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(**Research Article**)

Design of Smart Bin based on C# Through Raspberry PI

Buğra BEDER[1,*], Oğuzhan KARAHAN[2]

[1] Kocaeli Üniversitesi, Mühendislik Fakültesi, Elektronik ve Haberleşme Mühendisliği Bölümü, Kocaeli, ORCID No: http://orcid.org/0000-0002-7877-7763

[2] Kocaeli Üniversitesi, Mühendislik Fakültesi, Elektronik ve Haberleşme Mühendisliği Bölümü, Kocaeli, ORCID No: http://orcid.org/0000-0003-3827-0228

Keywords:
Raspberry pi,
C#,
Iot,
Software,
Environment

Abstract: Iot communication technology devices that can do any operation in a network without a domain, without the need of human or able to transfer data over a network or can be defined as. Thanks to the advantages of reducing costs and improving work efficiency in this technology, it is currently continuing to be widespread in many places from industry to textile factories to homes. In this study, an interface has been created in C# Windows Form and the control of the Smart Trash can via Raspberry Pi has been performed with this interface. This smart Trash Can is IoT based and as long as we know the ip address of the Raspberry Pi, we can control the trash can. The purpose of the study is to explain how we can control an object in real life via the Raspberry Pi microcontroller, which is widely used today, in a simple and understandable way.

(**Araştırma Makalesi**)

Raspberry PI Aracılığıyla C# Tabanlı Akıllı Kutu Tasarımı

Anahtar Kelimeler:
Raspberry pi,
C#,
Iot,
Yazılım,
Çevre

Özet: Nesnelerin interneti iletişim teknolojisi Bir ağdaki herhangi bir işlemi etki alanı olmadan, insana ihtiyaç duymadan yapabilen veya ağ üzerinden veri aktarabilen veya olarak tanımlanabilen cihazlar. Bu teknolojide maliyetlerin düşürülmesi ve iş verimliliğinin artırılmasının sağladığı avantajlar sayesinde sanayiden tekstil fabrikalarına, evlere kadar birçok yerde yaygınlaşmaya devam etmektedir. Bu çalışmada C# Windows Formunda bir arayüz oluşturulmuş ve bu arayüz ile Akıllı Çöp kutusunun raspberry Pi üzerinden kontrolü gerçekleştirilmiştir. Bu akıllı Çöp Kutusu IoT tabanlıdır ve raspberry Pi'nin ip adresini bildiğimiz sürece çöp kutusunu kontrol edebiliriz. Çalışmanın amacı günümüzde yaygın olarak kullanılan Raspberry Pi mikrodenetleyici ile bir nesneyi gerçek hayatta nasıl kontrol edebileceğimizi basit ve anlaşılır bir şekilde anlatmaktır.

1. INTRODUCTION

Connecting objects to the Internet of Things has become very possible for them to receive and send data from sensors and control them. The fact that the processing of data is visible somewhere and has given birth to a very large area that is either new to be accessed. The incredibly rapid developments in this area have become a very big step for the comfort of humanity in life. That is why this technology has become one of the most important sectors of the future, and it seems that it will remain so for a long time. According to the research conducted, it is projected to reach the level of 50 billion devices by 2022. According to the same research; in 2003, the rate of interconnected devices per capita in the world was 0.08, and the 2022 estimate of this rate is "6.48". And this area is one of the areas that is currently being studied the most. Communication of objects with each other without any influence of people eliminates many damages that may occur and provides convenience. The Internet of things continues to spread everywhere and has had a huge impact in driving society. It is processed everywhere, from software to cloud systems. Gianna Reggio, Maurizio Leotta, Romina Spalazzese, Maura Cerioli in an article

*Sorumlu Yazar/Corresponding Author: bugrabeder41@outlook.com

published [1]. It has been revealed where IoT is used all over the world and it has spread to all parts of life.

Ganesh Prasad, Pratik sheth Jain, Sowmya K , july 2021 they have made a smart trash bin in the flow. This project is aimed at reducing the pollution rate in the city. When the garbage is 70% full, we will send a message to the server and prevent garbage accumulation [2].

Bo Sun, Quanjin Ma, Hao Yao, Guangxi Zhuang in January 2021, they made a smart trash can suggestion based on WIFI environment and Arduino control. In this project, the separation of waste is to provide convenience by combining it with the Internet environment and people. Management is designed to ensure efficiency and prevent waste of resources [3].

Fady Samann published an article entitled Design and implementation of a smart trash can in January 2017. This was a cost-effective smart trash can for small-scale situations. The system is based on notifying the occupancy rate by SMS. In the studies conducted, the system performance is very satisfactory [4].

Ruchi Goel, Sahil Aggarwal, A. Sharmila, Azim Uddin Ansari published the article in September 2020. The topic of the article is to create a cleaner environment thanks to the smart trash can. jul. It generates a signal when the trash bin is close to filling and shares its location with the municipality. The system decomposes toxic gases and opens and closes the lid when it rains thanks to the rain sensor [5].

Takeo Hamada, Slamet Kristanto Tirto Utomo, Noboru Koshizuka published an article in June 2018. With the operation of low-energy intelligent garbage can architecture. This study predicts that more efficiency will be obtained by reducing the energy consumed by the garbage can. In the measurements made, the energy consumption is very low and the service life has been determined to be up to 5 times longer [6].

V. Sellam, R. Pushkala, V. Akshita, R. Nivetha published an article in December 2020. The purpose of the article is to show the occupancy of the garbage can and increase the efficiency of cleaning workers. The trash can uses the website to show the occupancy, and the cleaning workers can see the occupancy status very conveniently [7].

Oscar Karnalim, Oscar Wongso, Vincent Elbert Budiman, Felix Christian Jonathan published an article based on a Smart trash can in June 2020. The purpose of the article is to ensure the disposal of waste from a smart trash can. In the studies conducted, success has been achieved on these two issues. By including mobile application in the project, it has been even more encouraging for people to throw away garbage [8].

Prihatin Oktivasari made a trash can in 2018. it shows whether the trash is full or not, and when the trash is full, the notification goes to the phone. So it's checked on the phone [9].

Henry Vern Batabat, Rhea Mae Palban, Rhea Angela Anasco, Lorena Aguilar have made a design to prevent the spread of the disease more during the covid period and to increase hygiene. This design shows the trash can momentarily, and when it is full, it notifies the user and lights an led. It shows the status on the LCD screen [10].

Melih Kuncan and Ömer Çaça published an article called Wireless Smart Kit for Smart Home Technology in 2019. In the article, it is controlled by the switchboard depending on the data sent to the switchboard via an android-based mobile phone. It is an important step for IoT(Internet of Things) for developing technology [11].

Alaa Hamayel, Sıtkı öztürk and Fatma Kuncan published an article on PLC-Based Industrial Hardware Control with a Mobile Application in 2021. In the article, the conveyor system separates the iron and plastic objects entering the system from each other, and at the end of the process, the plastic objects are placed on the iron objects and removed from the conveyor. This system combined with PLC is an important article for industrial systems [12].

2. MATERIALS AND METHODS

In this project, the interface design first made in C# windows Form. This interface has textboxes that display data from the trash can, and buttons that are used to send data. This interface includes many different functions; fan controls, opening the lid, starting the buzzer and sending mail.

In the second stage, the data receive from the sensors is sent to the interface via the raspberry pi. The data sent from the interface is also read and processed on the raspberry Pi. Finally, the whole system is fully operational.

In this project, raspberry pi is working simultaneously in C# windows form with socket communication by receiving data from sensors.

2.1 Smart trash bin

The Smart Trash bin contains HC-SR04 distance sensor, buzzer, DHT11 temperature sensor, fire detection sensor, MQ-2 cigarette smoke sensor, 12V fan, SG90 mini servo motor and 9V battery. The fan, servo motor and buzzer are working with data from the interface. Other sensors send data to the interface.

2.2 Design of smart trash bin

Firstly, a trash can take, where the sensors will be connected. The location of the Raspberry pin, which is the place where the cables will come out, has been determined. Figure 1 shows the location of the Raspberry pin in the connected way.

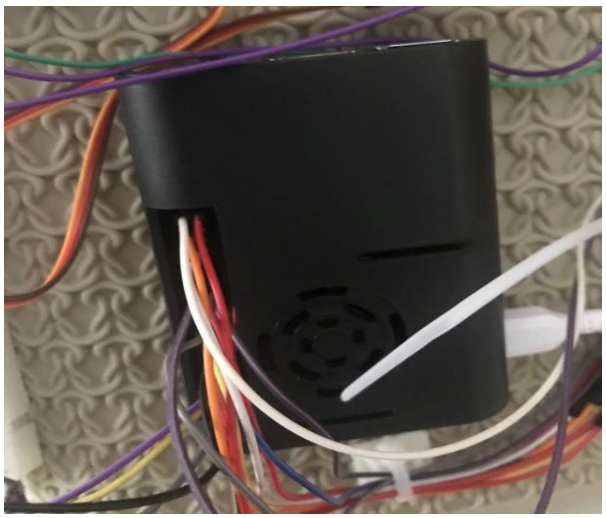

Figure 1. Image of Fixed Raspberry Pi

After the Raspberry pi fix, it was switch to determining the location of the sensors, and after that, the fixing operations were performed. Their fixed states are shown in Figures 2 and 3.

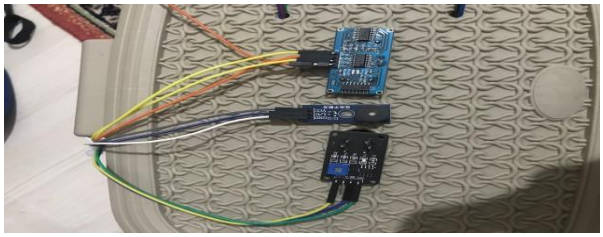

Figure 2. Image of the fixed sensors

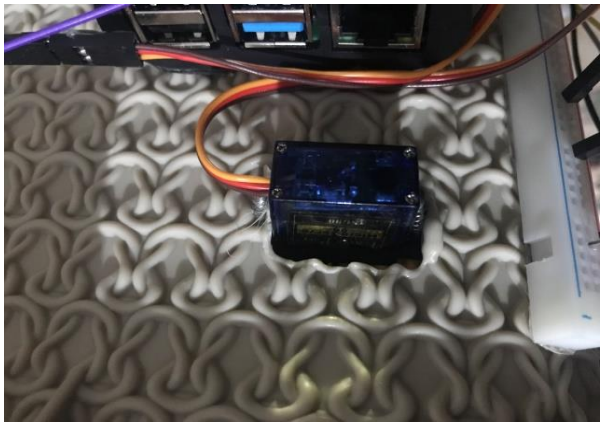

Figure 3. Image of the fixed sensors

After the location of the sensors was determined and fixed, the fan holes were drilled and the fan was fixed. Then the transistor circuit was placed under it for the operation of the fan commands and it was fixed together with the battery. This was showed in Figure 4.

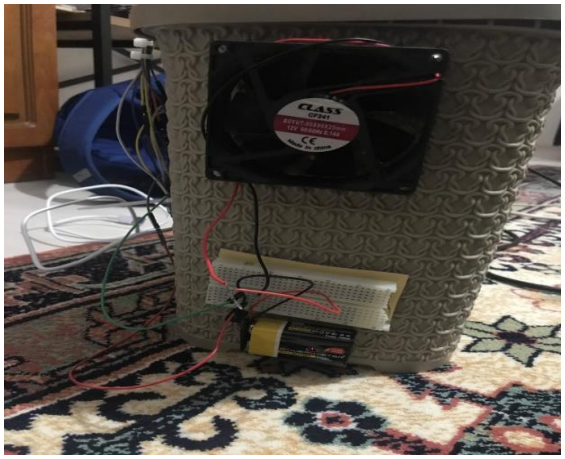

Figure 4. Image of the fixed fan and its circuit

Finally, the hardware part in the trash can was finished. The placement of the Raspberry pi, fan and other sensors has been completed. The cable connections have been made and the software part has been switched on.

2.3. Raspberry pi 4 (Model B)

Raspberry Pi is a credit card sized single card computer developed by the Raspberry Pi Foundation in the UK to teach computer science in schools.

Figure 5 shows the raspberry pi model used in this project. The Raspberry Pi 4 with Broadcom BCM2711 processor has a 4-core ARM architecture Cortex-A72.The Pi 4, which has LPDDR4 RAM, has 3 different RAM options, including 2GB, 4GB and 8GB, the 2GB model was used in this project.there are 2 USB 3.0 and 2 USB 2.0 ports.The Raspberry Pi 4, which has a Gigabit Ethernet port, is equipped with a 5.0 GHz Wireless connection and Bluetooth 5.0 technology.There are 2 micro HDMI ports that support 4K 60 fps.it has audio + composite video output via a 4-pole 3.5mm connection. It has a Type-C input, works with 5-3A.

In this project, raspberry pi sends the data it receives from the sensors to the c# interface with the help of socket. Then it reads the data sent from the c# interface and makes the necessary functions work. This data transfer is done with the wifi module located on it.

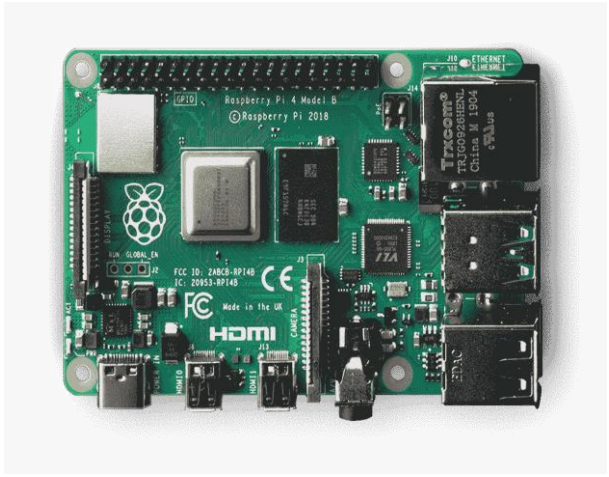

Figure 5. Image of Raspberry Pi 4 (Model B)

2.4. DHT11 Temperature Sensor

Figure 6 shows image of the temperature sensor. The temperature sensor measures the temperature of the environment and outputs a digital output.

In this project, it shows the instantaneous changes by measuring the temperature of the environment.

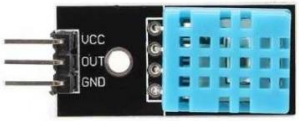

Figure 6. Image of DHT11 Temperature Sensor

2.5 HC-SR04 Distance Sensor

Figure 7 shows image of the Distance sensor. A distance sensor is an instrument that measures the distance to an object opposite it. it has 4 pins. (trig,echo,vcc,gnd) The trig pin sends a signal, then the signal that hits the object and rotates activates the echo pin so that the distance is measured.

In this project, the distance sensor was used for occupancy measurement. We process the measured distance in a function and get the output.

Figure 7. Image of Distance Sensor

2.6. Flame Sensor

Figure 8 shows image of the Flame sensor. The fire detection sensor has 2 outputs. The infrared sensor on it is able to detect fire and output digital or analog.

In this project, it was used to measure the temperature of the environment momentarily.

Figure 8. Image of Flame Sensor

2.6. Combustible Gas and Cigarette Smoke Sensor Card - MQ-2

Figure 9 shows image of the MQ-2 Gas and cigarette sensor.

The MQ-2 gas sensor is a type of sensor that will detect flammable gas and cigarette smoke at concentrations of 300 to 10,000 ppm.

In this project, cigarette smoke measurement was used. It measures whether a cigarette smoke is instantaneous or not.

Figure 9. Image of MQ-2 Gas and Cigarette Sensor

2.8. SG90 RC Mini Servo Motor

Figure 10 shows image of the Servo Motor. SG90 is an ideal servo motor for your small mechanisms. it can lift up to 1.8 kg.It works from 4.8 dec 6 V. it can rotate 180 degrees.

In this project, it was used to lift the lid.

Figure 10. Image of Servo Motor

2.9. Buzzer Module

Figure 11 shows image of the Buzzer Module. Buzzer module produces a single-tone sound when signal is high. Buzzer module consists of a piezoelectric buzzer with a built-in oscillator. It generates a sound of approximately 2.5 kHz when signal is high.

In this project, the buzzer mode was used for warning purposes.

Figure 11. Image of Buzzer Module

2.10. Fan

Figure 12 shows image of the Fan. Fan is a device that provides the flow of air by creating a pressure difference.

In this project, a 50 hz 12v fan was used and the bd135 trasnsitor was used to operate this fan in a controlled manner.

Figure 12. Image of Fan

3. SYSTEM ARCHITECTURE

In the first step, an interface was created in the C# windows form for interaction with the user. Using this page, the user can give instructions to the trash can and see the data coming from the trash can. Data retrieval is performed using a socket connection. The data that the user wants to send is sent instantaneously via the socket library and processed instantaneously. After processing, new data is expected to be deleted.

Figure 13 shows an example of sending data with socket in Raspberry Pi.

```
import socket
host = "localhost"
port = 12345
try:
    s = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
    print("socket oluşturuldu")
    s.bind((host, port))
    print("socket {} nolu porta bağlandı".format(port))
    s.listen(5)
    print("socket dinleniyor")
except socket.error as msg:
    print("Hata:",msg)
while True:
   c, addr = s.accept()
   print('Gelen bağlantı:', addr)
   mesaj = 'Bağlantı için teşekkürler'
   c.send(mesaj.encode('utf-8'))
   c.close()
```

Figure 13. Image of example send data with socket in Raspberry Pi.

In the second step, a socket is created to process one incoming data. It runs the function according to the data from the socket. Figure 14 shows an example code fragment for this.

```
import socket
def toplama():
    a=10
    b=5
    return (a+b)
host = "localhost"
port = 12345
try:
    s = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
    print("socket oluşturuldu")
    s.bind((host, port))
    print("socket {} nolu porta bağlandı".format(port))
    s.listen(5)
    print("socket dinleniyor")
except socket.error as msg:
    print("Hata:",msg)
while True:
   c, addr = s.accept()
   print('Gelen bağlantı:', addr)
   yanit=c.recv(1024)
   if yanit.decode("utf-8")=="0":
      toplama()
   c.close()
```

Figure 14. Image of Example Get Data in Raspberry Pi

In the third step, button encodings are made in C# that will accept the incoming data created on the raspberry pi and send the data to the socket that will process it. These data are in the function execution task on the raspberry Pi. Figure 15 shows the sample codes written for socket connection in c#.

```
int port = 90;
Socket buzzer = new Socket(AddressFamily.InterNetwork, SocketType.Stream, ProtocolType.Tcp);
IPHostEntry iPHost = Dns.Resolve("172.20.10.4");
IPAddress ipAddr = iPHost.AddressList[0];
IPEndPoint ipEndPoint = new IPEndPoint(ipAddr, port);
buzzer.Connect(ipEndPoint);
string mesaj = "3";
byte[] bytes = new byte[1024];
bytes = Encoding.UTF8.GetBytes(mesaj);
buzzer.Send(bytes);
```

Figure 15. Image of example send data from C# to Raspberry Pi

In the fourth step, a socket connection was created to read data from the raspberry pi. Incoming data was written by parsing it into texboxes created in windows form. Figure 16 shows the sample codes for this decomposition.

```
int port = 75;
IPEndPoint ipEndPoint = new IPEndPoint(IPAddress.Any, port);
s3.Bind(ipEndPoint);
s3.Listen(5);
MessageBox.Show("Server Başlatıldı.");
return s3;

Socket handler = socket5.Accept();
string data = null;
byte[] bytes = new byte[1024];
handler.Receive(bytes, bytes.Length, 0);
data = Encoding.UTF8.GetString(bytes);
handler.Close();
char ayrac = ',';
string[] veriler = data.Split(ayrac);
```

Figure 16. Image of example get data from Raspberry pi

In fifth step, the interface was designed in C# Windows form. The buttons for opening the lid, starting the fan, sending an e-mail and starting the buzzer have been created. Textboxes have been created in which data will be written on the screen, and the interface design has been completed. The interface is shown in Figure 17.

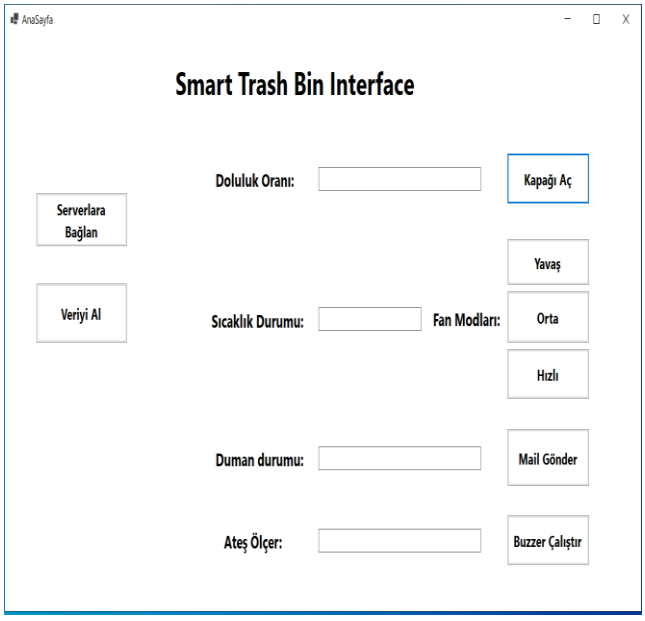

Figure 17. Image of interface

After the connections of the trash can were made, the system was made ready. The hardware-prepared version of the trash can is shown in Figure 18.

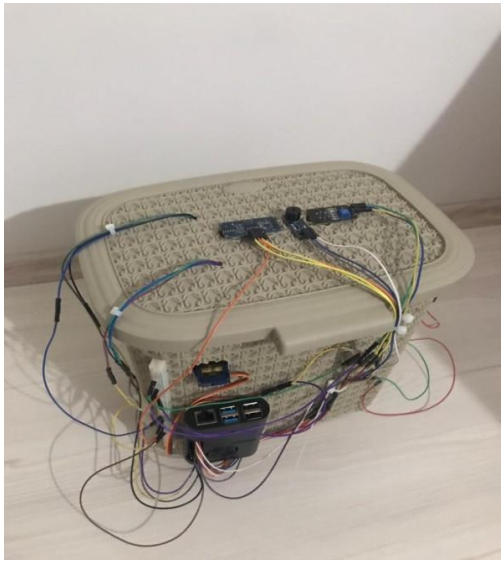

Figure 18. Image of Trash Bin

4.FUNCTIONING OF THE SYSTEM

Firstly, the fire status of the fire sensor, the temperature status of the temperature sensor, the occupancy with the distance sensor, the gas status with the gas sensor are measured. These data are sent to the port with the help of socket. The listener is printed to the interface with the help of socket. A message sender socket is created for the buttons on the interface to work. listener socket is created in raspberry pi. When any of the buttons is pressed, a message is sent via the message socket. The listener socket listens for incoming data and executes the function according to the situation

5. FUNCTIONAL BLOCK DIAGRAM

Ultrasonic distance sensor, Temperature sensor, Gas sensor, fire sensor, buzzer, fan, servo motor are shown in Figure 19. Data is received from the distance sensor, temperature sensor, gas sensor andfire sensor are sent to the windows form interface via Socket. The data received from the Window form via the socket comes to the raspberry pi and is processed there.

6. CONCLUSIONS

After the hardware parts of the smart trash can were placed, the control interface was created in C# Windows form.
The interface has text boxes showing the data in the trash can and buttons for the functions we want to run in the trash can. Thanks to the Socket, the received occupancy information, temperature information, fire status and cigarette smoke status will appear in the texts and be refreshed automatically. The open the lid of the trash can button turns the lid on and off for 7 seconds. The fan works fast, medium and slow for 5 seconds and turns off. Incoming data is sent instantly by pressing the button to the e-mail address I have saved for security purposes. There are options such as running the ringtone. When the buzzer start button is pressed, the buzzer makes a sound for 5 seconds. For example, pressing the open cover button creates a Socket connection. it is connected to the

socket that contains this function. and sends him data. the data is processed on the connected socket and the lid is opened. The function that will work depends on the value of the data sent from the socket varies.

Since the project is a Local project and involves multiple sensor controls, its development is important for environmental technology. If the project is moved to the Web, it will be a much better tool to control it from anywhere. It is an important step for the developing technology.

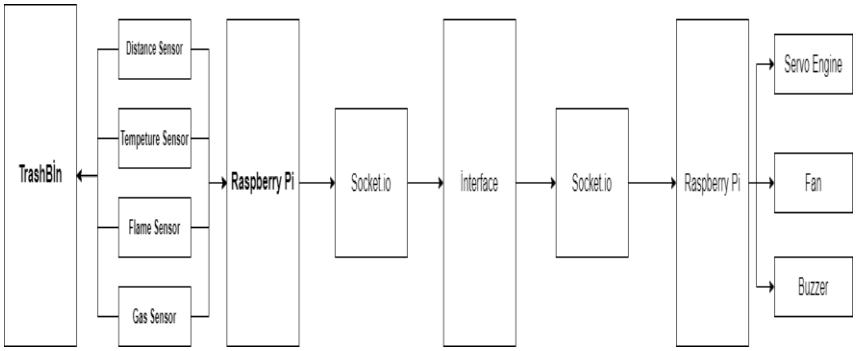

Figure 19. Image of Block Diagra

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