing software CURA.
- You can now change settings on CURA for the specified model to get better prints.
- Once settings are saved insert the SD card into your computer.
- Save the model as GCODE file and save it into the SD card
- Next power up the 3d printer and insert the SD card into the slot in the printer.
- Insert filament and press the button feed until the filament starts coming out from the nozzle.
- Thereafter go to bed levelling and level the bed.
- Once that is done ,select print and the name of your model and the machine will start heating
- After heating it will start to print
- There are settings you can change while the print is progress, these are:
- Nozzle temperature
- Bed temperature
- Print speed
- Z axis compensation
- Once the print is done you may remove the model from the build plate.

3D PRINTING-FILAMENT TYPES AND SPECIFICATIONS

THREE DOT ZERO studios

3D Printing Filament Comparison

Copyright 2017 ThreeDotZero Studios, LLC

V1.0 Feb 2017

Filament	Print Temp (°C)	Bed Temp (°C)	Strength	Flexibility	Durability	Difficulty	Shrinkage	Soluble	Food Safe*	Blue Tape	Glue Stick	Typical Uses
ABS Acrylonitrile Butadiene Styrene	210-250	50-100	●●	●●	●●●	●●		Acetone	No		GLUE	Functional Parts
ASA Acrylonitrile Styrene Acrylate	240-260	100-120	●●	●	●●●	●●		Acetone	No		GLUE	Outdoor Use
Carbon Fiber Carbon Fiber and PLA blend	195-220	N/A	●●	●	●●●	●●		No	No		–	Functional Parts
Cleaning Cleaning Filament	150-260	N/A	–	–	–	●	–	–	–	–	–	Nozzle Cleaning / Unclogging
Color Changing PLA or ABS with color changing properties	210-220	N/A	●●	●●	●●	●		No	No		GLUE	Educational, Modelling
Conductive Conductive PLA or ABS	215-230	N/A	●●	●●	●	●		No	No		–	Electronics
Flexible, TPE, TPU Thermoplastic Urethane / Polyurethane	225-235	N/A	●	●●●	●●	●●●		No	No		GLUE	Elastic Parts, Wearables
FPE Flexible Polyester	205-250	75	●	●●●	●●●	●●		No	Yes	–	GLUE	Flexible Parts
Glow-In-The-Dark Glow in the dark PLA or ABS	210-220	N/A	●●	●●	●●	●		No	No		–	Educational, Modelling
HIPS High Impact Polystyrene	210-250	50-100	●	●●	●●●	●●		Solvent	No		GLUE	Support Structures
Lignin (bioFila) Lignin and PLA plus additives	190-225	55	●●	●	●●●	●●●		No	Yes		GLUE	All Purpose
Magnetic PLA with powdered iron	195-220	N/A	●●	●●	●●	●●●		No	No		–	Educational, Experimental
Metal PLA / ABS Metal Powder and PLA or ABS blend	195-220	N/A	●●	●	●●●	●●●		No	No		–	Jewelry
nGen Similar to PETG	210-240	60	●●	●●●	●●●	●●		No	Yes		–	All Purpose
Nylon Polyamide	220-260	50-100	●●●	●●●	●●●	●●		No	Yes	–	GLUE	All Purpose
PC Polycarbonate	270-310	90-105	●●●	●●●	●●●	●●		Acetone	No	–	GLUE	Functional Parts
PC/ABS Polycarbonate ABS	260-280	120	●●	●	●●●	●●●		No	No	–	GLUE	Functional Parts
PET (CPE) Polyethylene Terephthalate	220-250	N/A	●●●	●●●	●●●	●●		No	Yes		–	All Purpose
PETG (XT, N-Vent) Poly-Ethylene Terephthalate Glycol	220-235	N/A	●●	●●●	●●●	●●		No	Yes		–	All Purpose
PETT (T-Glase) PolyEthylene coTrimethylene Terephthalate	235-240	N/A	●●●	●●●	●●●	●●		No	Yes		–	Functional Parts
PLA Polylactic Acid	180-230	N/A	●●	●	●●	●		No	Yes		GLUE	Consumer Products
PMMA, Acrylic Polymethyl Methacrylate	235-250	100-120	●●	●	●●●	●●		Acetone	No		GLUE	Light diffusers, Modelling
POM, Acetal Polyoxymethylene	210-225	130	●●●	●	●●	●●●		Chemical	No	–	ABS	Functional Parts
PORO-LAY Rubber-elastomeric polymer with PVA	220-235	N/A	●●●	●	●●	●		Water	Yes		–	Experimental
PP Polypropylene	210-230	120-150	●●	●●●	●●	●●●		No	Yes		–	Flexible Components
PVA Polyvinyl Alcohol	180-230	N/A	●●●	●	●●	●		Water	Yes		–	Support Structures
Sandstone (Laybrick) Co-polyester and chalk powder	165-210	N/A	●	●	●	●●		No	No		–	Architectural Modelling
TPC Thermoplastic Copolyester	210-210	60-100	●	●●●	●●	●●●		No	No		–	Elastic Parts, Outdoor Use
Wax (MOLDLAY) Wax-like properties	170-180	N/A	●	●	●	●		No	No		–	Lost Wax Casting
Wood (Laywood) Wood PLA Blend	195-220	N/A	●●	●●	●●	●●		No	No		–	All Purpose (natural finish)

3D PRINTING-FILAMENT TYPES

- ABS Filament
- PLA Filament
- PET Filament
- PETT Filament
- Nylon Filament
- PVA Filament
- Sandstone Filament
- Wood Filament
- Metal Filament
- HIPS Filament
- Magnetic Iron Filament
- Conductive Filament
- Carbon Fiber Filament
- TPE Filament
- Glow in the Dark Filament
- Amphora Filament

3D PRINTING-FILAMENT SPECIFICATION (PLA)

- Price- 300 rand for 1.75mm,1kg spool
- Print temperature range- 180 degrees Celsius to 230 degrees Celsius
- The Pros
- No harmful fumes, produces a sweet aroma when heated
- Easier to work with compared to ABS (great material for beginners)
- Compared to ABS, PLA is less prone to warping
- Available in special effects like glow-in-the-dark colors and translucency
- The Cons
- Susceptible to clogging the printer nozzle
- Can attract moisture that makes it potentially brittle and more difficult to print
- Less sturdy overall than ABS

PLA FILAMENT APPLICATIONS

PLA (Poly Lactic Acid) is popular for amateurs and professionals alike. It's a special type of thermoplastic made from organic materials, namely cornstarch and sugarcane. The main benefits of PLA are that it's safer and easier to use, and with no toxic fumes to worry about. Some users even find the sweet smell of the sugar-based filament pleasant. Compared to ABS, PLA produces 3D parts which are more aesthetically pleasing. This finish is thanks to its unique sheen and smooth appearance.

PLA filament is great for producing a whole range of consumer items. Other benefits of PLA are that it prints faster than ABS, and there's no need for a heated printer bed. The end products are a decent strength, durable, and offer some degree of impact resistance. Aside from 3D printing, other products that use PLA include food packaging, disposable tableware, and diapers, as a few examples.

3D PRINTING-CURA SLICING SOFTWARE

- Cura 3D is slicing software for 3D printers. It takes a 3D model and slices it into layers to create a file known as G-Code, which is the code that a 3D printer understands.
- Before we look at CURA, there's a little bit more to the whole print process when it comes to the 3D files and how they're prepared. It is the process of a 3D computer file to a solid object that can cause confusion. So it's good to have an understanding of the process even if you don't need to follow the first step.
- Three stages of 3D printing
- Modeling : This is carried out in any 3D modelling application such as Tinkercad or SketchUp, which are just two of many example applications. These applications have their own file format and these enable you to open, edit, save and export those 3D printer files from the application.
- 3D file export: Once you have created your model, it then needs to be exported as either an STL, OBJ or 3MF file. These are the file formats that are recognized by CURA. They differ from the file formats that are native to the 3D modelling applications as they just hold the final geometry and not the individual primitives and editable content. Still, you can change the size of the 3D model, but not the geometry.
- Slicing file export: The STL or OBJ file can then be imported into the CURA software where it is sliced and output as G-Code. This G-Code is just a text document (in essence) with a list of commands for the 3D printer to read and follow such as hot-end temperature, move to the left this much, right that much etc...

RESULTS

Size of robot	Distance covered	Size of bin	Amount of plastic accumelated in tons
Large (cargo ship size)	Can easily get from one country to another	5000-10000 cubic feet	0-600000 tons
Medium (averaged size boat)	Cover a little less than local ocean	25000-5000 cubic feet	0-300000 tons
Small (averaged sized fishing boat)	Local beaches of an area	1000 cubic feet	0-150000 tons

DISCUSSION OF RESULTS

Observing the estimated results I have discovered that medium sized ships is the most efficient way of constructing this robot, with an estimated cost of less than half a billion dollars it can do both the activities of a small and larger sized boats.

Reasons for why the medium sized ship is more efficient?

- ✓ Doesn't cost a lot
- ✓ Covers a large surface area
- ✓ Can Collect an average amount of plastic
- ✓ Easier to construct or build
- ❖ The system met all the specifications of the design criteria and is fully operational. The costing was about R5000. The system was fairly simple to assemble.
- ❖ The system was efficient at picking up plastic. The code had the best results in it.

LIMITATIONS AND GAPS

- Weight
- There was too much weight on the model of the robot
- There were many batteries which was needed to power up the micro-controllers
- Hard to construct as the model is small

IMPROVEMENTS

- Bigger solar panels produce more power.
- Bigger batteries can be used to store electricity, if the sun is not able to power the solar panels.
- Put an inflatable to give the boat more buoyancy if it capsizes.
- A load sensor can be added to the bin of the boat to sense when the bin is completely full with plastic.
- An auto return function can be added to the robot.
- Water turbines can also be used to produce electricity

FUTURE REASEARCH

- The size of this robot plays an important roll in the amount of plastic it collects.
- An estimated amount of 100 million aquatic life die each year from pollution.
- An estimated amount 269 000 tons of plastic enter the ocean each year.
- The size of this robot in reality should be about the size of a cargo ship which can carry a weight of 153,222 tons to 600 000 tons more than enough to reduce ocean pollution and prevent marine life from dieing.
- However the ship relys on fuel and electricity and cannot go to far distances, ther are 2 ways to deal with this problem, solar panels are added and also studying the ocean currents can lead u to all the plastic which will reduce the amount of distance covered.

CONCLUSION

The project will defnitley be useful in saving the environment as shown in future research however it all depends on the size of the bin you can either have one of this robots with a size of a cargo ship or you could have multiple smaller robots but one of the questions are is this robot going to have enough power to cover large distances?

Solar energy, water turbines and simply generating power from motors that are already running can produce renewable energy.

Studying ocean currents can also lead the robot to the plastic so it does not have to cover long distances which will put a strain on electricity and fuel.

REFERENCES

- https://www.pewtrusts.org
- https://www.annualreviews.org
- https://www.nationalgeographic.org
- https://ourworldindata.org
- https://www.condorferries.co.uk
- oceancrusaders.org › plastic-crusades › plastic-statistics
- https://www.toptechboy.com

ACKNOWLEDGEMENTS

FINALIST WOULD LIKE TO THANK FOLLOWING PEOPLE:

- MR T DENLI, finalist’s chemistry teacher, who help him to design his poster and portfolio.
-
- Miss S Pillay, finalist’s cousin , who helped him draw components for the prototype.
- MR Singh, finalist’s dad ,who helped him wire and code the microcontrollers.
- MRS Singh, finalist’s mother ,who helped him strengthen the boat hull.
- Miss M Pillay, finalists cousin , for use of her laptop.