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COMPUTER ENGINEERING DEPARTMENT

Project Report

Version 2

CENG 408

Innovative System Design and Development II

P201711
Sensor Programming with using Android Platform

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Abstract

In this report, the features and design of a prototype robotic vehicle with using Android devices and sensors are presented. This study was developed with the interaction of Android-based smartphone and Bluetooth technology. In addition, Arduino Uno, which is the brain of various sensors and robot, was used in this project. The aim of this project is to use for the military field to inform the military personnel in advance of possible terrorist attacks. The user can control the robotics movements from his/her own intelligent device or take the robot in automatic mode and let the car drive its own way. The robotic vehicle can detect whether the obstacles facing the vehicle are human or not. If the obstacle is a living entity, as for that is the human, the red led on the robot lights up and it will calculate the shortest distance it can avoid and will proceed in that direction. If any object we are comparing is inanimate, it will calculate the shortest distance it can avoid and will proceed in that direction. In addition, by using sensors such as infrared sensor, obstacle recognition sensor, the interaction between the robot and the environment is ensured. At the same time, the Bluetooth module allows Arduino to communicate with the Android-based phone. Thus, the importance of sensors is increasing day by day in the military area. Human detectable sensors are used by civilian and military personnel, especially in military areas, to ensure that necessary precautions are taken in advance to warn against possible terrorist attacks.

Key words:

Robotic vehicle, Android-based smartphone, Bluetooth technology, Arduino Uno, Sensors, Military area

Özet:

Bu raporda, Android cihaz ve sensörler kullanılarak gerçekleştirilen prototip bir robotik aracın özellikleri ve tasarımı sunulmaktadır. Bu çalışma Android tabanlı akıllı telefon ile Bluetooth teknolojisinin etkileşimi ile geliştirilmiştir. Ayrıca bu projede çeşitli sensörler ve robotun beyni olan Arduino Uno kullanılmıştır. Bu projenin amacı, askeri alanda kullanılmak üzere olası terörist ataklarına karşı askeri personeli önceden bilgilendirmektir. Kullanıcı robotik aracı isteğe bağlı olarak kendi akıllı cihazından kontrol edebilir veya robotu otomatik moda alıp aracın kendi yolunu çizmesini sağlayabilir. Araç karşısına çıkan engellerin insan olup olmadığını algılayabilir. Eğer karşılaştığı engel insansa üzerindeki kırmızı led yanacaktır ve

engelden kaçabileceği en kısa mesafeyi hesaplayıp o yöne doğru gidecektir. Eğer karşılaştığı herhangi bir cisim cansız ise engelden kaçabileceği en kısa mesafeyi hesaplayıp o yöne doğru gidecektir. Ayrıca kızılötesi sensörü, engel tanıma sensörü gibi sensörler kullanılarak robot ile çevre arasındaki etkileşim sağlanmış olmaktadır. Aynı zamanda Bluetooth modülü ile Arduino'nun, Android tabanlı telefon ile haberleşmesi sağlanmaktadır. Böylece askeri alan açısından sensörlerin önemi gün geçtikçe artmaktadır. İnsan tespit edebilen sensörler, özellikle de askeri alanlarda sivil ve askeri personel tarafından kullanılarak muhtemel terörist saldırılarına karşı önlem almak için önceden uyarması ile gerekli tedbirlerin alınmasını sağlar.

Anahtar Kelimeler:

Robotik araç, Android tabanlı akıllı telefon, Bluetooth teknolojisi, Arduino Uno, Sensörler, Askeri alan.

1. Introduction

In our daily lives, sensors used in conjunction with electronic devices play a vital role in facilitating life. Today, sensor technology is used in many areas. Examples of areas where sensor technology is used include military space, airports, factories, shopping malls, and hospitals. Today, there are even taps that feel the movement of the hand using the sensor. There are many sensor types such as sound, vibration, transport, electric current, magnetic, radio, distance, speed, thermal, infrared, temperature. Such sensors can provide a much more specific use of the Android platform for users. These areas of use can be very useful for people with disabilities, they can guide them and alert them to possible disabilities. Everyday life can be customized. What's more, the prominence of sensors in military affairs is increasing day by day.

1.1 Problem Statement

Sensors capable of detecting explosives or weapons have vital preventive measures to detect their position, especially in military territories, to prevent terrorists from taking countermeasures against possible terrorist attacks by civilian and military personnel. There is no limit to what needs to be done using sensor technology. The most common areas of use for robotic sensors are different device types, such as Android-based mobile phones, tablet computers, and smart clocks. With these devices, we can send and receive data to and from the sensors. One example of this is to control a robotic tool with an Android smartphone. Thanks to this communication between the devices, we can easily implement our needs. The aim of this project is to inform the military personnel in advance of possible terrorist attacks to use the military field. The user can control the robotics tool from his own intelligent device or take the robot in automatic mode and let the car drive its own way.

This project is aimed at the target, a military person with an Android device who knows how to use this Android device, and who has Bluetooth connectivity, or anyone who can benefit from this project. But our main goal is to detect enemies in the military field. If the project will be successful and military space is used, the enemy will be easily detected by the heat (infrared) and obstacle detection sensor.

1.2 Background or Related Work

Upon our research, we have found, Sharma at all. [2] new generation smartphones include proximity sensors and acceleration sensors included in the Bluetooth module and work with different operating systems such as Android. But in our project, we used sensors such as obstacle recognition sensor, temperature detection sensor. The target group of this project is, someone who has an Android device and knows how to use this Android device and who has a Bluetooth connection can take advantage of this project. But our primary goal is to identify enemies in the military field. If the project is to be successful and military space is to be used, the enemy will be easily detected by the heat (infrared) and obstacle detection sensor. Designed the robot [1] will be controlled by an Android application and connectivity between the robot and smartphone will be based on the Bluetooth technology. Android application can send data to the robot using Bluetooth module which connected to Arduino. Those data will send the data to micro-controller. When sending input from users to the microcontroller, the microcontroller will process the data. After that, the robot can move according to with this output. Android devices have many hardware components, such as orientation sensors, proximity sensors. Sharma at all.[2] new generation smartphones have proximity sensors and acceleration sensors also included Bluetooth module and are powered by different operating systems such as Android. In our research, we have seen that different applications have been made about the Bluetooth controlled robots. If we look at [3], this thesis was written about using Bluetooth technology in Android phones to control the direction of movement of the robot and additionally to adapt robot to move light objects with the aid of the added motor. Robot control is provided with Bluetooth on Android phones. (Figure 1)

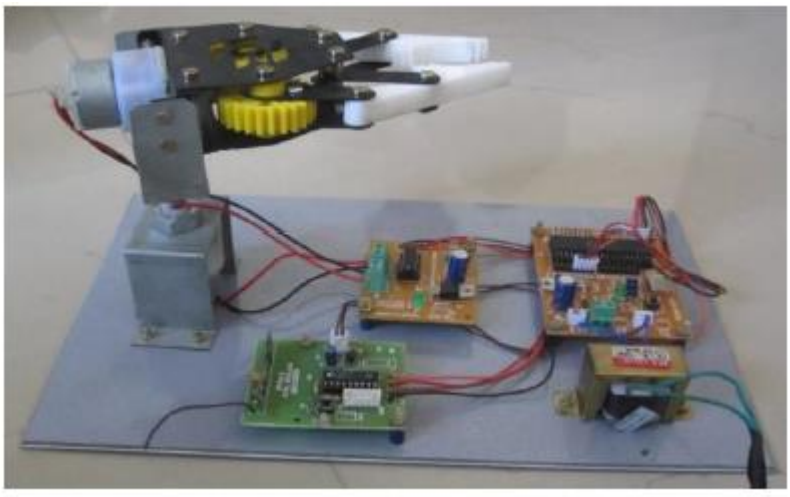

Figure 1. Sruthilaya's Robot

In our project, Robot will understand that the obstacle is alive with the temperature sensor and

will red led turn on. After the turning on, Robot will measure the farthest away from the obstacle and continue on its way. K.Pathak at all.[4]’s system consists of four-part. These are such as:

1)Bluetooth technology

2)Smartphone with the Android operating system,

3)The microprocessor (Arduino Uno R3)

4) DC Motor.

Arduino Uno R3 which used a microprocessor based on ATmega328P is the robot's brain. The Bluetooth is the bridge between the robot and the smartphone. The phone provides remote control of the robot. DC motor makes the system moving. DC motor driver L293D is used here [6]. This motor driver helps attached two DC motors to each other. They also used the HC-06 Bluetooth module to provide connectivity and designed a tiny car as a robot. In addition to this, some theses have been used in extra parts. Loic Frund [7], he used the proximity sensor, the ground sensor while developing a robot. And also used, microphone, speaker, and GPS. Another thesis Muhammed Jabir.N.K at all.[8], they used a soft catch to remove light boxes and also this thesis [9] used the soft catch arm to remove light boxes.

1.3 Solution Statement

In this section, we will share our solutions to the problems that are mentioned in the section of Problem Statement.

The purpose of our project is to use for the military field to inform the military personnel in advance of possible terrorist attacks. The user must first install the Android application on the Android-based phone. After installing the application, it can begin to use the application without any system registry. Once the user has entered the application, the robot should check to see if it is open. If it is not open, the robot should activate the robot with the on / off button. The user should also check that the Bluetooth connection is active on the device at the same time. If the robot is open and the user has turned on the application, then the interaction between the application and the robot is initiated via the Bluetooth connection. The user can control the robotics basic movements (move forward, backward, right, left) from his/her own intelligent device or take the robot in automatic mode and let the car drive its own way. The robotic vehicle can detect whether the obstacles facing the vehicle are human or not. If the obstacle is a living entity, as for that is the human, the red led on the robot lights up and it will calculate the shortest

distance it can avoid and will proceed in that direction. If any object we are comparing is inanimate, it will calculate the shortest distance it can avoid and will proceed in that direction. Arduino Uno is used as the brain of the robotic vehicle. In addition, by using sensors such as infrared sensor, obstacle recognition sensor, the interaction between the robot and the environment is ensured. At the same time, the Bluetooth module allows Arduino to communicate with the Android-based phone.

This is a prototype of a robot that can be used to detect a terrorist in the military field. This robot will deliver much better results using more robust and sophisticated materials.

1.4 Motivation

We are senior students interested in Robotics in Computer Engineering department. As a group, we have taken courses in Microprocessors. In this project, the microprocessor and the application communicate with each other. We use the Java language for the application. We use C language for the microprocessor. In this way, we communicate between the two languages and between the microprocessor and the application.

2. Literature Search

This is a Literature Review for creating Robotics vehicle with the help of Sensors with using the Android platform. Robotics vehicle programming was presented in this research by "Sensor Programming with using the Android Platform". This robotics vehicle was developed by using Bluetooth technology with Android devices. There is a growing literature on sensors used for robotic technology on Android platforms. The Android platform is an open source, Linux-based operating system purchased by Google from Android Inc., 2005 for smartphones and mobile devices. Android devices have many hardware components such as temperature sensors, proximity sensors, obstacle recognition sensors, and buzzers. It also consists of software components, such as applications, whose operating system is Android and which allows the robot to communicate with the Android phone via Bluetooth Technology. In this way, it becomes more powerful to control the robot with smart devices. Depending on the needs, sensors with a large number of hardware components have become useful for robot control when used. The purpose of our project is to control basic robotics movements using the communication between the Android application and the sensors. In addition, with the robot's automatic mode, the robot controls itself, identifies the obstacles in front, measures the distance between the obstacle and itself, and directs it to the farthest distance.

2.1 Robotic Sensors

The most common areas of use for robotic sensors are different device types, such as Android-based mobile phones, tablets, and smart clocks. With these devices, we can send and receive data to the sensors. An example of this is to control a robot with an Android smartphone. With this communication between the devices, we can easily implement our needs. The user can use any button on the mobile device or say some words to other smart devices such as robots, clocks or some applications. Too many Sensor types are available. Sharma at all. [2] new generation smartphones include proximity sensors and acceleration sensors included in the Bluetooth module and work with different operating systems such as Android. But in our project, we used sensors such as obstacle recognition sensor, temperature detection sensor. The target group of this project is, someone who has an Android device and knows how to use this Android device and who has a Bluetooth connection can take advantage of this project. But our primary goal is to identify enemies in the military field. If the project is to be successful and military space is to be used, the enemy will be easily detected by the heat (infrared) and obstacle detection sensor.

2.2 How Is Robotic Sensor work?

Designed the robot [1] will be controlled by an Android application and connectivity between the robot and smartphone will be based on the Bluetooth technology. Android application can send data to the robot using Bluetooth module which connected to Arduino. Those data will send the data to micro-controller. When sending input from users to the microcontroller, the microcontroller will process the data. After that, the robot can move according to with this output. Android devices have many hardware components, such as orientation sensors, proximity sensors. Sharma at all.[2] new generation smartphones have proximity sensors and acceleration sensors also included Bluetooth module and are powered by different operating systems such as Android. In our research, we have seen that different applications have been made about the Bluetooth controlled robots. If we look at [3], this thesis was written about using Bluetooth technology in Android phones to control the direction of movement of the robot and additionally to adapt robot to move light objects with the aid of the added motor. In our project, Robot will understand that the obstacle is alive with the temperature sensor and will red led turn on. After the turning on, Robot will measure the farthest away from the obstacle and continue on its way.

2.3 Parts and Properties of Robotic Sensor Elements

K.Pathak at all.[4] 's system consists of four-part. These are such as:

1)Bluetooth technology

2)Smartphone with the Android operating system,

3)The microprocessor (Arduino Uno R3)

4) DC Motor.

Arduino Uno R3 which used a microprocessor based on ATmega328P is the robot's brain. Bluetooth is the bridge between the robot and the smartphone. The phone provides remote control of the robot. The DC motor makes the system moving. DC motor driver L293D is used here [6]. This motor driver helps attached two DC motors to each other. They also used the HC-06 Bluetooth module to provide connectivity and designed a tiny car as a robot. In addition to this, some theses have been used in extra parts. Loic Frund [7], he used the proximity sensor, the ground sensor while developing a robot. And also used, microphone, speaker, and GPS. Another thesis Muhammed Jabir.N.K at all.[8], they used a soft catch to remove light boxes and also this thesis [9] used the soft catch arm to remove light boxes.

In addition to these, we used

- A sensor that detects an obstacle
- Temperature sensor
- Red led
- 9V battery
- Ultrasonic Sensor
- Motor Shield
- Servo-motor

2.4 Programming Language

Now let's see what programming languages are used. Jan Nadvornik at all.[10] used Java, Eclipse for Android phone application. Another thesis [11], they used Integrated Development Environment (IDE) is used for Arduino Uno's comments and messages. Also, they used Java Development Kit(JDK) for Java application and Java language and used Eclipse for writing Java codes. We used Embedded C, C ++ to code Arduino Uno, in our Project.

2.5 Usage Areas

Saurabh Khoje [1] Robots can be programmed for many different types of calculation which is very important and useful machines for use in industries, fabrication, manufacturing defect, and health industries. Robots can make faster and more accurate calculations when compared to humans. Nowadays Robotic systems are becoming more and more developed because of people needs. We designed this project to use against the military-terrorist threat.

3. Summary

As a result, this project works like Khoje, S. [1] 's project to create a robotic device that can be controlled via Bluetooth on Bluetooth. But the purpose of our project is to facilitate the detection of terrorist terrorists in the field. For this project, we can add more features like Wi-Fi connectivity, robotic arms, camera and different sensor types. Speed sensor, temperature sensor, PIR sensor, ultrasonic sensor, etc. There is no limit to what can be done using any type of sensor.

4. Software Requirements Specification

4.1 Introduction

4.1.1 Purpose

The purpose of this document is describing the project which is called Sensor Programming with Using The Android Platform. Our goal in this project is to create a robot prototype that recognizes the obstacles and to minimize the loss of life against terrorist attacks in the military area with this robot prototype. This document includes detailed information about requirements of the project. It reflects the identified constraints and proposed software functionalities. Moreover, the SRS document explains how the user interacts with the project.

4.1.2 Scope of Project

In our daily lives, sensors used in conjunction with electronic devices play a vital role in facilitating life. There is no limit to what needs to be done with using sensor technology. Today, sensor technology is used in many areas. Examples of areas where sensor technology is used include military area, airports, factories, shopping malls, and hospitals. Today, there are even taps that feel the movement of the hand using the sensor.

There are many sensor types such as sound, vibration, transport, electric current, magnetic, radio, distance, speed, thermal, infrared, temperature. These types of sensors can create a much more specific use of the Android platform for users.

These sensors are most commonly used devices, such as Android-based mobile phones, tablets, smart clocks. With these devices, we can send data to sensors and easily receive data. An example of this is to control a robot with an Android smartphone. Through this communication between the devices, we can easily implement our needs We have more than one option to communicate between devices. You can use any button on the mobile device, or you can say some words (voice commands) to other smart devices, such as a robot, clock, or some applications, or alert you to an obstacle when you see an obstacle.

These areas of use can be particularly suitable for people with disabilities, can guide them, and can alert them to obstacles to be met. It can be adapted to everyday life. What's more, the prominence of sensors in military affairs is increasing day by day.

Sensors capable of detecting explosives or weapons have vital preventive measures to detect the location of terrorists, especially in military areas, to take countermeasures against possible

terrorist attacks by civilian and military personnel.

On the other hand, the sensor technology is being sold at a reasonable price as its use becomes more widespread over the years when it was first produced. This cost is cheap and easily accessible, especially in the Chinese market.

The goal of our project is to control basic robotics movements using the communication between the Android application and the sensors. In addition, with the robot's automatic mode, the robot controls itself, identifies the obstacles in front, measures the distance between the obstacle and itself, and directs it to the farthest distance. Through this excitement, they will be able to perceive and warn terrorists who have lain in ambush. The loss of life on this count will be the least. In addition, this robot will deliver much more reliable results using robust and sophisticated materials.

We have two kinds of control mechanisms. The first is that the user can control the robot with the Android device and the second one can control itself with the Auto mode.

There is only one player in the first mode. This player can be a user (Soldier) who installs the app on the Android device. This user can perform basic movements of the robot through the application. The user will be able to use the Android device to control basic movements like left, right, forward and backward movement. The robot that moves, recognizes whether there is an obstacle due to the obstacle recognition sensor. If there is an obstacle, the temperature sensor is activated to determine whether the obstacle is human by looking at body temperature. If the obstacle is the human, the sensor will stimulate.

The second mode, the robot's automatic mode, the robot controls itself, identifies the obstacles in front, measures the distance between the obstacle and itself, and directs it to the farthest distance.

4.1.3 Glossary

Table 1 Glossary of SRS

Term	Definition
User	A military person with an Android device who knows how to use this Android device, and who has Bluetooth connectivity, or anyone who can benefit from this project.
Arduino Uno	The Arduino Uno is the robot's brain [1].
DC Motor	The DC motor makes the system moving.
HC-06 Bluetooth Module	The HC-06 Bluetooth module to provide connectivity and designed a tiny car as a robot.
Android Devices	The Android devices provide remote control of the robot.
Software Requirements Specification	A document that completely describes all of the functions of a proposed system and the constraints under which it must operate. For example, this document.
Ultrasonic Sensor	Ultrasonic sensors are sensors that emit ultrasonic sound waves and can determine the distance between them by calculating the time it takes for them to strike the obstacles.
Motor Shield	The Motor Shield controls the speed and direction of the motor.

4.1.4 References

[1] Verma, S, Android App Controlled the Bluetooth Robot, Internal Journal of Computer Applications, vol 152, no 9, p.35- 40

4.1.5 Overview of Document

The second part of the document describes functionalities of the sensor programming with using the Android platform. Informal requirements are described and it is a context for technical requirement specification in the Requirement Specification chapter. Requirement Specification chapter is written for software developers and details of the functionality of the application are described in technical terms.

4.2 Overall Description

4.2.1 Product Perspective

Sensor programming using the Android platform is a system that allows the user to control the robot in real time with the Bluetooth module. Thanks to the exchange of data, the robot informs the user that the obstacle is due to the ultrasonic sensor and the infrared and thermal sensor. At this point, data exchange takes place between the user and the robot.

4.2.2 Development Methodology

While developing the project, we planned to use the Scrum of the Agile software development methodology. A brief description of Scrum is the application development method in software engineering. The basic feature of this development method depends on the observer, the developer, and the repetition. The product owner is the person who gives the products quests, the scrum manager who manages the development team, and a development team is a group of developers working on the program according to the program. The development team has a daily meeting every morning which should be maximum 15 minutes. First, the development and problems of the project are kept on a daily basis and the development of the project is monitored by everyone. At the next stage, product functions are delivered to the customer at regular intervals and evaluated by the customer. And finally, product requirements are not determined at the same time, they are evaluated repeatedly, and adaptations and adjustments are made according to the situation. The aim is to produce the desired product quickly, cheaply and in good quality. Scrum's period of time which could be 30 days on average. The actions requested by the user are developed and re-glanced over a period of two or four weeks called "Sprint" (figure 2). These sprints are based on the requirements of the user. At the end of each Sprint, the functional part of the software is gone and the customer is available for delivery (presented to the customer for validation).

Figure 2. All sprints on the Scrum Board

Scrum is a method for experiencing agile software development principles. For this reason, the scrum board consists of six phases. These are such as (figure 3):

1) ("Project Needs") are all processes.

2) ("ToDo") priority.

3) ("During Progress") there are tasks created.

4) ("Review") is shown through the eyes.

5) ("To Deploy") contains the modules that are ready.

6) ("Done") indicates processes that are running successfully.

Members of the software team will give you a brief overview of what tasks you are working on in Scrum the day before and what your tasks are about to finish. Tasks that will not finish in a day are marked with a red dot. Thus, the obstacle to be encountered is easily detected and resumed from where it left off. The advantages of Scrum is included working with specialists in with small size group, playing an important role in communication, facilitating information sharing with day-

to-day meetings, self-organization, and self-planning [1]. It also focuses on the consistency of stages and the duration of the order with software development process models to improve the intended software product within time and cost estimates [2].

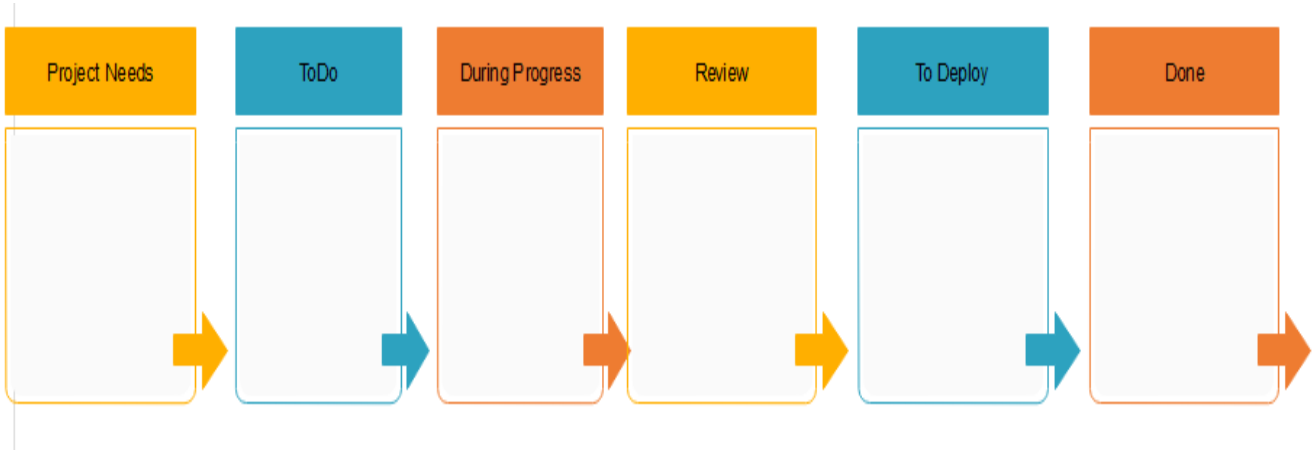

Figure 3. Scrum Board with task

The Gantt Chart is simply referred to as a business plan chart. This chart determines which job is to be done and when. The Gantt Chart is an application that is very useful in project management processes. With the Gantt chart, the work to be done in a project is divided into sub-sections to determine what work will take and how long it will take.

The project manager uses the Gantt chart to monitor and assess the work of the project. Job titles, durations, and dependencies are determined on the chart (Figure 4).

What works in a project is written once, or sometimes it is kept in mind, and when things start to blend in the project, and when the time is constrained, it may not be clear what time it will work and how long it will work. In summary, with this application, work, personnel and time can be done in the project.

Figure 4. Gantt Chart

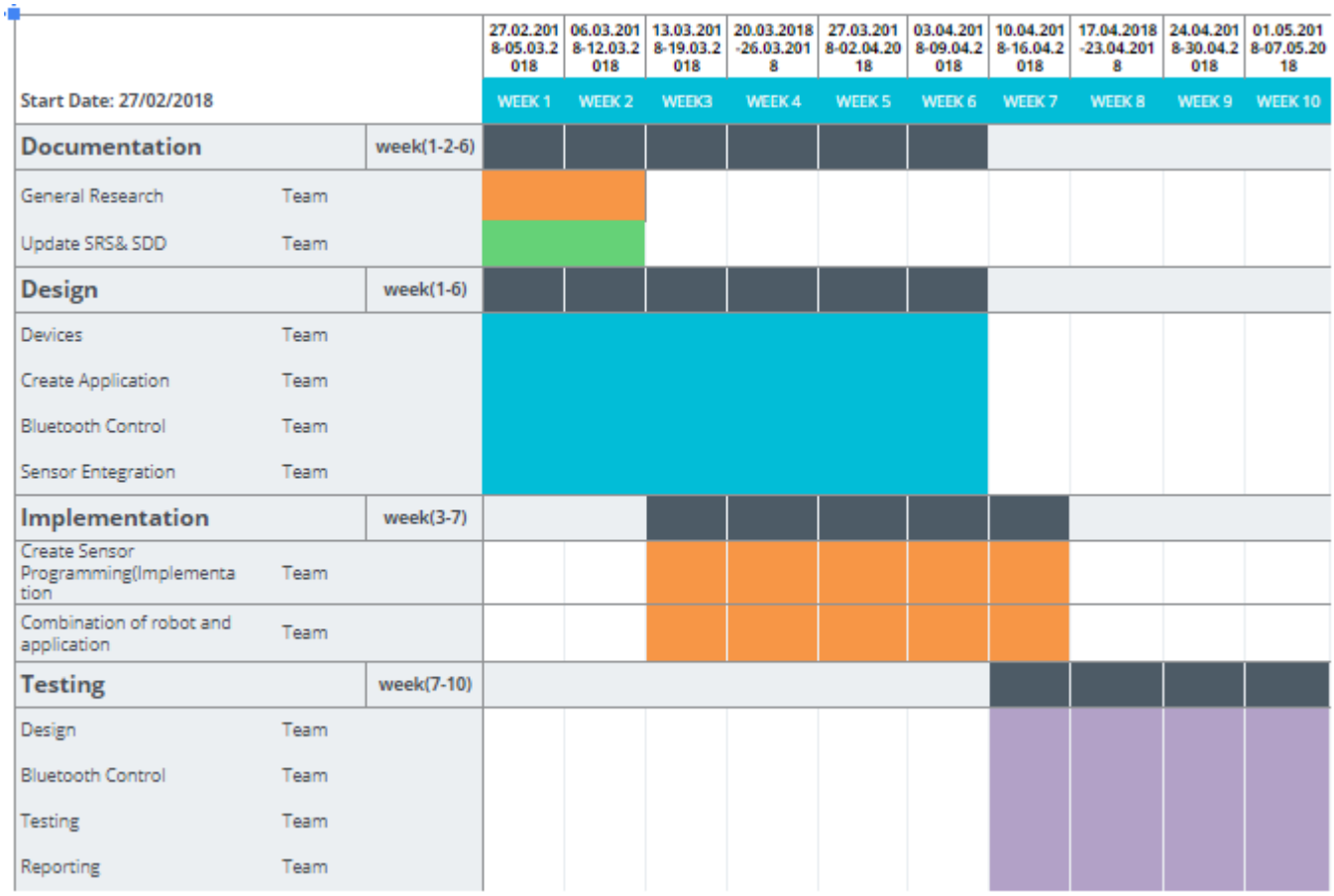

Figure 5. Project Plan

4.2.3 User Characteristics

4.2.3.1 Participant

A military person with an Android device who knows how to use this Android device, and who has Bluetooth connectivity, or anyone who can benefit from this project.

4.3 Requirements Specification

4.3.1 External Interface Requirements

4.3.1.1 User interfaces

The user interface will be worked on Android platform. With the Android Platform, the user can make basic movements of the robot or take the robot in auto mode.

4.3.1.2 Hardware interfaces

The project requires Android device. The Android device requires necessary drivers installed on the Android platform. Also, it requires Bluetooth connection. The robot requires two DC Motors, obstacle recognition sensor, a thermal sensor, Arduino Uno, Bluetooth module, Motor Shield, 9V Battery, servo motor, ultrasonic sensor, red led.

4.3.1.3 Software interfaces

There is software interface for the Android phone application. In this application, there will be left, right, go, back buttons and their interfaces.

To interact with Arduino's sensors, we also encoded the Arduino IDE in Embedded C language.

4.3.1.4 Communications interfaces

As a communication interface, there is a Bluetooth module that exchanges data between the robot and the Android device. In addition, the obstacle detection sensor and the temperature sensor enable the determination of the obstacles to be encountered.

4.3.2 Functional Requirements

4.3.2.1 Profile Management Use Case

Use Case:

- Install Application
- Activate Bluetooth Connection
- Start
- Exit

Diagram:

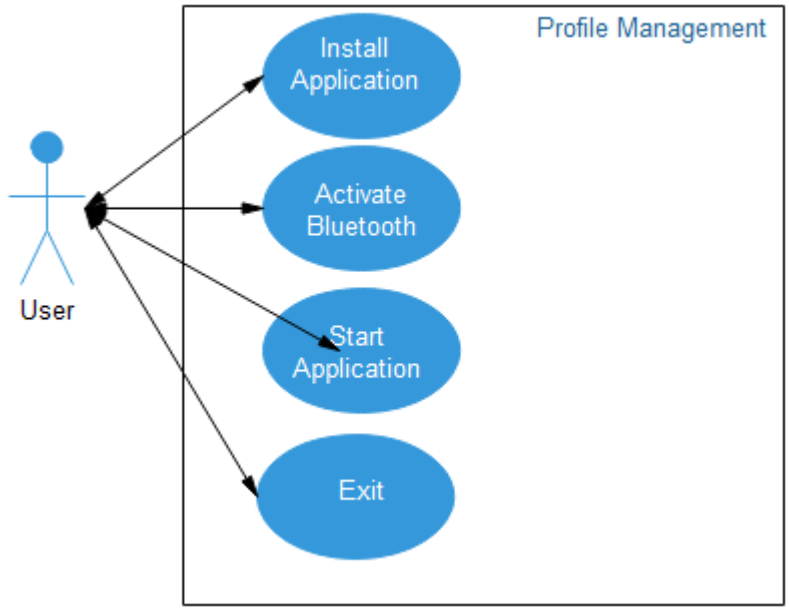

Figure 6. Profile Management Use Case

Brief Description:

Figure 6. shows profile management use case for user diagram. The user must install the application. The user must activate the Bluetooth connection after installing the application. Once the Bluetooth connection is activated, the user can start the application. After the application starts, the user may exit the application depending on the user's request.

4.3.2.2 Options Menu Use Case

Use Case:

- Left
- Right
- Go
- Back
- Automatic Mode

Diagram:

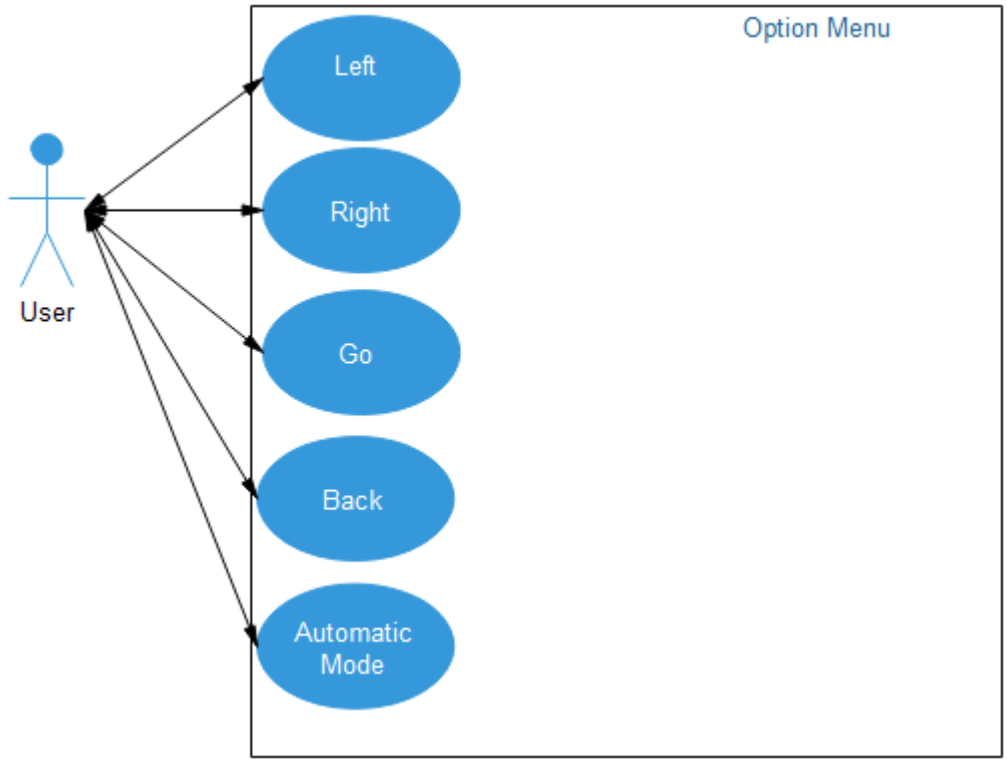

Figure 7. Option Menu Use Case

Brief Description:

Figure 7. shows option menu use case for user diagram. When the user entered the application, the user can display the controls menu then the user can control the robot by using this application. A user can execute functions of move right, move left, go and back. And also, select the automatic mode for automatic control.

Initial Step-By-Step Description:

1. The user can start an application without login.
2. If the user selects go button, the robot moves ahead
3. If the user selects back button, the robot moves back.
4. If the user selects the left button, the robot moves left.
5. If the user selects the right button, the robot moves right.
6. If the user selects the automatic mode button, the robot moves automatically.

4.3.2.3 Communication Use Case

Use Case:

- User
- Android Device
- Bluetooth Connection
- Arduino Uno
- DC Motor

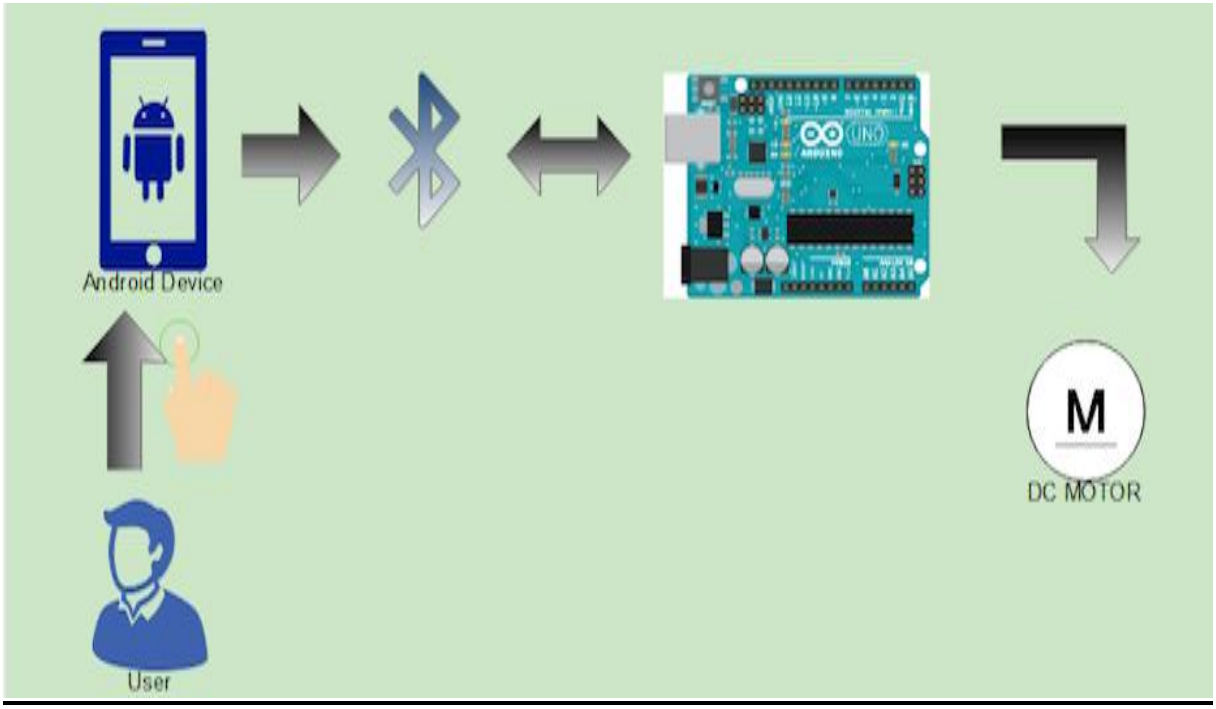

Figure 8. Communication Use Case

Brief Description:

Figure 8. refers to the interaction between the phone and Arduino when the user activates Bluetooth connectivity with the Android Phone.

4.3.3 Performance Requirements

Minimum requirements for running application are:

1. Device: Android Devices
2. Operating system: Android (version 3.0 or higher)
3. Bluetooth Connection
4. RAM: 4 GB
5. GPU: Mali-T760 MP8
6. 13 MB free area

4.3.4 Software system attributes

4.3.4.1 Portability

- The application can design for Android platform.
- Robotic Device is designed for Samsung Galaxy Note 5. But it can also work on any Android device.

4.3.4.2 Performance

- There will be no problem in terms of performance because the application is a simple application.
- The user should be as close as possible to the device because of Bluetooth is limited connection area.

4.3.4.3 Usability

- When the Bluetooth connection fails, an error message, which explains the reason that why the Bluetooth lose connection should be displayed.

4.3.4.4 Adaptability

- Since no data is acquired and saved from the runtime, there is no adaptability requirement.

4.3.4.5 Scalability

- Since only one user uses the system at a time, there is no scalability requirement.

4.3.5 Safety Requirement

- Bluetooth requires at most 10 meters square area. There may be an obstacle in the working environment. The robot recognizes these obstacles 10 cm in advance using the sensor. If the robots crash the obstacles, the robot may be damaged.
- As a result of excessive use, the eyes of the user may be deteriorated and the user may be exposed to radiation.

5. Software Design Description

5.1 Introduction

5.1.1 Purpose

The purpose of this Software Design Document (SDD) is to present the details of the project entitled "Sensor programming using the Android platform".

The target group of this project is, someone who has an Android device and knows how to use this Android device and who has a Bluetooth connection can take advantage of this project. The aim of this project is to use for the military field to inform the military personnel in advance of possible terrorist attacks. The user can control the robotics movements from his/her own intelligent device or take the robot in automatic mode and let the car drive its own way. The robotic vehicle can detect whether the obstacles facing the vehicle are human or not. If the obstacle is a living entity, as for that is the human, the red led on the robot lights up and it will calculate the shortest distance it can avoid and will proceed in that direction. If any object we are comparing is inanimate, it will calculate the shortest distance it can avoid and will proceed in that direction.

The goal of our project is to control basic robotics movements using the communication between the Android application and the sensors. In addition, with the robot's automatic mode, the robot controls itself, identifies the obstacles in front, measures the distance between the obstacle and itself, and directs it to the farthest distance. Through this excitement, they will be able to perceive and warn terrorists who have lain in ambush. The loss of life on this count will be the least. In addition, this robot will deliver much more reliable results using robust and sophisticated materials.

We have two kinds of control mechanisms. The first is that the user can control the robot with the Android device and the second one can control itself with the Auto mode.

There is only one player in the first mode. This player can be a user (Soldier) who installs the app on the Android device. This user can perform basic movements of the robot through the application. The user will be able to use the Android device to control basic movements like left, right, forward and backward movement. The robot that moves, recognizes whether there is an obstacle due to the obstacle recognition sensor. If there is an obstacle, the temperature sensor is activated to determine whether the obstacle is human by looking at body temperature. If the obstacle is the human, the sensor will stimulate.

The second mode, the robot's automatic mode, the robot controls itself, identifies the obstacles in front, measures the distance between the obstacle and itself, and directs it to the farthest distance.

This is a prototype of a robot that can be used to detect a terrorist in the military field. This robot will deliver much better results using more robust and sophisticated materials.

To provide a better understanding, this SDD includes various diagrams such as UML diagram, activity diagram.

5.1.2 Scope

This document contains a complete description of the design of Sensor programming with using Android devices.

The Android platform, which has a Linux-based operating system, is being developed by communities such as Google and the Open Handset Alliance.It is an operating system which is low cost and open source code. Originally used for tablets and smartphones, today's applications are developing and are almost using everywhere in our lives.

The Android operating system consists of 4 layers. [1] (figure 8)

1- Linux Kernel
2- Libraries & Android Runtime
3- Application Framework
4- Applications

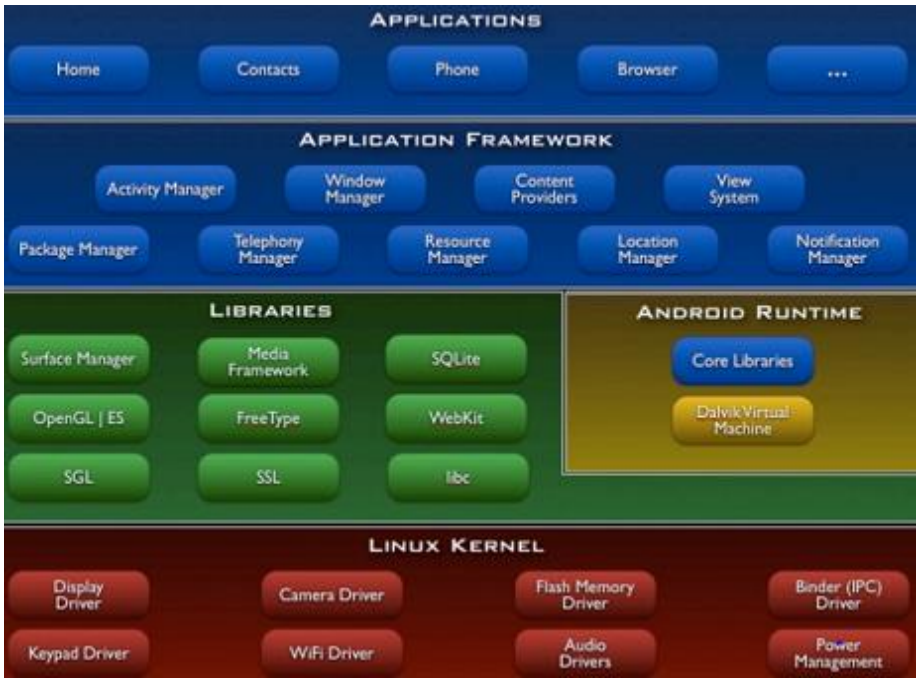

Figure 9. Android Layers

As we can see in Figure 9, the Kernel is the first layer of the Android operating system which is used for memory management, process management, and networking. The second layer is Libraries and Runtime which includes all libraries on the Android operating system are written in C and C ++. It is invoked via java interface. This layer works with the Dalvik virtual machine. This also serves as a kind of translator between the application and the operating system. The third layer is application framework which is used to determine the structure of an application for the Android operating system. The fourth and last layer is Applications which provides interaction between applications written in Java and users.

We decided to implement our sensor application on the Android platform. We decided to use the Java language while developing an app for the Android device. And we will use the Eclipse program for this Java language.

Microprocessors are small computers which are programmed using various languages such as C / C ++, assembly, and run only one program. They have their own RAM memory and program memory, which is normally too small. The microprocessor is the robot's brain [2]. Two of the most popular microprocessors on the market which are Raspberry Pi and Arduino UNO. Arduino is an open source hardware and software platform that uses Atmel 8,16 or 32-bit AVR microcontrollers. The most popular Arduino is the Arduino UNO. Arduino is an open source hardware and software platform that uses Atmel 8,16 or 32-bit AVR microcontrollers. The most popular Arduino card is the Arduino UNO model. It can be easily

programmed with Arduino libraries. It can detect signals by receiving analog and digital signals. Using signals from sensors, it helps to design robots and systems that interact with the environment. In this way, actions specific to the project, such as sound, light can create reactions. Raspberry Pi is a low-priced computer. It has the ability to work as a fully functioning computer, requiring fewer peripherals. Usually used with Linux operating systems.

We decided to use Arduino UNO (Figure 10) in our project. Because it is cheaper than Raspberry PI and we are at the beginning level, it will be easier for us. We decided to code Arduino UNO with the C language. The program we will code Arduino is a special coding program for Arduino.

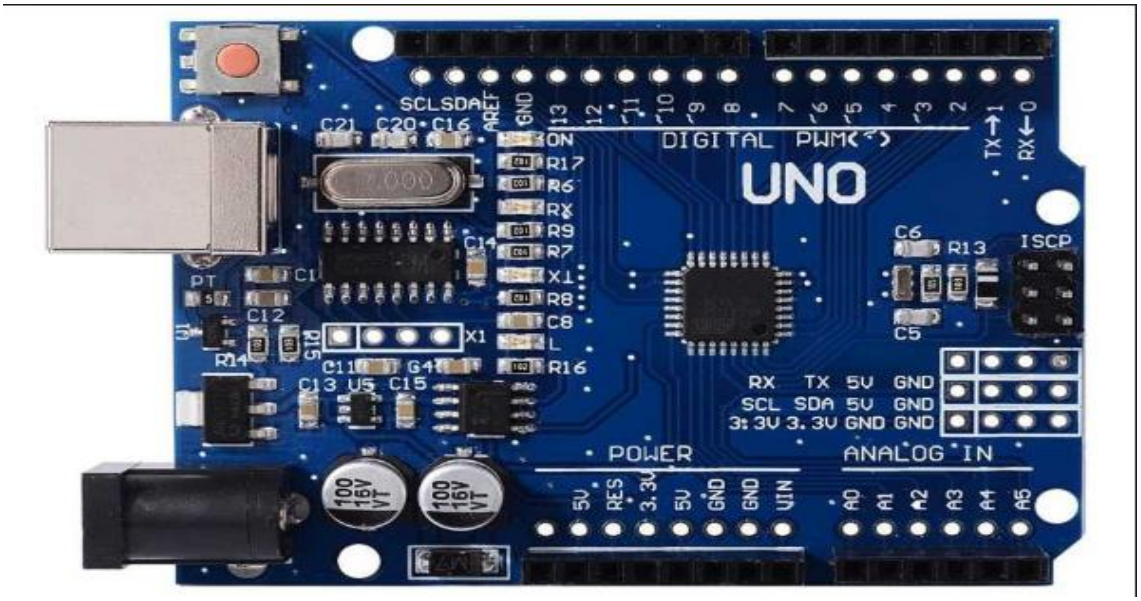

Figure 10. Arduino Uno

We also used ultrasonic sensor (obstacle recognition sensor) as shown in figure 11. Its working mechanism is an input source that calculates the distance to the object by using the ultrasonic sensor sonar (Sound Navigation and Ranging). The system we call "sonar" allows us to obtain the dimension of the distance by using sound waves. (figure 12)

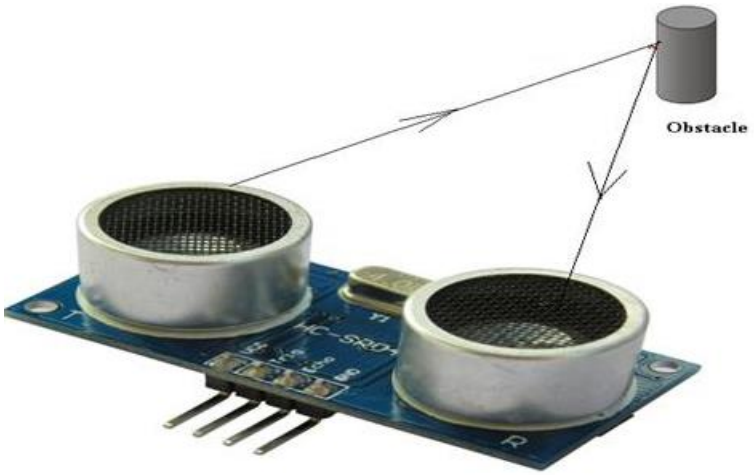

Figure 11. Ultrasonic Sensor

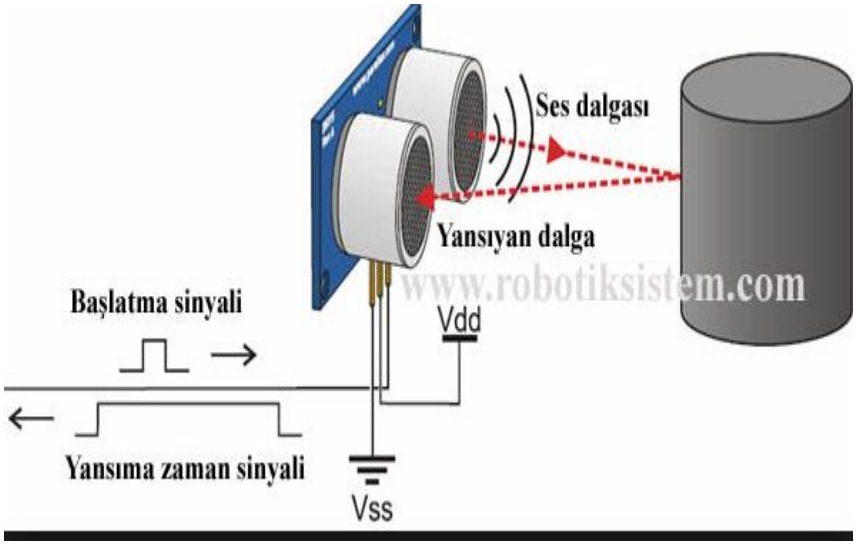

Figure 12.Working principle of Ultrasonic sensor

In our daily lives, sensors used in conjunction with electronic devices play a vital role in facilitating life. There is no limit to what needs to be done with using sensor technology. Today, sensor technology is used in many areas. Examples of areas where sensor technology is used include military area, airports, factories, shopping malls, and hospitals. Today, there are even taps that feel the movement of the hand using the sensor.

There are many sensor types such as sound, vibration, transport, electric current, magnetic, radio, distance, speed, thermal, infrared, temperature. These types of sensors can create a much more specific use of the Android platform for users.

These sensors are most commonly used devices, such as Android-based mobile phones, tablets, smart clocks. With these devices, we can send data to sensors and easily receive data. An example of this is to control a robot with an Android smartphone. Through this communication between the devices, we can easily implement our needs We have more than one option to communicate between devices. You can use any button on the mobile device, or you can say some words (voice commands) to other smart devices, such as a robot, clock, or some applications, or alert you to an obstacle when you see an obstacle.

These areas of use can be particularly suitable for people with disabilities, can guide them, and can alert them to obstacles to be met. It can be adapted to everyday life. What's more, the prominence of sensors in military affairs is increasing day by day.

Sensors capable of detecting explosives or weapons have vital preventive measures to detect the location of terrorists, especially in military areas, to take countermeasures against possible terrorist attacks by civilian and military personnel.

On the other hand, the sensor technology is being sold at a reasonable price as its use becomes more widespread over the years when it was first produced. This cost is cheap and easily accessible, especially in the Chinese market.

The goal of our project is to control basic robotics movements using the communication between the Android application and the sensors. In addition, with the robot's automatic mode, the robot controls itself, identifies the obstacles in front, measures the distance between the obstacle and itself, and directs it to the farthest distance. Through this excitement, they will be able to perceive and warn terrorists who have lain in ambush. The loss of life on this count will be the least. In addition, this robot will deliver much more reliable results using robust and sophisticated materials.

We have two kinds of control mechanisms. The first is that the user can control the robot with the Android device and the second one can control itself with the Auto mode.

There is only one player in the first mode. This player can be a user (Soldier) who installs the app on the Android device. This user can perform basic movements of the robot through the application. The user will be able to use the Android device to control basic movements like left, right, forward and backward movement. The robot that moves, recognizes whether there is an obstacle due to the obstacle recognition sensor. If there is an obstacle, the temperature sensor is activated to determine whether the obstacle is human by looking at body temperature. If the obstacle is the human, the sensor will stimulate.

The second mode, the robot's automatic mode, the robot controls itself, identifies the obstacles in front, measures the distance between the obstacle and itself, and directs it to the farthest distance.

5.1.3 Glossary

Table 2 Glossary of SDD

Term	Definition
Block Diagram	The type of schema which the components in the system are displayed in blocks.
User	The user who interacts with the application. Anyone with an Android phone can use this application.
DC Motor	The DC motor makes the system moving
Android Devices	The Android devices provide remote control of the robot.
Motor Shield	The Motor Shield controls the speed and direction of the motor.
SDD	Software Design Document
UML Diagram	It is a modeling language which is used in Software Engineering.

5.1.4 Overview of document

The remaining chapters and their contents are listed below.

Section 2 is the Architectural Design which describes the project development phase. Also, it contains a class diagram of the system and architecture design of the Robot's which describes the user, pre-conditions, and post-conditions. Additionally, this section includes activity diagram of sensor programming.

Section 3 is Use Case Realization. In this section, a block diagram of the system, which is designed according to use cases in SRS document, is displayed and explained and explained prototype how it was used.

5.2 Class diagram

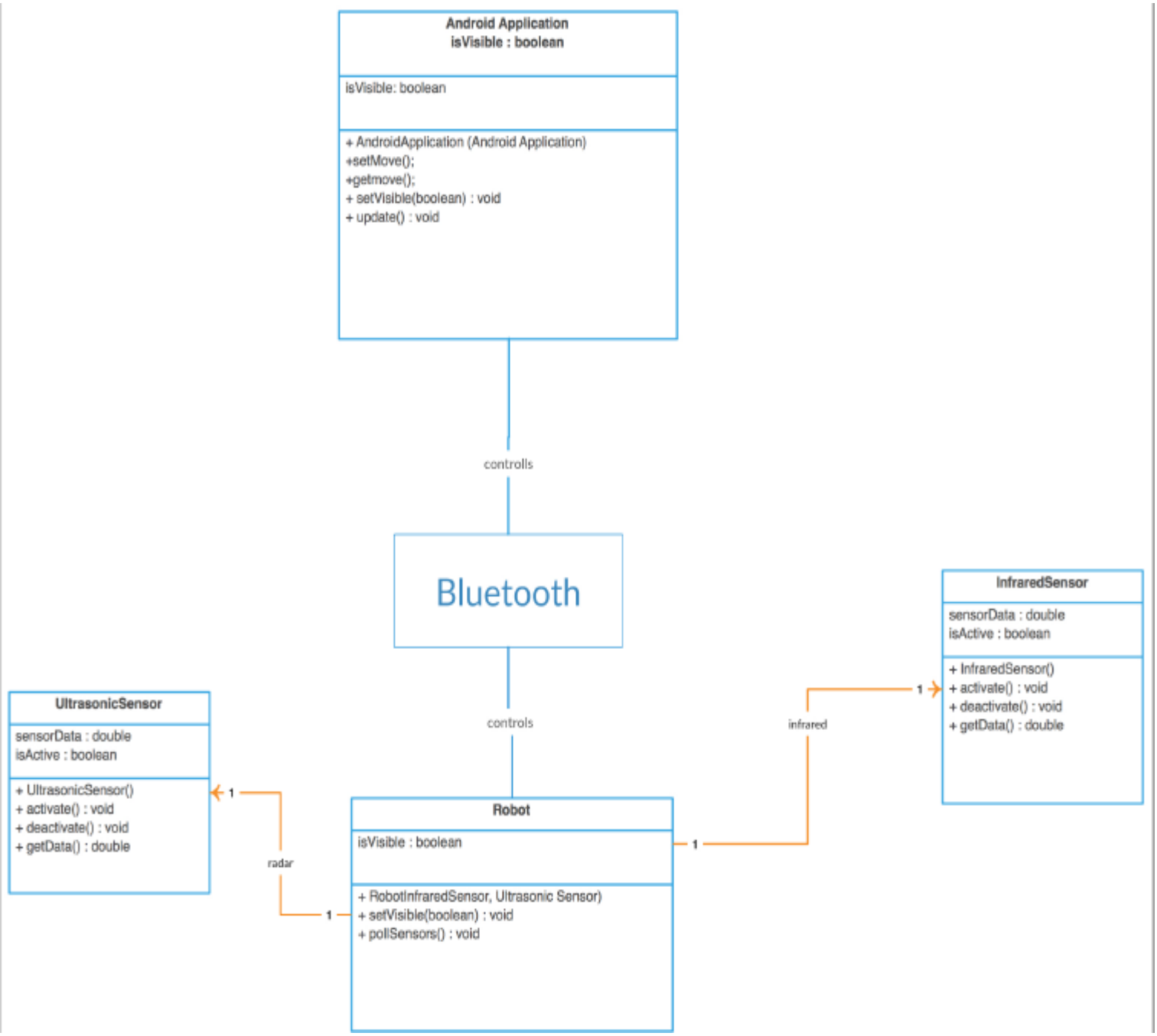

Figure 13. Class Diagram

Figure 13. displays information about connections between the systems within the project.

Robot Class is the main system, which contains other systems. It is responsible for connections between other systems such as Android Application, Ultrasonic Sensor, and

Infrared Sensor. Android Application class represents user control the Robot's movement methods such as go, back, turn left and turn right. Ultrasonic Sensor class is the part where the robot recognizes the obstacles. Infrared Sensor class detects the temperature of the obstacle detected by the ultrasonic sensor.

5.3 Architecture design

5.3.1 Profile Management

Summary: This system is used by the user. The user can install the application. Then User must start the application. Connect Bluetooth connection. The user can exit in the program.

Actor: User

Precondition: User must install the program.

Basic Sequence:

1. User shall install the application.

2. User shall Bluetooth connection on.

3. The user can exit from the system by selecting exit button.

Exception: None

Post Conditions: None

Priority: Low

5.3.2 Option Menu

Summary: This system is used by the user. The user controls the movements of the robot's basic movements such as turning left and turning right and going ahead and back. And also, the user can select automatic mode. The user can exit from the system.

Actor: User

Precondition: User must run the program.

Basic Sequence:

1. The user can start an application without login.
2. If the user selects go button, the robot moves ahead
    1. If the user selects back button, the robot moves back.

2. If the user selects the left button, the robot moves left.
3. If the user selects the right button, the robot moves right.
4. If the user selects the automatic mode button, the robot moves automatically.

Exception: Bluetooth connection can be failed.

Post Conditions: Bluetooth must be connected to the device.

Priority: High

5.3.3 Activity Diagram

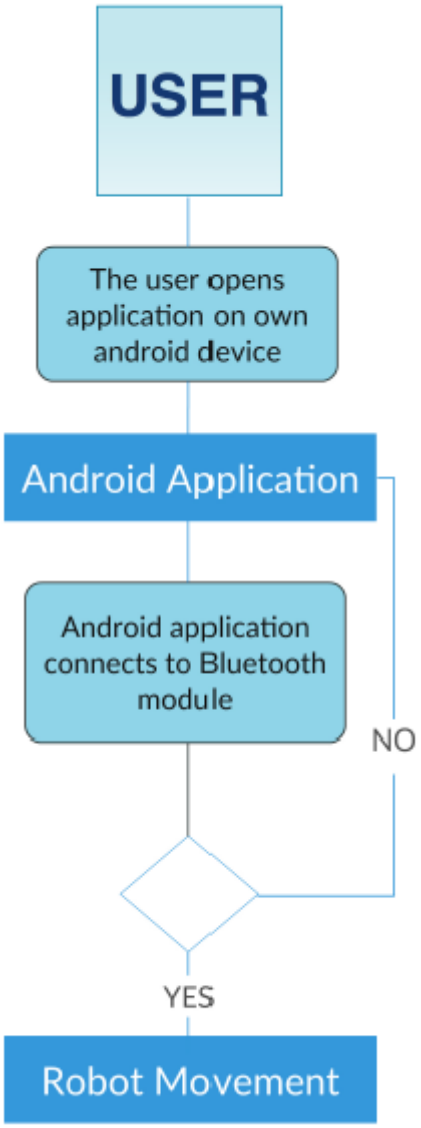

Figure 14. Activity Diagram

Figure 14. shows how the Sensor programming works as an activity diagram. As a first step, the user will open the Bluetooth connection on the Android device. The user will launch the Android application which is installed. If the Bluetooth connection is not turned on and the application is started, the user will exit the application and return to the first stage. If the Bluetooth connection is on, the user will start using the movement keys to move the robot. In this way, the user can control the movement of the robot.

5.4 Use case realizations

5.4.1 Profile Management Use Case

Use Case:

- Install Application
- Activate Bluetooth Connection
- Start
- Exit

Diagram:

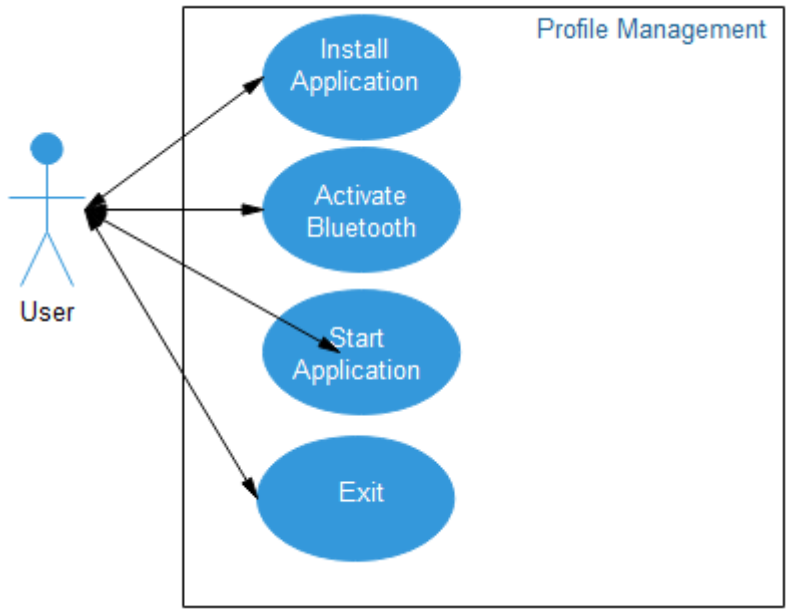

Figure 15. Profile Management Use Case

Brief Description:

Figure 15. shows profile management use case for user diagram. The user must install the application. The user must activate the Bluetooth connection after installing the application. Once the Bluetooth connection is activated, the user can start the application. After the application starts, the user may exit the application depending on the user's request.

5.4.2 Options Menu Use Case

Use Case:

- Left
- Right
- Go
- Back
- Automatic Mode

Diagram:

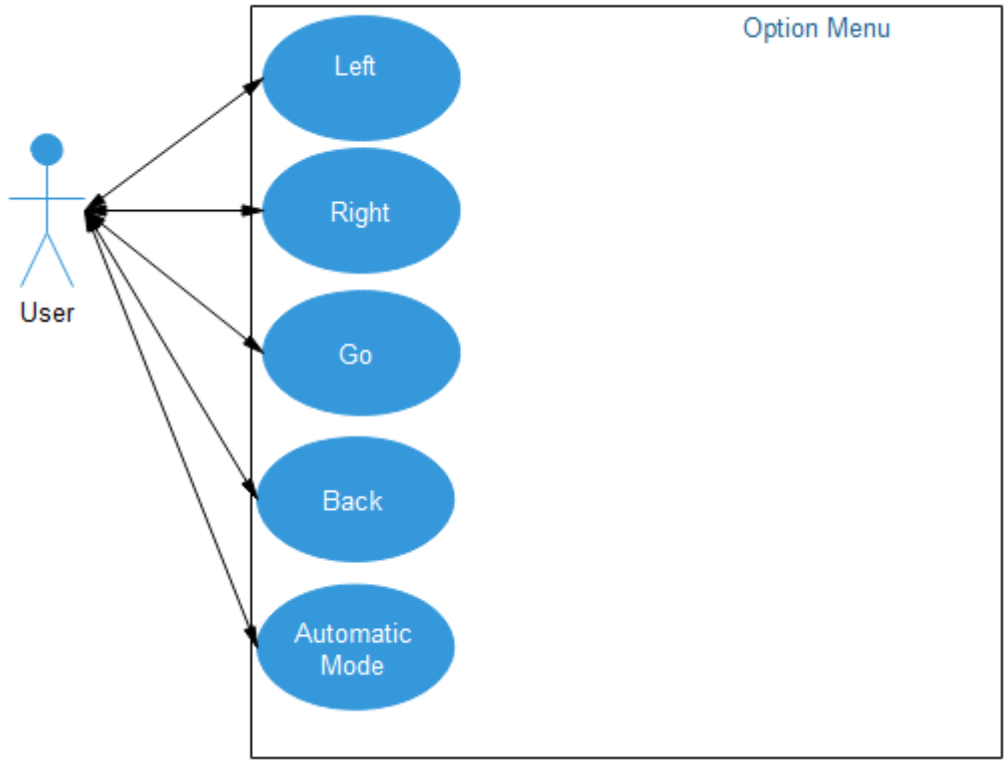

Figure 16. Option Menu Use Case

Brief Description:

Figure 16. shows option menu use case for user diagram. When the user entered the application, the user can display the controls menu then the user can control the robot by using this application. A user can execute functions of move right, move left, go and back. And also, select the automatic mode for automatic control.

Initial Step-By-Step Description:

7. The user can start an application without login.
8. If the user selects go button, the robot moves ahead
9. If the user selects back button, the robot moves back.
10. If the user selects the left button, the robot moves left.
11. If the user selects the right button, the robot moves right.
12. If the user selects the automatic mode button, the robot moves automatically.

5.4.3 Communication Use Case

Use Case:

- User
- Android Device
- Bluetooth Connection
- Arduino Uno
- DC Motor

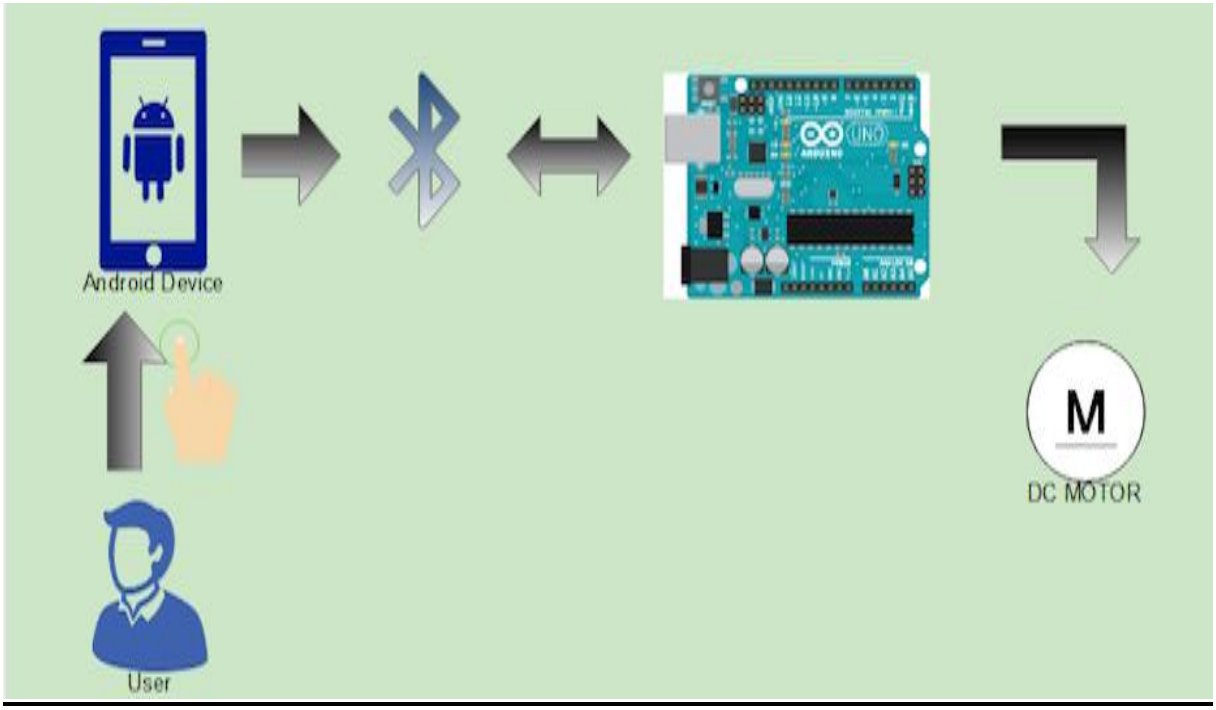

Figure 17. Communication Use Case

Brief Description:

Figure 17. refers to the interaction between the phone and Arduino when the user activates Bluetooth connectivity with the Android Phone.

5.5 Robotic Vehicle's Design

Arduino Uno, which is the brain of various sensors and robot, was used in this project. The aim of this project is to use for the military field to inform the military personnel in advance of possible terrorist attacks. The user can control the robotics movements from his/her own intelligent device or take the robot in automatic mode and let the car drive its own way. The robotic vehicle can detect whether the obstacles facing the vehicle are human or not. If the obstacle is a living entity, as for that is the human, the red led on the robot lights up and it will calculate the shortest distance it can avoid and will proceed in that direction. If any object we are comparing is inanimate, it will calculate the shortest distance it can avoid and will proceed in that direction. Arduino Uno is used as the brain of the robotic vehicle. In addition, by using sensors such as infrared sensor, obstacle recognition sensor, the interaction between the robot and the environment is ensured. At the same time, the Bluetooth module allows Arduino to communicate with the Android-based phone.

And also, we used:

- A sensor that detects an obstacle
- Temperature sensor
- Red led
- 9V battery
- Ultrasonic Sensor
- Motor Shield
- Servo-motor
- PIR

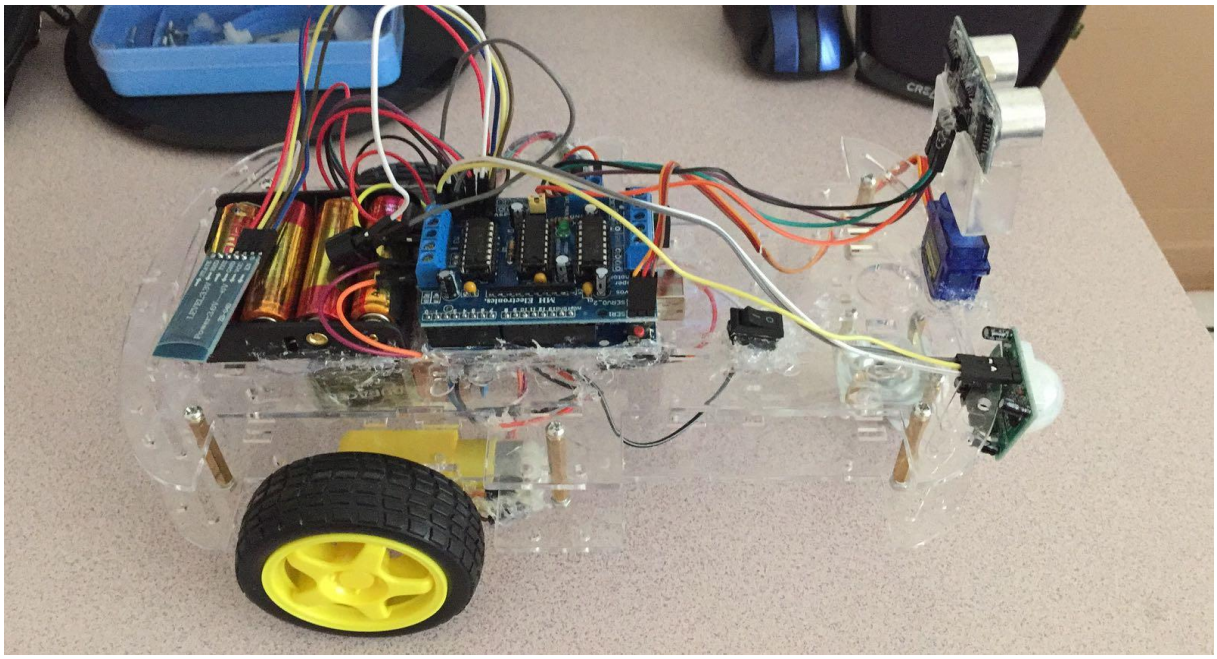

Figure 18. Robotic Vehicle-1

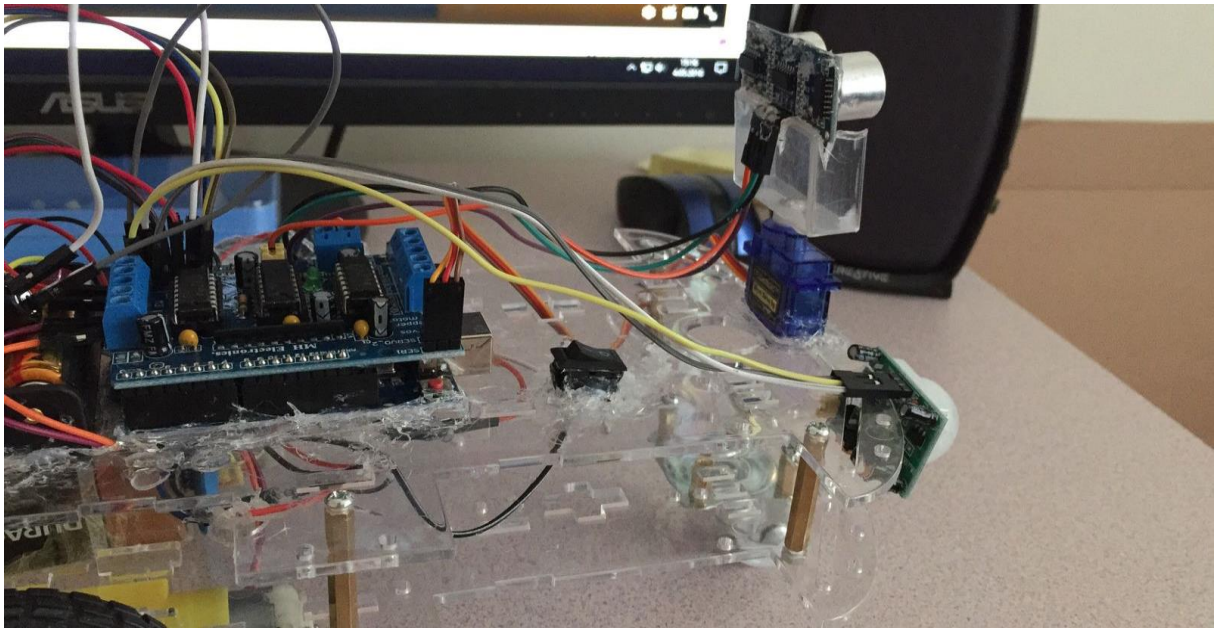

Figure 19. Arduino Uno, Ultrasonic Sensor

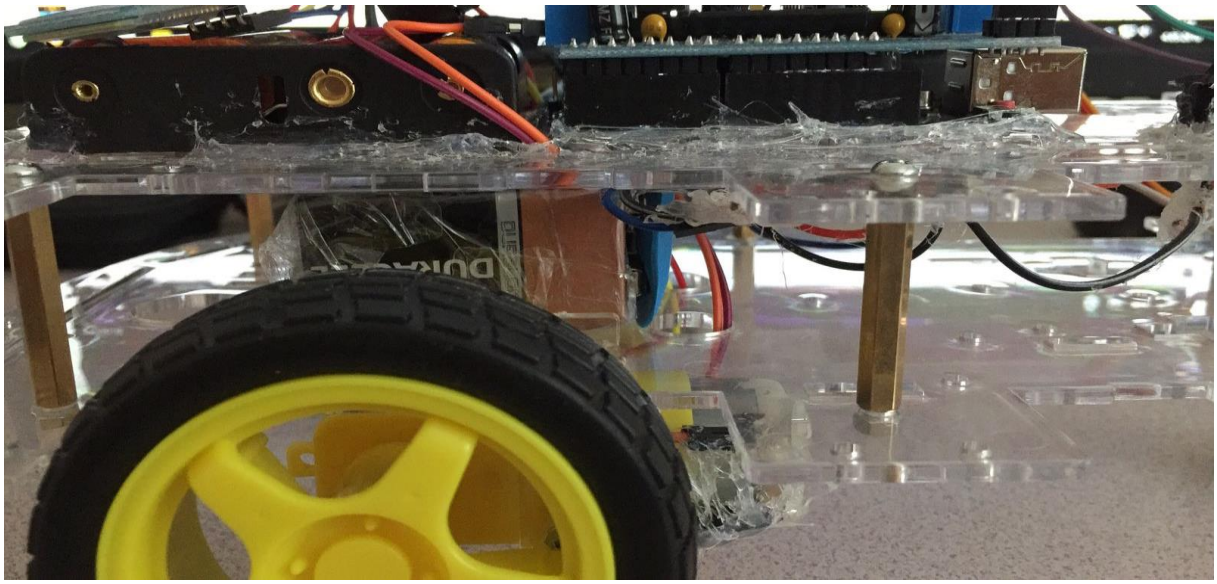

Figure 20. 9V Battery

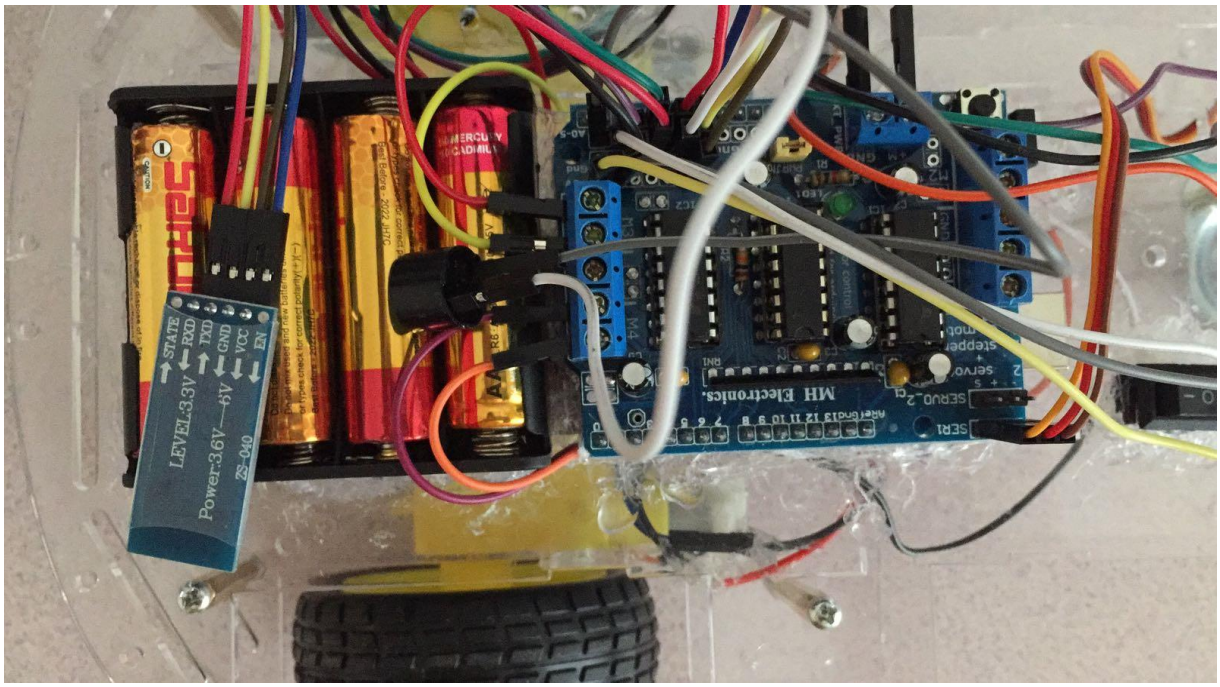

Figure 21. Bluetooth Module, Arduino Uno

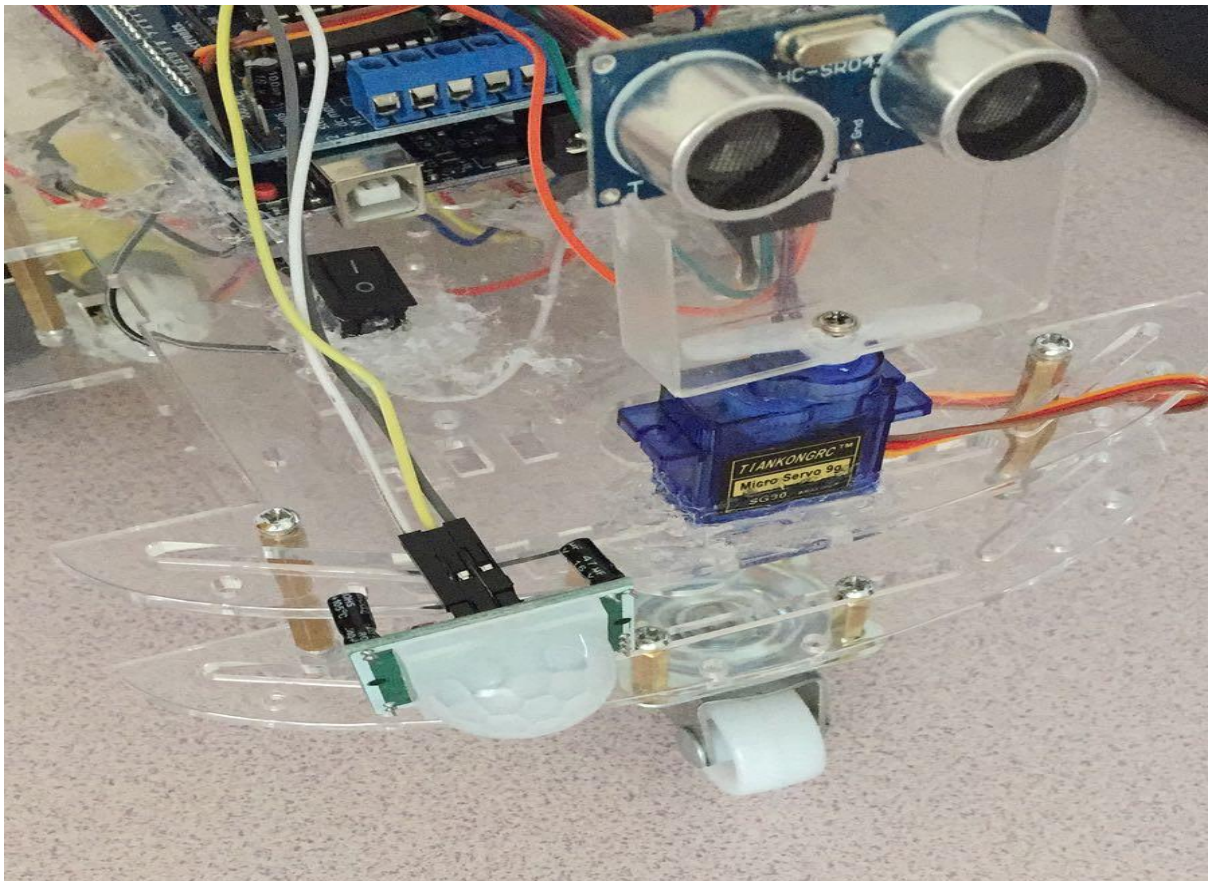

Figure 22. Obstacle Detection Sensor, Servo Motor, PIR

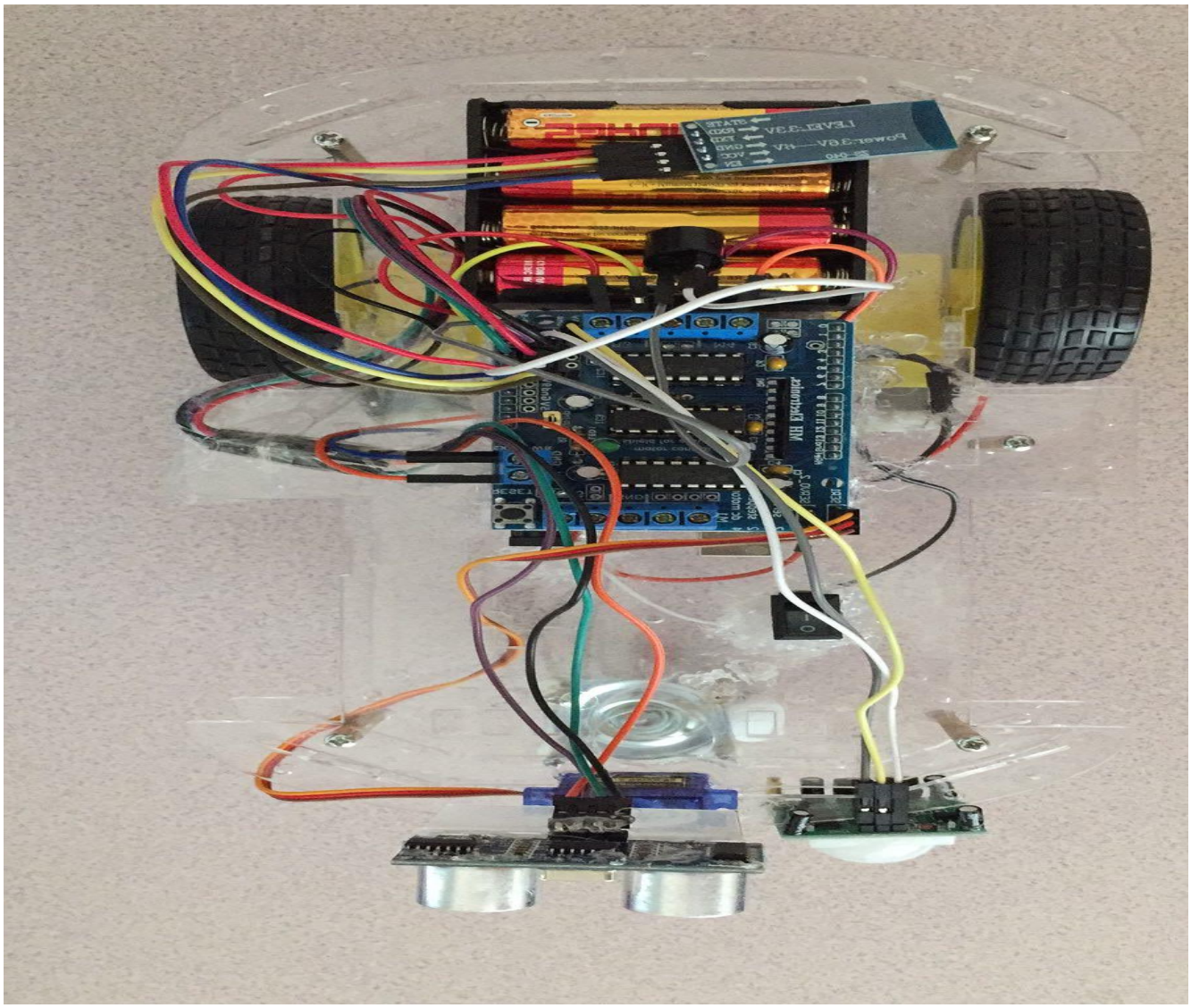

Figure 23. Robotic car top view

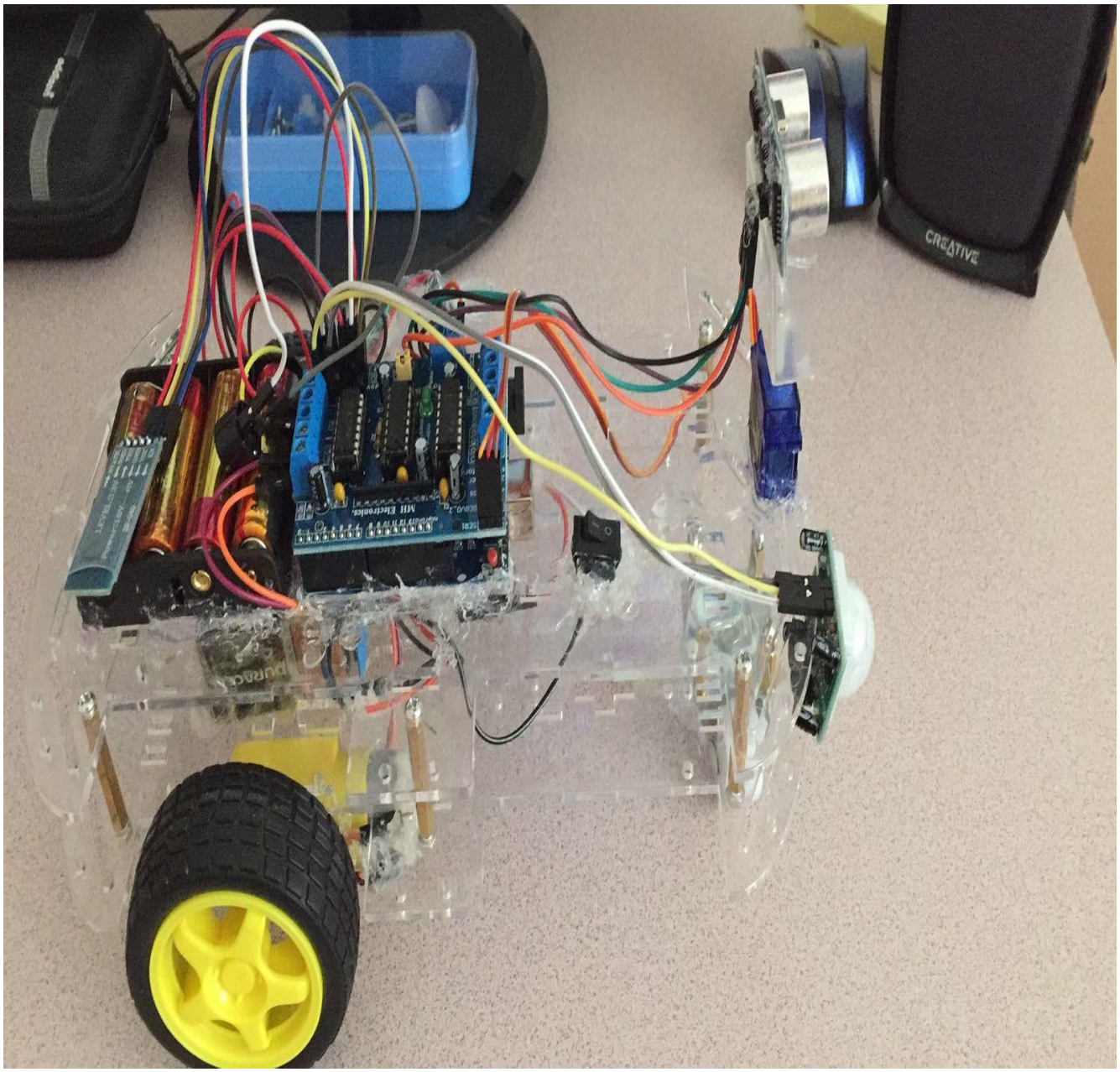

Figure 24. General view of the robotic car

5.6 Help system design

To install the app, firstly, you must have Google Play installed on your Android Device. If you have Google Play installed, you need to download the application called Arduino Bluetooth Controller. To be able to connect to the application, Bluetooth must be turned on.

After downloading the application, you should connect the Bluetooth Module (HC-06) with using password “1234”.

Then, select the HC-06 and user will see some selection.

Select in the menu “Controller Mode” and the user should set those input value to any button showing in “Controller Mode”.

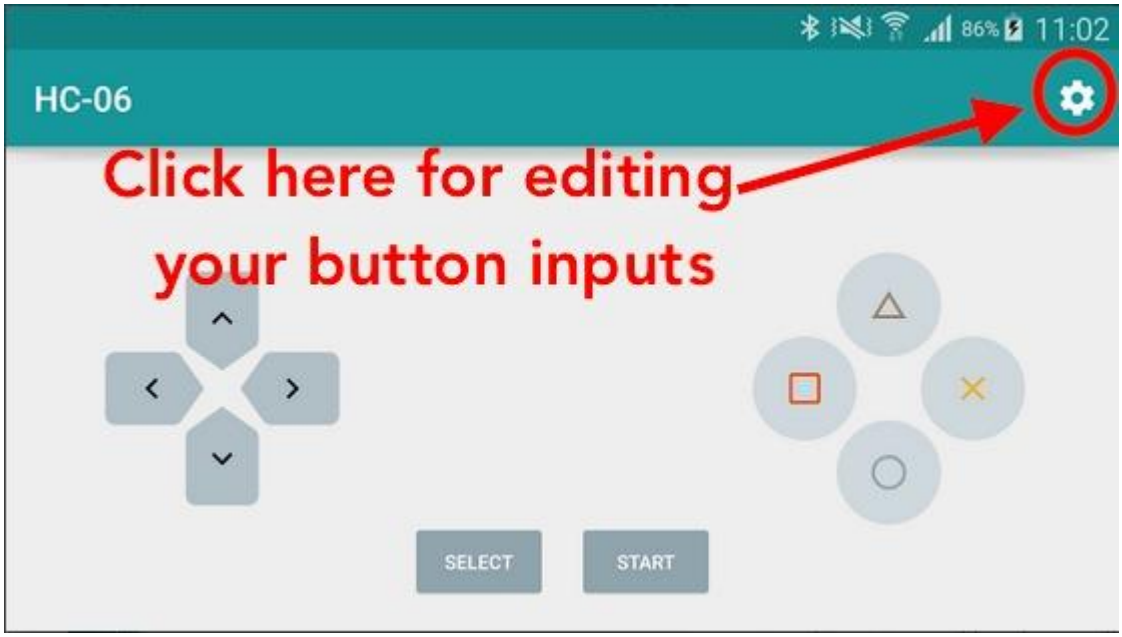

Figure 25. Buttons

Figure 25. shows how we can change buttons. As shown in the picture, when we click on the symbol in the upper right corner, we can assign the desired value to the buttons. When we press the Start button, the program starts running. With the Select key, we can select the desired key.

The keys and values we assign in our project are as follows:

 = Forward Button

 = Backward Button

 = Left Button

 = Right Button

 = Stop Button

 = Automatic Mode (without Bluetooth Control)

6. Test Plan

6.1 Introduction

6.1.1 Version Control

Table 3 Version Control

Version No	Description of Changes	Date
1.0	First Version	May 17, 2018

6.1.2 Overview

The use case of Sensor programming with using Android platform system users namely participant which had been determined in SRS document will be tested.

6.1.3 Scope

This document encapsulates the test plan of the use cases, test design specifications and the test cases correspond to test plan.

6.1.4 Terminology

Table 4 Terminology

Acronym	Definition
GUI	Graphical User Interface(GUI)
CNC	Connectivity

6.2 Features to be tested

This section lists and gives a brief description of all the major features to be tested. For each major feature, there will be a Test Design Specification added at the end of this document.

6.2.1 GUI (Graphical User Interface)

The graphical user interface components are used in the project. The GUI section consists of the Main Menu. Each part of the GUI also contains smaller parts. GUI section, buttons configuration on the project, Bluetooth connection etc. It includes testing the functions of the GUI components used.

6.2.2 Connectivity (CNC)

The connectivity part consists of 2 parts:

1. Check the Bluetooth activity of your Android device

2. Check the connection between the Android device and the Arduino Bluetooth module.

6.3 Features not to be tested

Features that will not be tested in this project; the resistance of the device to water, dust will not be tested.

6.4 Item pass / fail criteria

6.4.1 Exit Criteria

- 100% of the test cases are executed
- 99.9% of the test cases passed
- All High and Medium Priority test cases passed

6.5 References

[1] Group11_SRS_V2.0, March 13, 2018

[2] Group11_SDD_V2.0, March 13, 2018

6.6 Test design specifications

6.6.1 Graphical User Interface (GUI)

6.6.1.1 Subfeatures to be tested

6.6.1.2 Start Button (GUI.STRT_BTN)

The participant can select a "Start" button. The robot becomes controllable after the start button is pressed.

6.6.1.3 Button Configuration (GUI.CNFGRTN_BTN)

The participant can select a "Button Configuration" button. When the user presses this button, they can edit the inputs of the button to control the robot movements.

6.6.1.4 Move Forward Button (GUI.FRWRD_BTN)

The participant can select a "Move Forward" button. After pressing this key, the robot moves forward.

6.6.1.5 Move Back Button (GUI.BCK_BTN)

The participant can select a "Move Back" button. After pressing this key, the robot moves back.

6.6.1.6 Move Right Button (GUI.RGHT_BTN)

The participant can select a "Move Right" button. After pressing this key, the robot moves right.

6.6.1.7 Move Left Button (GUI.LFT_BTN)

The participant can select a "Move Left" button. After pressing this key, the robot moves left.

6.6.1.8 Automatic Mode Button (GUI.AUTO_BTN)

The participant can select an "Auto Mode" button. After pressing this key, the robot moves automatically.

6.6.1.9 Bluetooth Button (GUI.BLTTH_BTN)

The participant can select a "Bluetooth" button. When the user presses this key, it checks whether the Bluetooth connection is open for the application.

6.6.1.10 Exit Button (GUI.EXT_BTN)

The participant can select an "Exit" button. After pressing this key, the application will be closed.

6.6.1.11 Test Cases

Here list all the related test cases for this feature

Table 5 Test Cases

TC ID	Requirements	Priority	Scenario Description
GUI.STRT_BTN	4.3.2.1	*High*	Select “START” button. The robot becomes controllable after the start button is pressed.
GUI.CNFGRTN_BTN	4.3.2.2	H	The participant can select a "Button Configuration" button. When the user presses this button, they can edit the inputs of the button to control the robot movement.
GUI.FRWRD_BTN	4.3.2.2	H	The participant can select a "Move Forward" button. After pressing this key, the robot moves forward.
GUI.BCK_BTN	4.3.2.2	H	The participant can select a "Move Back" button. After pressing this key, the robot moves back.
GUI.RGHT_BTN	4.3.2.2	H	The participant can select a "Move Right" button. After pressing this key, the robot moves right.
GUI.LFT_BTN	4.3.2.2	H	The participant can select a "Move Left" button. After pressing this key, the robot moves left.
GUI.AUTO_BTN	4.3.2.2	H	The participant can select an "Auto Mode" button. After pressing this key, the robot moves automatically.
GUI.BLTTH_BTN	4.3.2.1	H	The participant can select a "Bluetooth" button. When the user presses this key, it checks whether the Bluetooth connection is open for the application.
GUI.EXT_BTN	4.3.2.1	H	The participant can select an "Exit" button. After pressing this key, the application will be closed.

6.6.2 Connectivity

6.6.2.1 Subfeatures to be tested

6.6.2.2 Download the Application (CNC.DWNLD.01)

The user must install the application on the Android device so that the Robot connection can be performed.

6.6.2.3 Enter the Application (CNC.ENTRAPP.02)

The user must run the application after installing the application.

6.6.2.4 Bluetooth Connection (CNC.BLTTHC.03)

In order for the application to be able to connect to the Robot, the user must enable Bluetooth connectivity on their Android device.

6.6.2.5 The connection between Android Device and Robot(CNC.AR.04)

If the connection between the Android device and the robot cannot be established, an error report will be displayed in the user interface. If a connection is established, robot movements can be controlled through this connection and application.

6.6.2.6 Button Configuration (CNC.CNFGRTN_BTN)

The participant can select a "Button Configuration" button. When the user presses this button, they can edit the inputs of the button to control the robot movements.

6.6.2.7 Test Cases

Here list all the related test cases for this feature

Table 6 Test Cases

TC ID	Requirements	Priority	Scenario Description
CNC.DWNLD.01	4.3.2.1	H	The user must install the application on the Android device so that the Robot connection can be performed.
CNC.ENTRAPP.02	4.3.2.1	H	The user must run the application after installing the application.
CNC.BLTTHC.03	4.3.2.2	H	In order for the application to be able to connect to the Robot, the user must enable Bluetooth connectivity on their Android device.
CNC.AR.04	4.3.2.3	H	If the connection between the Android device and the robot cannot be established, an error report will be displayed in the user interface. If a connection is established, robot movements can be controlled through this connection and application.
CNC.CNFGRTN_BTN	4.3.2.2	H	The participant can select a "Button Configuration" button. When the user presses this button, they can edit the inputs of the button to control the robot movements.

6.7 Detailed Test Cases

6.7.1 GUI.S_STRT_BTN

Table 7 GUI.S_STRT_BTN

TC_ID	GUI.S_STRT_BTN
Purpose	The robot becomes controllable after the start button is pressed.
Requirements	4.3.2.1
Priority	High.
Estimated Time Needed	2 Minutes
Dependency	The application is executed.
Setup	The application should install on the Android Device.
Procedure	[A01] Select “Start” button from the main menu.
Cleanup	Exit

6.7.2 GUI.S_CNFGRTN_BTN

Table 9 GUI.S_CNFGRTN_BTN

TC_ID	GUI.S_CNFGRTN_BTN
Purpose	When the user presses this button, they can edit the inputs of the button to control the robot movement.
Requirements	4.3.2.2
Priority	High.
Estimated Time Needed	3 Minutes
Dependency	The button configuration must be available.
Setup	The user can change the button configuration settings according to his/her request.
Procedure	[A01] Select “Configuration” button from the main menu. [A02] The user can edit the button configuration.
Cleanup	Go back to the main menu.

6.7.3 GUI.S_FRWRD_BTN

Table 10 GUI.S_FRWRD_BTN

TC_ID	GUI.S_FRWRD_BTN
Purpose	The robot moves forward.
Requirements	4.3.2.2
Priority	High.
Estimated Time Needed	1 Minutes
Dependency	The application is executed.
Setup	The application is started and press forward button.
Procedure	[A01] Select “Move Forward” button from the main menu.
Cleanup	Go back to the main menu.

6.7.4 GUI.S_BCK_BTN

Table 11 GUI.S_BCK_BTN

TC_ID	GUI.S_BCK_BTN
Purpose	The robot moves back.
Requirements	4.3.2.2
Priority	High.
Estimated Time Needed	1 Minutes
Dependency	The application is executed.
Setup	The application is started and press back button.
Procedure	[A01] Select “Move Back” button from the main menu.
Cleanup	Go back to the main menu.

6.7.5 GUI.S_RGHT_BTN

Table 12 GUI.S_RGHT_BTN

TC_ID	GUI.S_RGHT_BTN
Purpose	The robot moves right.
Requirements	4.3.2.2
Priority	High.
Estimated Time Needed	1 Minutes
Dependency	The application is executed.
Setup	The application is started and press right button.
Procedure	[A01] Select “Move Right” button from the main menu.
Cleanup	Go back to the main menu.

6.7.6 GUI.S_LFT_BTN

Table 13 GUI.S_LFT_BTN

TC_ID	GUI.S_LFT_BTN
Purpose	The robot moves left.
Requirements	4.3.2.2
Priority	High.
Estimated Time Needed	1 Minutes
Dependency	The application is executed.
Setup	The application is started and press left button.
Procedure	[A01] Select “Move Left” button from the main menu.
Cleanup	Go back to the main menu.

6.7.7 GUI.S_AUTO_BTN

Table 14 GUI.S_AUTO_BTN

TC_ID	GUI.S_AUTO_BTN
Purpose	The robot moves automatically.
Requirements	4.3.2.2
Priority	High.
Estimated Time Needed	1 Minutes
Dependency	The application is executed.
Setup	The application is started and press auto mode button.
Procedure	[A01] Select “Automatic Mode” button from the main menu.
Cleanup	Go back to the main menu.

6.7.8 GUI.S_BLTTH_BTN

Table 15 GUI.S_BLTTH_BTN

TC_ID	GUI.S_BLTTH_BTN
Purpose	This button checks whether the Bluetooth connection is open for the application.
Requirements	4.3.2.1
Priority	High.
Estimated Time Needed	3 Minutes
Dependency	The Android device must have Bluetooth connectivity.
Setup	The application should be started.
Procedure	[A01] Select “Bluetooth Connectivity” button from the main menu. [A02] The information message about the connection status is displayed on the screen.
Cleanup	Go back to the main menu.

6.7.9 GUI.S_EXT_BTN

Table 16 GUI.S_EXT_BTN

TC_ID	GUI.S_EXT_BTN
Purpose	Exit from the application.
Requirements	4.3.2.1
Priority	High.
Estimated Time Needed	1 Minutes
Dependency	The application should be started.
Setup	Exit button is scripted.
Procedure	[A01] Select “Exit” button from the main menu. [A02] Verify that program is closed
Cleanup	Exit the application.

6.7.10 CNC.C_DWNLD.01

Table 17 CNC.C_DWLND.01

TC_ID	CNC.C_DWLND.01
Purpose	The user must install the application on the Android device so that the Robot connection can be performed
Requirements	4.3.2.3
Priority	High.
Estimated Time Needed	5 Minutes
Dependency	The application should be uploaded to the Google Play.
Setup	The application needs to exist.
Procedure	[A01] User's device must have Google play installed [A02] The app must be installed on Google Play. [A03] The app must be compatible with the Android version of the device.
Cleanup	-

6.7.11 CNC.C_ENTRAPP.02

Table 18 CNC.C_ENTRAPP.02

TC_ID	CNC.C_ENTRAPP.02
Purpose	The user enters the application.
Requirements	4.3.2.1
Priority	High.
Estimated Time Needed	1 Minutes
Dependency	The user must install the application.
Setup	The application needs to exist.
Procedure	[A01] The user needs to install the application on his/her Android device. [A02] The user executes the application. [A03] The user enters the application.
Cleanup	-

6.7.12 CNC.C_BLTTHC.03

Table 19 CNC.C_BLTTHC.03

TC_ID	CNC.C_BLTTHC.03
Purpose	The user must enable Bluetooth connectivity on their Android device.
Requirements	4.3.2.3
Priority	High.
Estimated Time Needed	3 Minutes
Dependency	The user device has Bluetooth Connection.
Setup	The Bluetooth connection must be turned on.
Procedure	[A01] The user needs to install the application on his/her Android device. [A02] The user executes the application. [A03] The user enters the application. [A04] The user must enable Bluetooth connectivity on their Android device.
Cleanup	-

6.7.13 CNC.C_AR.04

Table 20 CNC.C_AR.04

TC_ID	CNC.C_AR.04
Purpose	If the connection between the Android device and the robot cannot be established, an error report will be displayed in the user interface. If a connection is established, robot movements can be controlled through this connection and application.
Requirements	4.3.2.3
Priority	High.
Estimated Time Needed	5 Minutes
Dependency	The user device has Bluetooth Connection.
Setup	The Bluetooth connection must be turned on.
Procedure	[A01] The user needs to install the application on his/her Android device. [A02] The user executes the application. [A03] The user enters the application. [A04] The user must enable Bluetooth connectivity on their Android device. [A05] The connection between the Android device and the robot can be established
Cleanup	Exit.

6.7.14 CNC.C_CNFGRTN_BTN

Table 21 CNC.C_ CNFGRTN_BTN

TC_ID	CNC.C_ CNFGRTN_BTN
Purpose	When the user presses this button, they can edit the inputs of the button to control the robot movement.
Requirements	4.3.2.2
Priority	High.
Estimated Time Needed	3 Minutes
Dependency	The button configuration must be available
Setup	The user can change the button configuration settings according to his/her request.
Procedure	[A01] Select “Configuration” button from the main menu. [A02] The user can edit the button configuration.
Cleanup	Go back to the main menu.

7. Test Results

7.1 Individual Test Results

Table 22 Individual Test Results

TC ID	Priority	Date Run	Run By	Result	Explanation
GUI.CNFGRTN_BTN	H	17.05.2018	Esra Yılmaz	Fail	This problem will be fixed in the next release
GUI.FRWRD_BTN	H	17.05.2018	Ahmet Kara	Pass	The robot started to move forward.
GUI.BCK_BTN	H	17.05.2018	Ahmet Kara	Pass	The robot started to move back.
GUI.RGHT_BTN	H	17.05.2018	Ahmet Kara	Pass	The robot started to move right.
GUI.LFT_BTN	H	17.05.2018	Ahmet Kara	Pass	The robot started to move left.
GUI.AUTO_BTN	H	17.05.2018	Esra Yılmaz	Pass	The robot started to move automatically.
GUI.BLTTH_BTN	H	17.05.2018	Esra Yılmaz	Pass	Bluetooth has been connected.
GUI.EXT_BTN	H	17.05.2018	Esra Yılmaz	Pass	Exit the application.

Table 23 Individual Test Results

TC ID	Priority	Date Run	Run By	Result	Explanation
CNC.DWNLD.01	H	17.05.2018	Esra Yılmaz	Pass	The application has been downloaded.
CNC.ENTRAPP.02	H	17.05.2018	Esra Yılmaz	Pass	Start the application.
CNC.BLTTHC.03	H	17.05.2018	Ahmet Kara	Pass	Bluetooth connection with Robot.
CNC.AR.04	H	17.05.2018	Ahmet Kara	Pass	Bluetooth connection with Robot.
CNC.CNFGRTN_BTN	H	17.05.2018	Ahmet Kara	Pass	Configuration button started.

7.2 Summary of Test Results

Table 24 Test Results

Priority	Number of TCs	Executed	Passed
H	14	14	13
M	0	0	0
L	0	0	0
Total	**14**	**14**	**13**

We have executed 14 test cases and 13 test cases are passed. Exit criteria are met.

7.3 Exit Criteria

We have executed all test cases and 92% of test cases are passed. Software development activities are completed within the anticipated cost. Software development activities are completed within the anticipated timeline. Exit criteria are met.

Table 25 Exit Criteria

Criteria	Met or Not
100% of the test cases are executed	M
95% of the test cases passed	M
All High and Medium Priority test cases passed	N

7.4 Known Problems

At some time the battery power is insufficient. This problem will be solved.

8. Conclusion

In this study, Sensor Programming has been developed using Bluetooth Technology on the Android platform. A robotic vehicle is controlled by an Android device using Bluetooth technology. During this control basic movements of the robotic such as forward, backward, right, left has been performed by the user. At the same time, if the user selects an automatic mode from the application, the control will pass the robot. The robot that encounters an obstacle gives different responses when it perceives the obstacle which lives or dies. The robot uses the temperature sensor to determine if the obstacle is alive. It detects the body temperature as a person between 32-39 ° C. When it detects a living entity, the red led on it will start to light up. The robot will also try to escape from the obstacles. To escape the hurdle, it scans the circumference and measures the furthest distance from the obstacle and begins to move in that direction until it is removed from the automatic mode. Thus, it is aimed to be used in the military field for identifying terrorists. This work was carried out at a certain cost using various hardware materials. The system was run through various tests such as power supply, data transfer time. The Robot can be further developed using more sophisticated materials. The WI-FI module can be used instead of the Bluetooth module. For this, the WI-FI module can be used so that the Bluetooth does not break and can be used in larger areas.

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References

[1]- Khoje, S., Urad, D., Shirke, M., Robotic Control Using an Android Application, International Journal of Computer Science and Information Technologies, vol 7, no 2, p.773 - 776

[2]-Sharma, A., Verma, R., Gupta, S., Android Phone Controlled Robot Using Bluetooth, International Journal of Electronic and Electrical Engineering. , vol 7, no 5, p.443 - 448

[3]-Sruthilaya, G., CONTROL OF BLUETOOTH ENABLED ROBOTS VIA ANDROID APK, International Journal of Advances in Engineering &Technology, Apr., 2016., vol 9, no 2, p.262 - 267

[4]-K.Pathak, M, Khan, J., Koul, A., Kalane, R., Varshney R., Robot Control Design Using Android Smartphone, JOURNAL OF BUSINESS MANAGEMENT AND ECONOMICS, vol 3, no 2, p.31 - 33

[5]-KC, K, CONTROLLING A ROBOT USING ANDROID INTERFACE AND VOICE, Bachelor's thesis Degree programme: Information Technology Specialisation: Android and Arduino Development.

[6]-Verma, S, Android App Controlled Bluetooth Robot, Internal Journal of Computer Applications, vol 152, no 9, p.35 - 40

[7]-Frund, L, Intergacing an Android-based phone-robot with Webots, p.1 - 42

[8]-.N.K, M, Fayas, M., Mohan, M., Sajeev, M. and C.N, S., Wireless Control of Pick and Place Robotic Arm Using an Android Application, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, vol 4, no 4, p.2410 - 2416

[9]-Shuvo, M, Android- Based Remote Robot Control System, American Society for Engineering Education.

[10]-Nadvornik, J. and Smutny, P. (2014). Remote control robot using Android mobile device. Proceedings of the 2014 15th International Carpathian Control Conference (ICCC).

[11]- Chakraborty, D., Sharma, K., Roy, R., Singh, H. and Bezboruah, T. (2016). Android application based monitoring and controlling of movement of a remotely controlled robotic car mounted with various sensors via Bluetooth. 2016 International Conference on Advances in Electrical, Electronic, and Systems Engineering (ICAEES).