[DOCUMENT TITLE]

[Document subtitle]

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[Company address]

Table of Contents

Table of Figures

Introduction

From the beginning of the human civilization, people used various methods of waste disposal to get rid of unwanted material. Sometimes it was buried in the land, thrown in the sea, fed to the animal or burnt. Getting rid of unwanted material was always a major concern for the modern society. Trash had played a tremendous role in history. The bubonic plague, cholera and typhoid fever, to mention a few, were diseases that altered the populations of Europe and influenced monarchies. They were perpetuated by filth that harboured rats, and contaminated water supply [1]. When wastes were not properly managed then it may cause serious hazard, as seen in 1350. "Black plague" erupted and more than 25 million people from all over Europe fall victim to it in just five years [2]. There was an increasing rate of waste generation in Bangladesh and it was projected to reach 47,064 tonnes per day by 2025. The waste generation rate (kg/cap/day) was expected to increase to 0. 6 in 2025. A significant percentage of the population had zero access to proper waste disposal services, which will in effect lead to the problem of waste mismanagement [3]. The total waste collection rate in major cities of Bangladesh such as Dhaka was only 37%. When waste was not properly collected, it will be illegally disposed of and this will pose serious environmental and health hazards to the people of Bangladesh [4]. This was not the only problem of Dhaka city but also for other big cities around the world [5]. With so much concern recently about being greener and economically friendly, waste management had become a very important topic. People and companies were starting to realize that the things they used and the way they dispose of them could make a big impact on our world. Proper management of waste plays a vital role in global environment. That was why a waste sorting system was designed which could be used in houses, offices as a part of smart waste management system

Learning Outcomes

The four learning outcomes that your report should demonstrate that you have achieved are:

1. Identify, plan and commence a project that leads to the solution of an authentic IoT problem;
2. Deploy an appropriate combination of knowledge, research, analytical methods, cross-disciplinary learning skills, and creativity to conceive, design, and develop a solution to a complex IoT problem with intellectual independence;
3. Develop a project management plan that outlines objectives, activities, resources, timeline and risk assessment to demonstrate self-discipline, self-management skills, and personal responsibility; and
4. Reflect upon and critically review project work and apply advanced communication skills to convey progress.

There were millions of cupped used in a day but 70% of them left unrecycled because of their material looks same, dump in the same bin and cannot be identified by a human due to lack of knowledge. Human was confused about where to recycle things, and consumers were confused about the actual material the packaging was made of. There were hundreds of materials out there that looked the same, but couldn't be recycled in the same ways. Millions of waste material used in a single day. Only Starbucks produced 4 billion waste material per year and from which 3 billion left recycled therefore it needs smart sorting technology to sort them.

Benefits of solution

If these cups sorted by a smart sorting bin could help to increase the recycling rates of waste material and help to make a cleaner environment. It helps the shop to save their money and time to manage their waste. Unique design in terms of safety of bin, the safety of human and animals from diseases, no-overflow, need compact space, huge bins capacity, non-smelly bin. It automatically sorts waste accordingly just put waste put in a single bin. The device could sort cupped in a different bin, it will be easy to recycle it further.

What if the problem is left unsolved?

If unsolved it will lead to an environmental disaster. Unsorted waste degrades the quality of material which leads the material to dump at landfills site and near the road (where it emits harmful gases, leaching). It needs more time and money to recycle and sorting. It leads to diseases and environmental changes as some material need special handling.

Its scope and limitation

It will only be used for a shop where the frequency of plastic cupped, bottle, metal cupped, could, the bottle was high. It cannot be placed on the road as it only detects the single material at a time, it cannot detect/identify the mixed things at a time. It was not compatible for home, the municipal corporation only compatible for shops like Starbucks, ccd, McDonald and other beverages shop.

Summary

In the today world, there were millions of waste material produced in a day. It was a huge problem and need to be solved. Intelligent sorting bin was a solution for separating the different typed of waste material (metal, plastic, paper). It will direct benefit to shops, waste management vendors, environment. If left unsolved, this affect the shop business, environment. Its limitation was only used in shops where consumption of drinks were huge.

Contents of the Literature Review

Market Research
  1. Industry analysis

1.1. Political
- The supreme court directed the government of India, state governments, and municipal authorities to took the necessary actions.[6]
- The Ministry of environment and forests was directed to expeditiously issue rules regarding MSW management and handling regulation defines the process that waste should be sorted at the initial dumping time and collected the waste in different container.
- Contract of system is only for 5 years and need to be renew.

1.2 Economic
- Opportunity costs of clean up campaigns and behavior changed initiatives.
- Financial support as capital investment need to grow.
- Inflation rate affect the price of system and ongoing operation.
- Urban location was the main market.
- 25 % Corporate tax and 18% GST tax affect the cost of system.[7]

1.3 Social
- Awareness of segregate the waste at home and collection of waste in different container help us to grow faster.
- Increase the urbanization increase the sale of system and help the citizen to learn to sort waste. [8]

1.4 Technology
- Artificial intelligence, IoT, machine learning, computer vision help to develop the system efficient.
- Internet access and IoT, help to reduce the cost of system.
- Cloud service price were high of waste detection.
- Lithium ion battery for good power backup.

1.5 Industry

- Low used of waste sorting bin because of less awareness on waste.
- Increasing of population, increase in waste and improper waste management, hence help to grow faster but competition was also increasing.
- Need to invest millions to money to just awareness and then sell and not had faster cash flow.

  2. Competitor analysis

2.1 Competitor analysis for Clean Robotics [9]

1. Established date oct 2015.
2. Product

- Clean robotics had built an autonomous system that uses robotics, computer vision and artificial intelligence to detect and separate landfill from recyclables.
- It has this more accurately than human beings, captures high quality waste data and it lets staff know when it's getting full. Cloud connectivity allows individual units to learn from the global.
- It has this more trashbot fleet, becoming more intelligent over time. It also had a monitor for corporate communications, education and advertising.

3. Market shared 10%
4. Value to customers their ai was 3x more accurate than human beings at the pointed of disposal.
5. Strengths

- Diversion, expense and savings projections.
- O-demand and exportable waste audits.
- Fullness and trashbot status for custodial operations.
- Customizable ai for compliance.
- Granular data for decision insights.

6.Weakness

- Clean robotics' ai enabled sorting technology separates recyclable vs. Landfill items with only 90% accuracy.
- Only one item dump in bin at a time.
- Sometime confused where to push the material.
- No process that could teach system about new waste where to dump when it was confused.

2. Competitor analysis for Cambridge consultants [10]

1. Established date 1960.
2. Product

- Product design and development firm Cambridge consultants had developed a smarter recycling concept which tackles the challenged of improving the efficacy of recycling and incentivizing consumers to recycle, whilst addressing the end-of- life problem faced by consumer brands.
- The technology within the system was designed to identify the typed of waste the consumer wants to dispose of using image recognition. The system combines machine vision with machine learning and could be trained to recognized new items over time.
- It could also detect the difference between a recyclable cupped and a compostable cupped, potentially challenging to the untrained eyed. It then

indicates which section of the waste disposal unit the item should be placed in.

3. Market shared 28%
4. Value to customer's smart bin could distinguish between pet, pp, compostable.
5. Strengths
   - Have funds to develop accurate prototype.
   - It acts as a marketing tool, to show that the brand was proactively leading the way to a sustainable future.
   - Provides additional consumer insights such as when and where products were consumed.
6. Weakness
   - Only developed for high profile shop like Starbucks.
   - Not feasible for outdoor waste.

2.3   Competitor analysis for E-bin [11]
1. Established date 2015

2. Product
   - Bin-e was an IoT-based smart waste bin that recognizes, sorts and compresses the waste automatically. It was born out of the need for a smart waste separation solution in places where an efficient sorting system was hard to introduce.
   - In public and office spaces people often don't sort the waste properly due to lack of motivation, knowledge or proper infrastructure. Bin-e improves the recycling chain by increasing the amount of recovered resources and reducing the amount of waste that goes to landfills. It transforms waste management into an integrated system to facilitate the way towards a circular, sustainable economy.
   - Automatic separation – the smart waste bin identifies the typed of waste thanks to a recognition system based on artificial intelligence and image processing.
   - Compression of plastics and paper – an embedded mechanism reduces the volume of plastics and paper.
   - Filled level controlled – the filled level of each bin inside of the device was displayed on the touchscreen and in the app.
   - Automatic notifications - the waste management company gets notified via the app when one of the bins was full and needs to be emptied • data collection – the device gathers data about each objected and uploads it onto a cloud; the app delivers real-time data and summary reports.
   - IoT platform – for optimizing all waste management operations.

3. Market shared 50%
4. Value to customers

- Combined automatic sorting, compression, filled level controlled and data processing into one device. All these functions allowed to transform waste management into an integrated system.
- It's the key for reaching our global recycling goals and a circular economy.

5. Strengths
   - More resources recovered & higher quality of raw materials.
   - Less waste on landfills.
   - Lowered frequency and costs of waste disposal.
   - Optimized waste collection routes & convenient waste management.
   - Reduced costs, time and labour for waste management.
7. Weakness it was very costly 5800$.

2.4 Competitor analysis for R3D3 [12]

1. Established date 2010.
2. Product
   - Iron first in a beautiful case, r3d3 revolutionizes the world of sorting bins. R3d3 was a linked bin that recognizes, sorts and compacts cans, waste material and plastic bottles.
   - Dedicated to any space where beverages were consumed, in public spaces, at the workplace, r3d3 invites you to participate actively in sorting drink packaging, whilst improving how this waste was recycled.
   - Dropped the package.
   - It compacted and sort.
   - Stayed connected, it send an email of bin was full
   - Real time monitoring of your fleet and sorting statistics.
   - It could sort paper, could, bottle less than 50 cl.

3. Market shared 11%.
4. Value to customers
   - Combined automatic sorting, compression, filled level controlled and data processing into one device. All these functions allowed to transform waste management into an integrated system.
   - It's the key for reaching our global recycling goals and a circular economy.

5. Strengths
   - 100% reliable sorting.
   - Time saving.
   - Connectivity.
   - Capacity*10.
   - Hygiene.

6. Weakness

- Not work for municipality.
- Can handle limited waste typed only.

Products and/or services (Intelligent sorting bin)

- It was an iot based device which identify the plastic, paper, metal, glass, wet waste, and e -waste material.
- Each typed of waste had separate compartment inside the bin. After the identification of material, it transferred to its compartment.
- This device had sensors to detect the material typed and camera took two photo of it and feed the photo to computer vision algorithm to predict the material. Further the data generated by sensor and CV algorithm feed to machine learning algorithm to identify the material and then transferred.
- Information on the weight of material and bin fullness level and other factors could be viewed on app. Information feedback to system for better identification of material.
- A consumer goes to a Starbucks and orders a latte in a paper cupped (or a juice in a plastic bottle, or a milk in a carton, etc.). Once he's finished, he goes up and taps his phone against the bin, registering his identity with the bin app via Bluetooth.
- User then dump his cupped into the bin where sensors identify the properties of cupped and bin's cameras, which took two photos. The computer vision and machine learning identified the cupped lights up the corrected area and transferred to that area. If the user didn't want to use the app or register his identity, he simple dump his cupped.
- Price range 2000$

Market position************

My targeted customers are who produce similar type of waste daily like Starbucks café. They compare my product as this is low cost product then other.

Benefits to customer

- Total containment eliminates overflow, windblown litter, resulting aesthetics and a safe environment.
- Encouraged recycling and reduce carbon footprints & greenhouse emission.
- Our system leaves the labour free other productive tasks.
- Saves a lot of money.

Pricing strategy

Product	Forecast total sales ($)	Forecast costs ($)	Mark-up (%)	Gross profit ($)	Gross profit margin (%)
Intelligent sorting bin(per unit)	2000	1500	33.3%	500	25%

Intelligent sorting bin(10 unit)	20000	13500	48.1%	6500	32.5%

Summary

In today scenario, there were millions of cupped produced in a day and present solution provide the solution for this but dumping a one cupped took 1. 5 minute –2 minutes and was not capable for handling large quantity of cupped in an hour. It needed large investment to setup the bin.

Proposed solution took only 20 sec to complete the process and could handle large quantity of cups and low cost was market advantage.

Requirements

After the problem and potential solution became cleared, they define each stakeholder's potential interaction(s) with a solution, including the solution objectives, success, and acceptance criteria from the perspective of the stakeholder. To provide a comprehensive picture of the subject gait many parameters were required to be measured. Due to time and budget, only certain parameters will be measured. The device must be:

- Device help shops to decrease the waste management budget and able to focus only on their business.
- It helps to increase the recycling percentage of waste material and make a cleaner environment.
- User was now free from knowing the typed of cupped material, device sorts for them automatically.
- Data generated from the device help developer to develop a more accurate system (feedback controlled system).
- Collection Service Company knows free from sorting the waste material and directly send to the treatment facility.

Specifications

Specifications were the requirements of the project expressed using technical language.

- Sensor: a distance proximity sensor was a sensor able to detect the presence of nearby objects without any physical contact. A typical sensing range for proximity sensors was 1 inch to 2 inches.
- Sensor: inductive proximity sensor an inductor develops a magnetic field when a current flowed through it; alternatively, a current will flow through a circuit containing an inductor when the magnetic field through it changes this effect could be used to detect metallic objects that interact with the magnetic field. Non-metallic substances such as liquids or some kinds of dirt did not interact with the magnetic field, so an inductive sensor could operate in wet or dirty conditions. It was used for the detection of metallic properties of the metal.
- Sensor: the raspberry pi camera module v2 was a high quality 8 megapixel Sony imx219 image sensor custom designed add-on board for raspberry pi, featuring a fixed focus lens. It's capable of 3280 x 2464 pixel static images, and also supports 1080p30, 720p60 and 640x480p60/90 video. It was used in the project from taking images of material and that image sends to aws recognition for analysis of the image. [13,14,15]
- Actuator: Towerpro sg90 1. 2kgcm 180 degree rotation servo motor used as actuator because it had the capability of rotating at 180 degrees, operating voltage: 3. 0v~ 7. 2v. when device predicts the output metallic or non-metallic, for metallic motor rotate clockwise 90 degrees, non-metallic motor rotate anti-clockwise 90 degrees. It was used to transfer the material in a particular bin. [16]
- Microcontroller: the Arduino mega 2560 was a microcontroller board based on the atmega2560. It had 54 digital input/output pins (of which 15 could be used as pwm outputs), 16 analog inputs, 4 uarts (hardware serial ports), a 16 MHz crystal oscillator, a usb connection, a power jack, an icsp header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with an usb cable or power it with an ac-to-dc adapter or battery to get started. Its operating voltage: 5v, input voltage

(recommended):7-12v, input voltage (limit):6-12v. It was used for controlling the sensor and actuator.

- Microprocessor: the raspberry pi 3 model b builds upon the features of its predecessors with a new, faster processor on board to increase its speed. It also features Wi-Fi and Bluetooth low energy capabilities to enhance the functionality and the ability to power more powerful devices over the usb ports. Quad-core 1. 2ghz Broadcom bcm2837 64bit cpu, 1gb ram, bcm43438 wireless lan and Bluetooth low energy (ble) on board, csi camera port for connecting a raspberry pi camera. [17,18]
- Connectivity: Wi-Fi was used as connectivity because power was not a constraint and Lora, nb-iot,4g, sigfox not needed as they had more than 10km coverage.
- Power supply: this prototype was designed indoor area like shops so the power supply was not an issue, it could be taken directly from the shop. But any fluctuation in voltage could damage the device so the voltage regulator was used and AAA rechargeable battery was used for power backup.
- Cloud service: aws was a platform that enables you to connect devices to aws services and other devices, secure data and interactions, process and acted upon device data, and enable applications to interact with devices even when they were offline. Aws provides the cloud service which provides security, integration with other services of aws. [19]
- Aws iot sdk: the aws iot device sdk helps you easily and quickly connect your hardware device or your mobile application to aws iot core. The aws iot device sdk enables your devices to connect, authenticate, and exchange messages with aws iot core using the mqtt, http, or web sockets protocols. The aws iot device sdk supports c, JavaScript, and Arduino, and includes the client libraries, the developer guide, and the porting guide for manufacturers. You could also used an open-source alternative or write your sdk.

Evaluation of alternative solutions

Sorting of waste waste material was the global problem and had different solution around the globe

- Cambridge consultants had provided a smart bin solution which had smart camera detection of waste material and four-compartment inside the bin each had light indicators. When the cupped placed on the device identify it and the right container light glow, then user picks and put the cupped inside the bin. It takes 1 min to identify and put the cupped inside the bin, might affect the business.
- Collected the mixed waste material and send to sorting facility, then sort the waste material but it takes a lot of resources and money.
- Choosing the intelligent sorting bin was designed for minimizing the time to dump the waste material within 30 sec and help to save resources and money in long term. When the user put the cupped inside the bin, then firstly sensor identifies the material properties and the camera takes two photos of it and cv algorithm identify its shape and properties, then all the data feed into ml algorithm to predict the material, and send the predict data to a device for actuation function.

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- Arduino mega 2560 was used as a microcontroller and configured with raspberry pi 3 model b.
- Inductive proximity sensor used as an input to Arduino mega 2560 and all connection and wiring all been done.
- Distance proximity sensor connected to Arduino mega 2560 and had been configured and all wiring had been done.
- The pi camera had been connected to a raspberry pi.
- For communication between Arduino mega and raspberry pi, used simple serial communication over the usb cable was completed.
- Aws iot sdk and aws recognition sdk were installed in raspberry pi.
- Wi-Fi built-in raspberry pi used for internet connectivity between device and aws iot and had been configured.
- All the data publish and subscribe over mqtt protocol to aws iot.
- When user put the cupped in bin aws iot triggers the aws lambda function to analyse the data of inductive proximity sensor.
- Image data was analysed on raspberry pi using aws rekoginition sdk.
- Combination of analysed proximity sensor data and analysed image data sent to cloud for predicting whether material was metallic or not.
- If it predicts metal, aws lambda function triggers the servo motor to turn on 180 degrees clockwise.
- If it predicts non-metal, aws lambda function triggers the servo motor to turn on 180 degrees anti-clockwise.

Summary

In this module, requirements of stakeholder had been discussed, prototype process, specification, and alternative solution of the problem was discussed.

For Metallic cup

When user put the cup inside the bin distance sensor identify whether there was something inside the bin and aws iot send trigger to aws lambda function to analysis the data of inductive sensor and pi camera took photo of material and send for analysis on raspberry pi aws sdk rekoginition. The combination of sensor data and image data decided whether it was metallic or not. If found it as metallic, aws iot triggers servo motor to rotate 180 degree clockwise.

For Non-Metallic cup

When user put the cup inside the bin distance sensor identify there was something inside the bin and aws iot send trigger to aws lambda function to analysis the data of inductive sensor and pi camera took photo of material and send for analysis on raspberry pi, aws sdk rekoginition. The combination of sensor data and image data decided weather it was metallic or not. If found it as non-metallic, aws iot triggers servo motor to rotate 180 degree anti-clockwise.

Evaluation of progress

Work need to be done:

- Need to deploy advance algorithm to process optical sensor data to produced optimum output.
- Need to deploy security at the data management and network.
- Optical sensor and capacitive sensor need to be connected with Arduino mega 2560 for detecting plastic waste material material.

Problems and/or delays are foreseen
- Security was the biggest concern when someone in shop knows the Wi-Fi password.
- M2m IoT sim need to deploy for internet connection but it may be costlier.
- Power issue was the concern when continuous power cuts, voltage fluctuations were there.

Worst case Scenario
- Worst case was when user put multiple cups in bin.
- When someone get Wi-Fi access ,it will affect the device so security stepped need to be taken.

Summary
There were some sensor need to be added and deploy advance algorithm to produced optimum output, Wi-Fi might be the problem, when someone tried to access its password.

Conclusion

In this section the full report was summarised without any new information being added with the exception of a section describing future work.

This report had laid a sounded and effective foundation for others to build upon and complete the solution for the intelligent sorting bin. The used of inductive proximity sensor had been found to be a suitable metal detection and pi camera was used as secondary verification using aws rekoginition sdk. Wi-Fi had been found to be a suitable transmission medium, provided that it was implemented correctly. Wi-Fi communication systems were conveniently available in the Wi-Fi access pointed at shop. However, the issue found with Wi-Fi access pointed, when new password entered, changed of host name and someone tried access the Wi-Fi. It need to be implement m2m sim for communication.

Future work

Intelligent sorting bin was a automatic waste sorting device but it only sort metal material and non-metal material into two compartment in the bin. It need to add more funcnality like sorting the types of plastic, paper, wet waste. It need to sort multiple thing at a time, right it only sort one thing at a time. After completing all need funcnality, then started production and send for test at real market places like shops

Project Plan

Intelligent sorting bin project plan had user stories to complete it stepped by stepped from initial to end phase, but some of the user stories were left complete because of limited time and budget

WBS NO.	Activity	Earliest start date	Latest End date	Resources	Timelines	Risk assessment
1	Project management					
2	Canvanizer	23-Jul-19	07-Aug-19	Time and Computer	Week 3-Week 4	
3	Video presentation	08-Aug-19	23-Aug-19	Time and Video capturing equipment	Week 4-Week 6	
4	Market research cost report	24-Aug-19	08-Sep-19	Time and research cost	Week 7-Week 8	
5	Prototype	01-Sep-19	25-Sep-19			
5.1	Process map out	01-Sep-19	01-Sep-19	Paper	Week 9 Day 1	Need to identify required Input and output
5.2	Identify the control system	02-Sep-19	02-Sep-19	paper	Week9 Day 2	Control system affect the device performance

6	Required devices to be connected					
6.1	Identify the sensor	03-Sep-19	03-Sep-19	Inductive proximity sensor, capacitive proximity sensor, plastic detection sensor, pi camera.	Week 9 Day 3	Need to identify precision based sensor
6.2	Identify the Actuator	04-Sep-19	04-Sep-19	Servo motor 180 degree rotation	Week 9 Day 4	Need to identify actuator which can load up to 200g of weight
6.3	Identify the intermediate device	05-Sep-19	05-Sep-19	Arduino MEGA 2560 and raspberry pi	Week 9 Day 5	Need to identify minimal processing Micro and low cost
7	IOT protocol considerations	06-Sep-19	06-Sep-19	Range within the shop	Week 9 Day 6	need 24/7 internet connectivity
8	IoT protocol choice	07-Sep-19	07-Sep-19	Wi-Fi	Week 9 Day 7	need 24/7 internet connectivity
9	Data					
9.1	Type generated	08-09-2019	08-09-2019	Volume, limited data range, partly processed in fog, analysis shared on web	Week 10 Day 1	Need to process data in low processing Micro
9.2	Storage solution	09-09-2019	09-09-2019	Local server, backed up	Week 10 Day 2	It will cost more
9.3	analysis overview	10-09-2019	10-09-2019	Identify the type of material and report to the device for functioning	Week 10 Day 3	Might not always identify the material

10	Programming Required					
10.1	device function	11-Sep-19	14-Sep-19	"Programming to record the type of material. Holds data for 24 hours unless in contact with Wi-Fi when it uploads data."	Week 10 Day 4-Week 10 day 7	May be sometime Wi-Fi not connect more than 24 hrs
10.2	networking requirement	15-Sep-19	15-09-2019	Data from sensor directed to Wi-Fi on AWS IOT.AWS Iot send data to device via Wi-Fi to direct actuator	Week 11 Day 1	Need 24/7 internet connectivity
10.3	data management	16-Sep-19	17-09-2019	Data needs algorithm to identify material that suggests whether the material is metallic or non-metallic, help device to separate the material in different bin	Week 11 Day 2-day 3	May need more time and cost
11	Security and privacy consideration					
11.1	device	18-Sep-19	18-09-2019	Need to be secured from water, dust	Week 11 Day 4	May be liquid material push to bin and affect the device

11.2	network	19-Sep-19	19-09-2019	Resist the Wi-Fi coverage outside the shop and stop being connected that Wi-Fi to other	Week 11 Day 5	Might be attackers try to access the Wi-Fi
11.3	data	20-Sep-19	20-09-2019	Protect historical data from being lost, stolen or ransomed, guard against re-setting of algorithm so shows all material are metallic or all non metallic	Week 11 Day 6	Data need to be protected from hackers
12	Final report	21-Sep-19	28-09-2019		Week 11 Day 7 - week 12	

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Appendix B Code listing

Arduino Mega 2560

```
int metal Sensor = A0;

// the setup routine runs once when you press reset:

void setup()

{

// initialize serial communication at 9600 bits per second:

Serial.begin(9600);

// make the sensor's pin an input:

pinMode(metalSensor, INPUT);

}

// the loop routine runs over and over again forever:

void loop()
```

{

// read the input pin:

int sensorState = analogRead(metalSensor);

// print out the state of the sensor:

if(sensorState == 1020)
  Serial.println("yes");
if(sensorState == 1021)
  Serial.println("yes");

delay(1000);
if(sensorState == 1022)
  Serial.println("no");
if(sensorState == 1023)
  Serial.println("no");

delay(1000);

delay(1000);

// delay in between reads for stability

}

Aws Sdk code

```
'use strict';
console.log('Running...');
const SerialPort = require('serialport');
const Readline = require('@serialport/parser-readline')
const portName = '/dev/ttyACM0';
const port = new SerialPort(portName, (err) => {
if (err) {
return console.log('Error: ', err.message);
}
});

const deviceModule = require('aws-iot-device-sdk').device;
const parser = port.pipe(new Readline({ delimiter: '\r\n' }));
const rePattern = new RegExp(/C: (.+)F:(.+)/);

parser.on('data', (data) => {
const arrMatches = data.match(rePattern);
if(arrMatches && arrMatches.length >= 1) {
const readingInC = arrMatches[1].trim();
console.log(readingInC);
sendDataToTheNube(readingInC);
```

```javascript
}
});

const defaults = {
protocol: 'mqtts',
privateKey: '.*********',
clientCert: '.****************',
caCert: './iot/root-CA.crt',
testMode: 1,
/* milliseconds */
baseReconnectTimeMs: 4000,
/* seconds */
keepAlive: 300,
/* milliseconds */
delay: 4000,
thingName: '****************',
clientId: 'nouser' + (Math.floor((Math.random() * 100000) + 1)),
Debug: false,
Host: '***********************',
region: '************'
};

function sendDataToTheNube(readingInC) {
const device = deviceModule({
    keyPath: defaults.privateKey,
    certPath: defaults.clientCert,
    caPath: defaults.caCert,
    clientId: defaults.clientId,
    region: defaults.region,
baseReconnectTimeMs: defaults.baseReconnectTimeMs,
    keepalive: defaults.keepAlive,
    protocol: defaults.Protocol,
port: defaults.Port,
   host: defaults.Host,
defaultsefaultsefaults.Debug
});

device.publish(`Inductive/${defaults.thingName}`,
JSON.stringify({
temperature: readingInC
}));
}
```
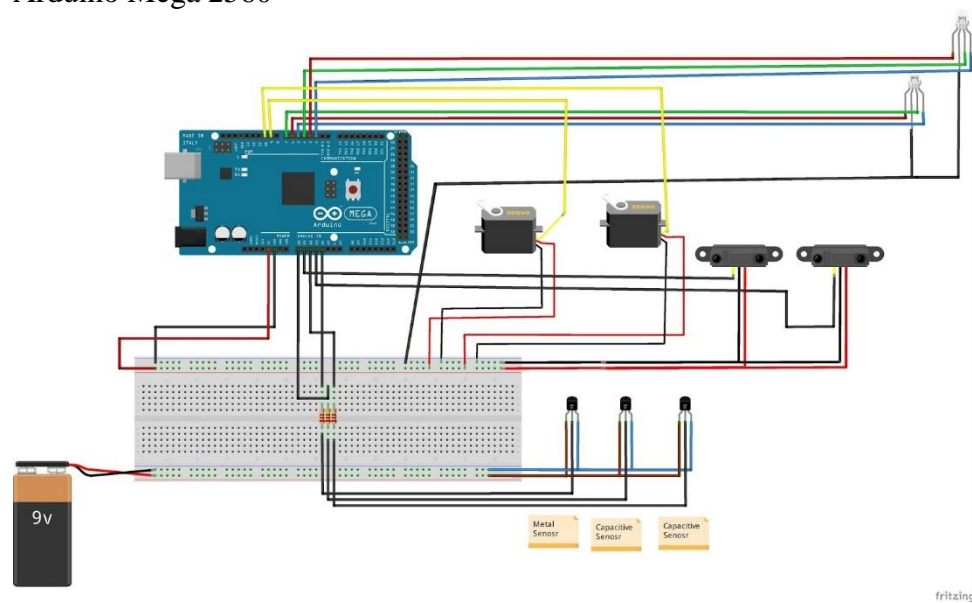
Appendix B

Arduino Mega 2560

Servo Motor schmentic