University of Palestine

Faculty of Information Technology

# Exploration Robot Controlled by an Android Application (ERCAA)

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To

Our Parents ...

Our Brothers and Sisters ...

Our Friends ...

With all Love and Gratitude

We Dedicate This Work

# ACKNOWLEDGMENT

We would like to express our heartfelt gratitude to everyone who supported us through our work on this project, both directly and indirectly. First of all, thanks to Allah Almighty for giving us the courage and power to accomplish this project.

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# ABSTRACT

In recent years, with the pace of technological development, people have become more and more demanding in terms of quality of life. At the same time, there is an increasing need for bringing and merging new ideas of technology to create new products. That need is stemming out of the big curiosity of people to try new technologies that helps and entertain them in their daily life.

A robot is usually an electro-mechanical machine that is guided by computer and electronic programming. Many robots have been built for manufacturing purpose and can be found in factories around the world. We have designed ROBOT which can be controlled using an APP of android mobile. This Robot is provided with Camera on it to empowers user to explore. We have developed the remote buttons in the android app by which we can control the robot motion and the Camera View with them. And in which we use Wi-Fi communication to interface controller and android. Controller can be interfaced to the Wi-Fi module. According to commands received from android the robot motion can be controlled. Robot can be reprogrammable and tooling can be interchanged to provide for multiple applications according to the Arduino Chip we use.

We have used the Android, C, HTML Programming Languages to develop each of the Application and the Hardware components and electronic Chips.

Following, is the test analysis section, which discusses whether the proposed system met its objectives. Performance is also evaluated near the end of the paper along with possible extensions of the system.

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# LIST OF ABBREVIATIONS

| Abbreviation | Meaning |
|---|---|
| **API** | Application Programming Interface |
| **App** | Application |
| **ART** | Android Runtime |
| **CSS** | Cascading Style Sheets |
| **ER** | Entity Relationship |
| **E-Survey** | Electronic Survey |
| **FR** | Functional Requirements |
| **GPS** | Global Positioning System |
| **HCI** | Human Computer Interaction |
| **HTML** | HyperText Markup Language |
| **KDS** | Kitchen Display Systems |
| **LAN** | Local Area Network |
| **MAN** | Metroplitan Area Network |
| **NFR** | Non-Functional Requirements |
| **PDA** | Personal Digital Assistants |
| **UML** | Unified Modeling Language |
| **WAN** | Wide Area Network |

# GLOSSARY

**Block Diagram:** A block diagram is a specialized, high-level flowchart used in engineering. It is used to design new systems or to describe and improve existing ones. Its structure provides a high-level overview of major system components, key process participants, and important working relationships.

**Flow Chart:** A flowchart is a visual representation of the sequence of steps and decisions needed to perform a process. Each step in the sequence is noted within a diagram shape. Steps are linked by connecting lines and directional arrows. This allows anyone to view the flowchart and logically follow the process from beginning to end.

**Functional Requirement:** The functional requirements are user "visible" features that are typically initiated by stakeholders of the system, such as generate report, login, and signup.

**Non-Functional Requirements:** they are requirements that describe how the system will do what it is supposed to do, for example, security, reliability and maintainability.

**Sequence diagram**: It models the collaboration of objects based on a time sequence. It shows how the objects interact with others in a particular scenario of a use case.

# CHAPTER 1:
# INTRODUCTION

# 1 CHAPTER 1: INTRODUCTION

Nowadays smart phones are becoming more powerful with reinforced processors, larger storage capacities, richer entertainment function and more communication methods. Wi-Fi is widely used in businesses, agencies, schools, and homes as an alternative to a wired LAN. Many airports, hotels, and fast-food facilities offer public access to Wi-Fi networks, add new features to smart phones. Wi-Fi technology, these locations are known as hot spots. Many charge a daily or hourly rate for access, but some are free.

An interconnected area of hot spots and network access points is known as a hot zone, shows its advantage by integrating with smart phones. It has changed how people use digital device at home or office, and has transferred traditional wired digital devices into wireless devices [1].

## 1.1 BACKGROUND

Robotics is a growing field. This has caused many universities to offer classes and programs in the field of robotics that combine elements of electrical engineering, mechanical engineering and computer science.

Students can then program them to perform tasks such as discovering some places from a distance or travelling from one area to another.

Our project proposes a robot that can be handled remotely through an android based device. The control device is integrated with a Wi-Fi device that allows capturing and reading the commands. The robot may then be operated as desired as commanded through the android application. The Robot is integrated with Arduino microcontroller that is used to operate the Robot as per android commands. The controlling device may be any android based Smartphone/tab etc. having an android OS. The android controlling system provides a good interactive GUI that makes it easy for the user to control the vehicle. The transmitter uses an android application required for transmitting the data. The receiver end reads these commands and interprets them into controlling the robot. The android device sends commands to move the Robot and the Camera attached with the Robot. After receiving the commands, the microcontroller then operates the motors I order to move the Robot and the Camera. The communication between android device and receiver is sent as serial communication data. The microcontroller program is designed to move the motor s through a motor driver IC as per the commands sent by android device.

## 1.2 Project Motivation

This project represents the specification, design, and implementation a Robot of a discovering and surveillance robot that can explore some places that the human can and can't explore, capturing some photos, recording some videos, exploring some places, all these are needs that moves the wheel of motivation to do this project that considered as a motivation of this project.

## 1.3 Problem Statement

As long as technology is growing and keeps on going very fast, people had to keep up with new technologies as fast as possible in order to keep up with the other communities, according to that, and as Palestinians citizen, we ought to improve our nation and raise it as we can, each in his own field of learning, so we decided to merge and develop a Robot of robot which can be controlled by an Android application.

## 1.4 Project Question

The focus of this project is on developing a Robot and a mobile App. The Project questions are:

- How to develop a robot that controlled by android device?
- How to make the robot and mobile App more flexible and user friendly?"
- What are the user requirements towards the use of Robot functionality?
- What are the features used in the Robot that could help it to accomplish its tasks?

## 1.5 Project Objectives

The main objective of this project is to let the wheel of the technology keeps moving here in Gaza, other benefits can be:

- Develop a Robot that can do exploring task and discovering provided with camera to take live show to empower the user to see all what the robot sees.
- Develop an android application which controls the robot by Wi-Fi signals and to let the user to control the movement and the camera options of the robot.
- Evaluate both the Robot and the mobile App on the end-user.
- Helping the people who are interested with such projects.
- Provide some results and information about making the project and encourage people to make projects similar to this one.
- Applying and merging our knowledge and merging ideas to create something new.

## 1.6 PROJECT SIGNIFICANCE

The suggested Robot and mobile Application allows some interested people and institutions to use the features of the robot with useful ways and to let the students learn new technology. Also this will have considered as a good jump of the technology in Gaza Strip. Consequently, the significance of this study arises from several points as follows:

- Applying some of the latest software and electronics technologies (Arduino, Wi-Fi Module, Android).
- Breaking the ice of linking the software with the hardware.
- Using mobile phones and Android Operating System to interact with hardware.
- Raising the realizing of Robotics and Robot concept to the people in Gaza.

## 1.7 PROJECT SCOPE

The Scope of the project can be explained for large segment of people, but, for specific, the disabled people are the most segment whom expected to benefit the most of this project, they will be able to explore the places where they settle's while it's hard for them to still moving around to check the rooms of their houses for example. According to the Ministry of Health, one hundred thirteen thousand is the number of disabled people in Palestine, thirty-eight thousand of them are in Gaza. Which makes them 2.5 percent of people in Gaza.

## 1.8 FIRST STEPS

At the first, we built a simple robot controlled be an electrical signals taken from a toy car bought from toy markets, then we have reshaped it to look like a robot, so we created two metal legs for that Robot to let it walk on metal legs, that Robot wasn't good looking one, but it was doing its functions with very good performance, we were to an exhibition called "Expotech" after building it, and there was a lot of people who seems very interested to see such a robot that is been controlled wirelessly and moves on metal legs, it feels great to see such reaction of those people, after that we decided to move on and to improve our simple Robot into a something much applicable and efficient having some more features, so that was the kicking off of this project.

The first step we took to build this project was the interviews with some experts about the hardware component we might need and we have made an oral simple questionnaire and queries to experts of software in order to check the possibilities of creating such system on the

Android devices, replying with “yes, why not” experts said, they told us that this is a good idea and you should start doing that project according to the meaningful revenue of that project.

## 1.9 ROBO-EX IN GAZA STRIP

People in Gaza always have big curiosity towards new technologies, this curiosity leads them to try that technologies by themselves. When they see new technology made by their own people they would feel proud, especially when these technologies are built to help disabled segment of people, so we expect that this project would gain the gratitude of people in Gaza Strip.

# CHAPTER 2:
# LITERATURE REVIEW

# 2 CHAPTER 2: LITERATURE REVIEW

This chapter includes a literature review of Robot, its history, concepts and benefits to users.

## 2.1 ROBO-EX

ROBO-Ex is divided into two main phases: Building the hardware of the robot and getting everything about circuits done and building the software mobile application which will control the robot.

## 2.2 DEFINITION OF ROBOT

a machine that looks like a human being and performs various complex acts (as walking or talking) of a human being; also: a similar but fictional machine whose lack of capacity for human emotions is often emphasized [2].

### 2.2.1 Using Arduino

What is Arduino? Arduino is an open-source prototyping platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular

needs. The software, too, is open-source, and it is growing through the contributions of users worldwide.

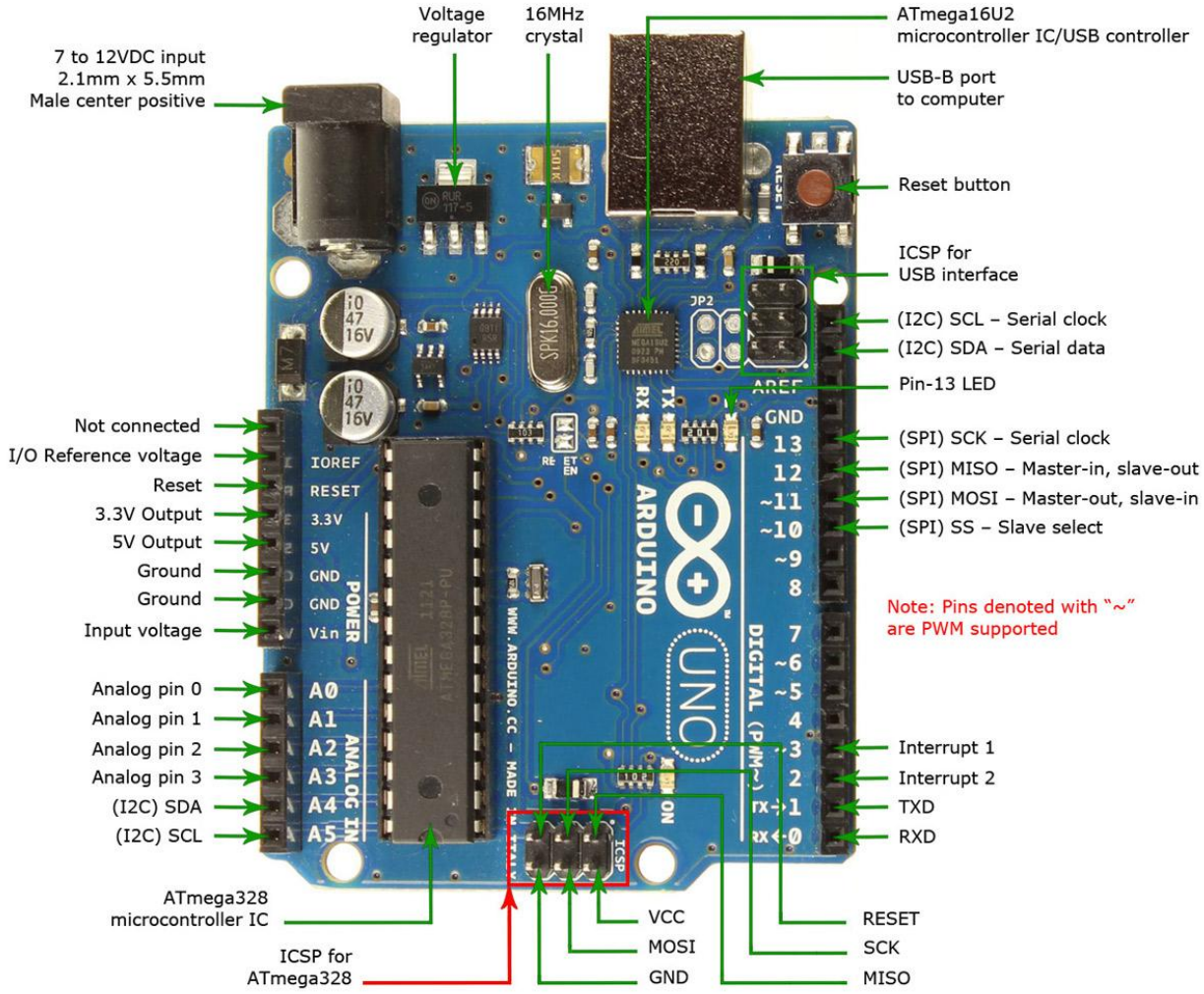


**Figure 2.4 Arduino Uno Chip [15]**

### 2.2.2 Why Arduino?

Thanks to its simple and accessible user experience, Arduino has been used in thousands of different projects and applications. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux. Teachers and students use it to build low cost scientific instruments, to prove chemistry and physics principles, or to get started with programming and robotics. Designers and architects build interactive prototypes, musicians and artists use it for installations and to experiment with new musical instruments. Makers, of course, use it to build many of the projects exhibited at the Maker Faire, for example. Arduino is a key tool to learn new things. Anyone - children, hobbyists,

artists, programmers - can start tinkering just following the step by step instructions of a kit, or sharing ideas online with other members of the Arduino community.

There are many other microcontrollers and microcontroller platforms available for physical computing. Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handyboard, and many others offer similar functionality. All of these tools take the messy details of microcontroller programming and wrap it up in an easy-to-use package. Arduino also simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students, and interested amateurs over other systems:

**Inexpensive** - Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled by hand, and even the pre-assembled Arduino modules cost less than $50

**Cross-platform** - The Arduino Software (IDE) runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows.

**Simple, clear programming environment** - The Arduino Software (IDE) is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well. For teachers, it's conveniently based on the Processing programming environment, so students learning to program in that environment will be familiar with how the Arduino IDE works.

**Open source and extensible software** - The Arduino software is published as open source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based. Similarly, you can add AVR-C code directly into your Arduino programs if you want to.

**Open source and extensible hardware** - The plans of the Arduino boards are published under a Creative Commons license, so experienced circuit designers can make their own version of the module, extending it and improving it. Even relatively inexperienced users can build the breadboard version of the module in order to understand how it works and save money [3].

### 2.2.3 Dc Motors

Almost every mechanical movement that we see around us is accomplished by an electric motor. Electric machines are means of converting energy. Motors take electrical energy and produce mechanical energy. Electric motor is used to power hundreds of devices we use in

everyday life. An example of small motor applications includes motors used in automobiles, robot, hand power tools and food blenders. Micro-machines are electric machines with parts the size of red blood cells and find many applications in medicine [4].

### 2.2.4 Wi-Fi

Initially, Wi-Fi was used in place of only the 2.4GHz 802.11b standard, however the Wi-Fi Alliance has expanded the generic use of the Wi-Fi term to include any type of network or WLAN product based on any of the 802.11 standards, including 802.11b, 802.11a, dual-band and so on, in an attempt to stop confusion about wireless LAN interoperability. Considering its normal working area of within one hundred meters, it is especially useful in home and office environment. Thank for Wi-Fi technology and other similar techniques, with dramatic increase in Smartphone users, smart phones have gradually turned into an all-purpose portable device and provided people for their daily use. In recent years, an open-source platform Android has been widely used in smart phones. Android has complete software package consisting of an operating system, middleware layer and core applications. Different from other existing platform like iOS (iPhone OS), it comes with software development kit (SDK), which provides essential tools and Application. Using a Smartphone as the “brain” of a robot is already an active research field with several open opportunities and promising possibilities. In this project we present a review of current robots controlled by mobile phone and discuss a closed loop control system [5].

## 2.3 RELATE WORK

There are several similar projects locally and internationally and some of them uses some similar components to our project. Table 2-3, compares the similar projects showing the advantages and disadvantages of each of them and summarize the main features in the table. These are some of the projects:

### 2.3.1 Auto Robot

Auto Robot is a project for secondary school students which supported by the Danish Company called “LEGO”, this project is under supervision of number of specialist of robotics in Gaza, “LEGO” worked in a collaboration with UNRWA to provide the electronics chips and the necessary pieces required to start the project [6].

The main goal of the project is to change the learning techniques, growth the innovative thinking, building a positive guidance for the student.

### 2.3.2 Risky Environment Robot

Risky Environment Robot is a graduation Project of 2013 Mechatronics Engineering department in Yemen, it uses the Wi-Fi method to enter the places where no one can enter in order to collect some information about the place using sensors sticks to it, also it has a live camera transmission. Some of the main objectives of the robot is measuring the temperature of atmosphere and find out if there is any leak of gas or any toxic smokes [7].

### 2.3.3 Security Robot

Mohammed Seraj Al-Deen, Ameer Moayed and Mohammed Al-Marzooky are the graduate students from university of Al-Shariqa whom built the security Robot which is a Robot to help security people and prepared for special operations and discovering the dangerous environment, the Robot was built to protect the human individuals, it has sensors to measure temperature and smokes, also it can climb letters [8].

| **Criteria** | **Platform** | | | |
|---|---|---|---|---|
| | **Auto Robot** | **Risky Environment Robot** | **Security Robot** | **Robo-Ex** |
| **Have Camera** | | ✓ | | ✓ |
| **Provide Mobile application** | ✓ | | ✓ | ✓ |
| **Controlled by User** | ✓ | ✓ | | ✓ |
| **Use Wireless signals** | | | ✓ | ✓ |
| **Recording the activities** | | ✓ | | ✓ |
| **Controlled from far distance** | ✓ | | ✓ | ✓ |
| **Simple usage** | | | | ✓ |
| **Attractiveness** | ✓ | ✓ | ✓ | ✓ |
| **Use Wheels to move** | | ✓ | ✓ | |
| **Use legs or other methods to move** | ✓ | | ✓ | ✓ |
| **Have Speakers** | | ✓ | | ✓ |
| **Have Mic** | ✓ | | | ✓ |
| **Use Arduino or other modern technology chips** | | ✓ | ✓ | ✓ |
| **Have a Rechargeable Battery** | ✓ | ✓ | ✓ | ✓ |

**Table 2-2 similar projects and comparison**

# CHAPTER 3:
# METHODOLOGY

# 3 CHAPTER 3: PROJECT METHODOLOGY

This chapter describes the adopted methodology throughout the project the chapter will describe the methodology phases that we will use to accomplish the project and the phases that this methodology consist, then the reasons of choosing waterfall methodology will be listed, after that, each phase of waterfall methodology will be described. Finally, it represents the requirement engineering methodology followed in the project.

## 3.1 ADOPTED METHODOLOGY

The adopted methodology during the development of this project is shown in Fig. 3-1. To accomplish this project, the waterfall modified SDLC model will be followed which is the most suitable methodology for small to medium system or sub systems, Just like Robo-Ex. And also it is suitable for Robo-Ex because the requirements are well-understood. As shown in Figure 3.1, there are five steps in waterfall methodology, starts with Requirement analyses, and finishes with Testing and Maintenance.

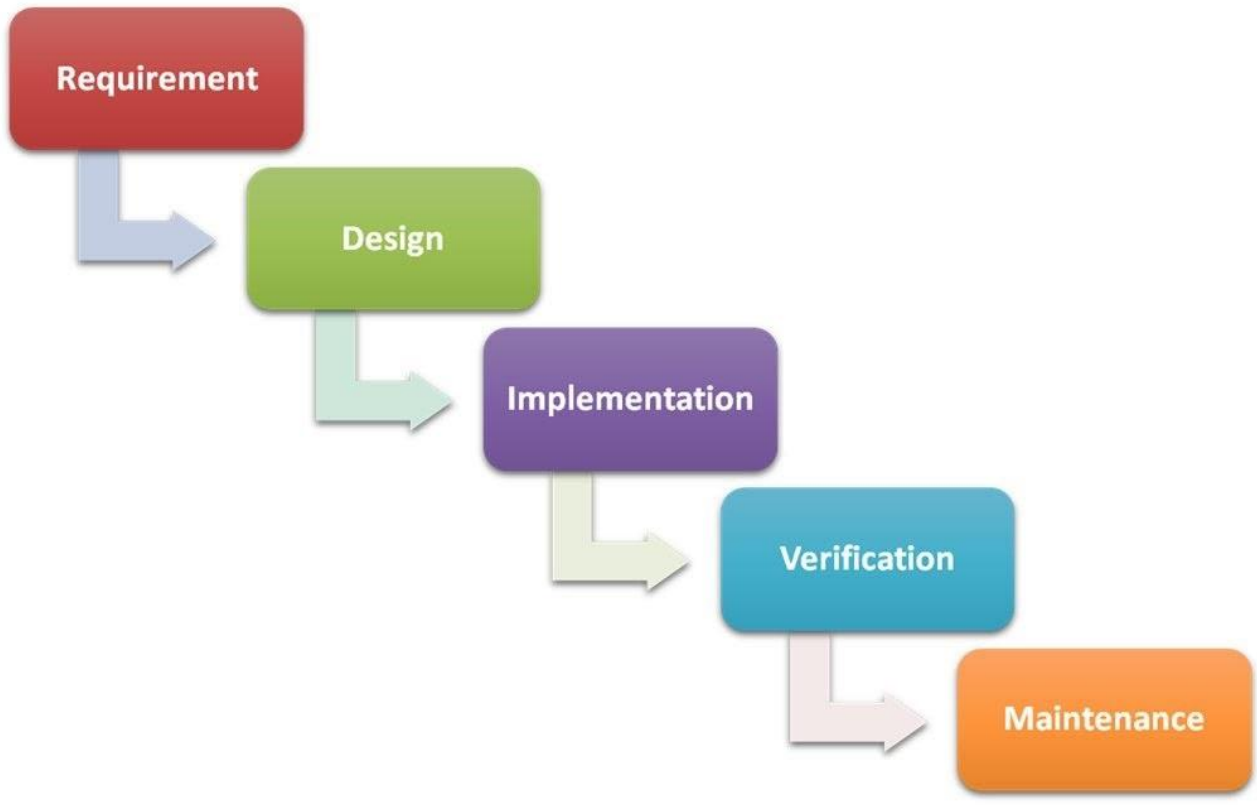

**Figure 3-1: Adopted methodology**

## 3.2 WATERFALL METHODOLOGY

There are several sources or frameworks for classifying non-functional requirements. The first The waterfall methodology founded in 1970 by Dr. Winston Royce who is developed that methodology to help on software development process [9]. It worked well at that time, and it has many changes and revisions. From 1974 to 1976, Dr. Barry Boehm has developed the Waterfall model into other phases to enhance development projects using this methodology. Waterfall now is the most widely used methodology, it gets its name from the analogy of water falling downward. The waterfall model was difficult to use because it is incomplete in its original framework and structure. Now, the most commonly used version available includes a corrective feedback mechanism.

## 3.3 WHY ADOPTING WATERFALL IS SUITABLE FOR ROBO-EX?

This methodology has been chosen because:

1- The requirements are clear, simple, and well understood for the project.
2- 2- Can be developed step by step.
3- 3- Understand the requirements of the system significantly.
4- 4- It's suitable for small systems.

## 3.4 IMPLEMENTATION OF WATERFALL

The five steps of waterfall will be implemented to accomplish this project, each step has its own functions, for example; in requirement gathering and analysis step, the requirements gathered from interviewing, observation, and search [10]. Also System design is divided to logical design like use cases and sequence diagrams, and interface design. See Figure 3.2.

| |
|---|
| 1. Requirements gathering<br>1.1 interview<br>1.2 observation<br>1.3 record searching |
| 2. UML Analysis Design<br>2.1 logical design |
| 3. Implementation and coding<br>3.1interface design<br>3.2 processing design<br>3.2.1 database design |
| 4 Testing and Evaluation |
| 5. Feedback and Maintenance |

Figure 3.4 Waterfall Steps

# CHAPTER 4:

# ANALYSIS AND DESIGN

# 4 CHAPTER 4: REQUIREMENT ANALYSIS

This chapter will provide a full description of the system and its users. Then it depicts the functional and non-functional requirements that have been collected using several methods from brainstorming and interview. After determining the most important requirements, requirement analysis was adopted using several tools such as use-case diagram, sequence diagram and activity diagram.

## 4.1 PROJECT DESCRIPTION

Robo-Ex is a project that mixes the Information Technology software with Mechatronics and Robotics, the project purpose is to enable users to control robot in order to explore and carry some light materials to transfers it from a place to another. This project was developed with more than a year, at the first, it was a simple Robot that can move by remote controller on a metal legs we created, the main objective was to make it capable to move and carry a small weight.

Later time we have started to develop a new modern Robot using modern technologies that has more features and specifications and thus we started to develop the project.

## 4.2 USER DESCRIPTION

There is one main user for the proposed system. User can perform several different functions during the usage of the system. These functions were determined according to the design of the proposed system to make the system more effective and efficient [11]. Figure 4-1 summarizes the functions performed by each user.

User Can Control the Robot and move it anywhere he would like to, surveil the place where the Robot moves by camera on the mobile screen, scroll the camera view up and down to check and see more of the place. He also in addition, can load a small weight with the Robot to transfer it to another place.

## 4.3 REQUIREMENTS DEVELOPMENT

To develop the functional and non-functional requirements of the proposed system, brainstorming sessions were held by the project team. Through these sessions, the system was analyzed and some of the requirements were generated according to the previous models. After that, interviews with experts were held to validate the requirements [12].

## 4.4 SYSTEM REQUIREMENTS

Before creating the robot or a mobile App, it is necessary to visualize the layout, design and all features intended to be incorporated. In addition, how users will interact with the application and the robot together. Requirements are the necessary attributes in the system, a statement that identifies a capability, characteristic or quality factor of the system in order to have value and utility to the users. Once the requirements are set, developers can initiate the other technical work including system design, development, testing, implementation, and operation.

For any system, there are functional and non-functional requirements to be considered while determining the requirements of the system [13]. On the other hand, nonfunctional requirements are requirements that describe how the system will do what it is supposed to do, for example, security, reliability and maintainability.

### 4.4.1 Functional Requirements

The functional requirements were developed through reviewing literature review, revising similar systems, brainstorming sessions with team members and interviews with experts [14].

User of the system has specific functional requirements that enable user to use the system. Actually, these requirements describe what the Robot or App should do.

#### *4.4.1.1 User Requirements*

The main user requirement to use the project is having an Android device, other functional requirements are user setup the software application to start using the system

1- User should have an Android Device provided with Wi-Fi.
2- Also user should have the Android application of this project to connect to the robot.
3- There must be wireless Router adapter.

### 4.4.2 Non-Functional Requirements

Several NFR can be considered while developing a robot or a mobile App. For example, the system must be effective and simple to achieve the goal of quality metrics and to be understandable and easy to learn and use [15]. To derive the most important requirements for the system, survey was designed and developed to assess the importance of the NFR adopted after the brainstorming sessions and interviews. The survey was distributed among 200

participants via Facebook, Twitter and email. The data from the survey were analyzed using SPSS, and the NFR were organized and categorized according to their importance to the users of the system [16].

**Performance**

- Response requirements
- Scalability requirements

**Usability**

- Attractiveness/aesthetics
- Ease of use
- Internationalization / Localizations Requirements
- Learning requirements: training, well-structured user manuals
- Simplicity

**Security**

- Confidentiality
- Authorization
- Availability

**Reliability**

- Availability
- Dependability
- Failure rate
- Recovery rate

**Interoperability**

**Compatibility**

**Effectiveness**

**Efficiency**

- Expandability requirements

**Flexibility**

**Supportability**

- Adaptability
- Internationalization requirements
- Maintainability

*Fig. 4-1: Non-Functional requirements [18]*

## 4.5 System Analysis

This part contains the analysis of the functional and non-functional requirements using use-case diagrams, and use-cases details. In addition, the interactive behavior of the activities is analyzed using sequence diagrams, activity diagrams and block diagram.

### 4.5.1 Use-case Diagram

To capture the dynamic aspect of the project, the use-case diagram was developed. The diagram depicts the interactions among the three elements of the system [20]. It was used to identify, clarify, and organize system requirements. Figure 4-6 demonstrates the use-case diagram of the system.

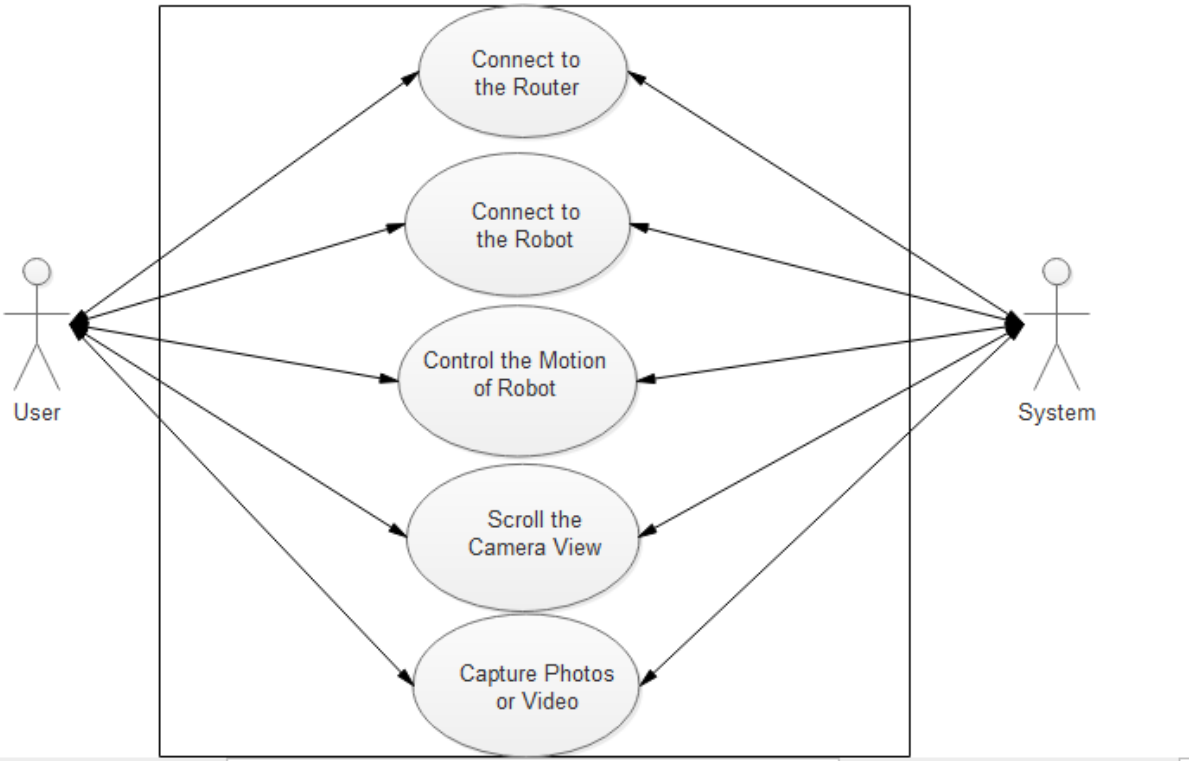


*Fig. 4-4-21 Use-Case diagram for the system*

### 4.5.2 Block Diagram

A smart phone Android operated robot. Now here is a simple to control your robot using Wi-Fi module ESP8266 and Arduino microcontroller with your android Smartphone device. The controlling devices of the whole system are a microcontroller. Wi-Fi module, Camera, DC motors are interfaced to the microcontroller [21]. The data receive by the Wi-Fi module from android smart phone is fed as input to the controller. The controller acts accordingly on the DC motor of the robot. The robot in the project can be made to move in all the directions using the android phone. In achieving the task, the controller is loaded with program written using Embedded 'C' Languages. Android smart phone controller Wi-Fi robot using microcontroller.

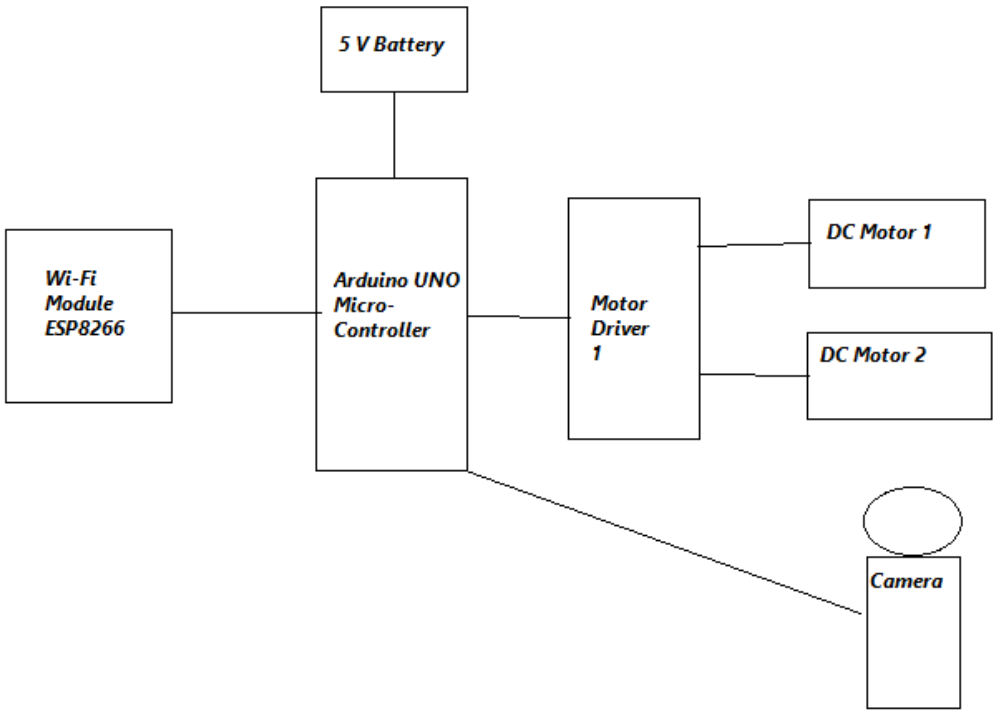


Figure 4-4-3 Block Diagram

# CHAPTER 5:
# IMPLEMENTATION

# 5 CHAPTER 5: DESIGN AND IMPLEMENTATION

This chapter explains the design and implementation phases of the system, the implementation phase combines the requirements, design phase outputs, and process them using the appropriate technologies.

## 5.1 DESIGN PHASE

Designing phase can be explained as the linkage of every node of the project, the robot holds the Arduino chip, Motor, Camera, and Batteries.

The Router will be the intermediary which will transmits the vision of the Camera, also it will connect the mobile with the Robot Wi-Fi module to empower the motion controlling of the Robot. Figure 5-1 shows the System structure and the main objects within the project:

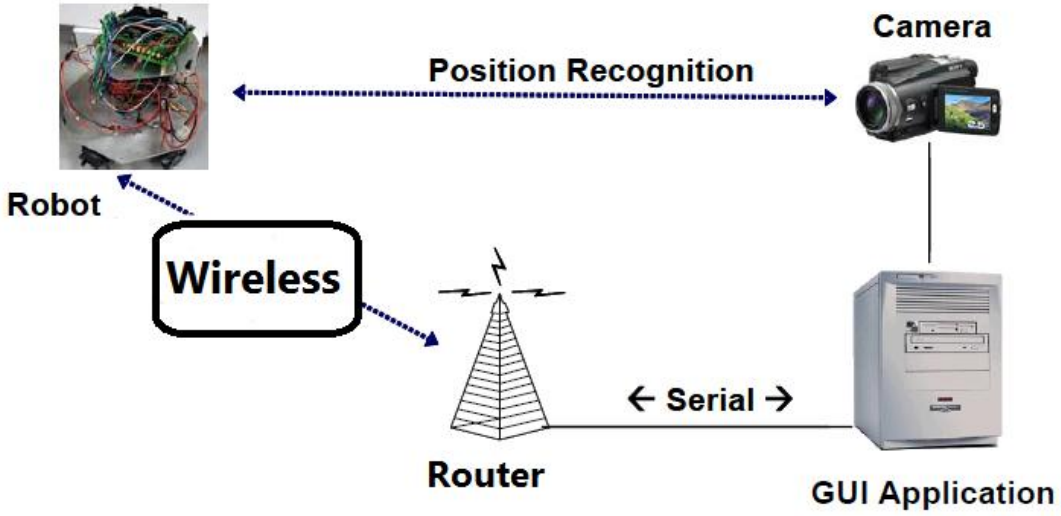


**Figure 5-1 System Structure**

### 5.1.1 Building the Hardware

It took us more than four months, gathering some materials and components and waiting for some of it to be deliver to Gaza, because there are some electronic chips that are not available here in the strip, so we had to wait for it, and after gathering all the hardware components, we started to build the Robot using all the resources we had of time and cost in order to deliver it on the time, these are the list of all the hardware components used in the project:

| Number | Name |
|---|---|
| 1 | Arduino UNO Chip |
| 2 | Wi-Fi Module |
| 3 | IP Provision Camera |
| 4 | Batteries |
| 5 | DC Motors |
| 6 | Router Adapter |
| 7 | Metal |
| 8 | Plastic |
| 9 | Charger |
| 10 | Resistors |
| 11 | Transistors |
| 12 | Regulators |
| 13 | Wires |

**Table 5-1-1 Hardware tools used to build the Robot**

## 5.2 BUILDING THE SOFTWARE

When the Hardware materials were collected, we built the software android application, the priority was to the hardware in the first place, as long as we get further of building the hardware, we were building the android application also, so it took us too much time to make a successful software application, time is considered as a cost when trying to build such a project, also we have had some troubles with the application so we looked for some consultants help to get it done and we gained it, thus the android application was ready.

### 5.2.1 Sequence Diagram:

The sequence diagram was used as a form of interaction diagram, which shows the interactions between the objects over time. During the analysis of the requirements, use-cases were

extended to the next level by providing a more formal level of refinement. Accordingly, use-cases were refined into one or more sequence diagrams.

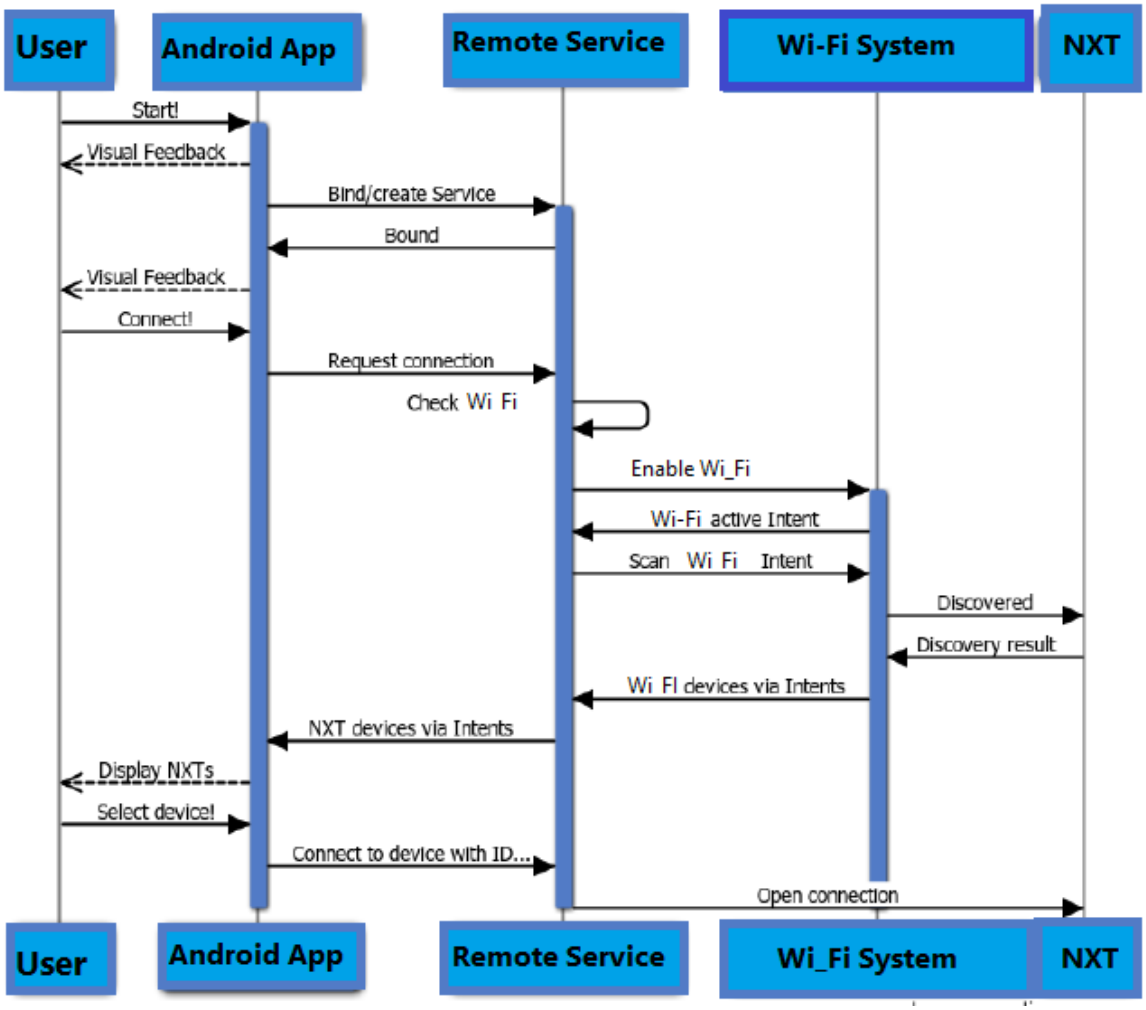


**Figure 5.2 Sequence Diagram for Connection**

## 5.3 Implementation Phase

After developing the Hardware of the system, the implementation phase emerges and through this phase, several activities and techniques were used to develop the hardware and mobile App. The development of the app starts with designing the app structure using XML. After that, enhanced user interfaces and dynamic app were developed. Later on, the app contents and buttons and web view space of the screen.

Then the Android mobile App was developed using the Android Studio v.1.5.

### 5.3.1 3D Design of the Robot

We have designed 3D forms for the Robot declaring all the pieces and details which we used to build the Robot. Figure 5.2.1 – Figure 5.2.3 shows the design.

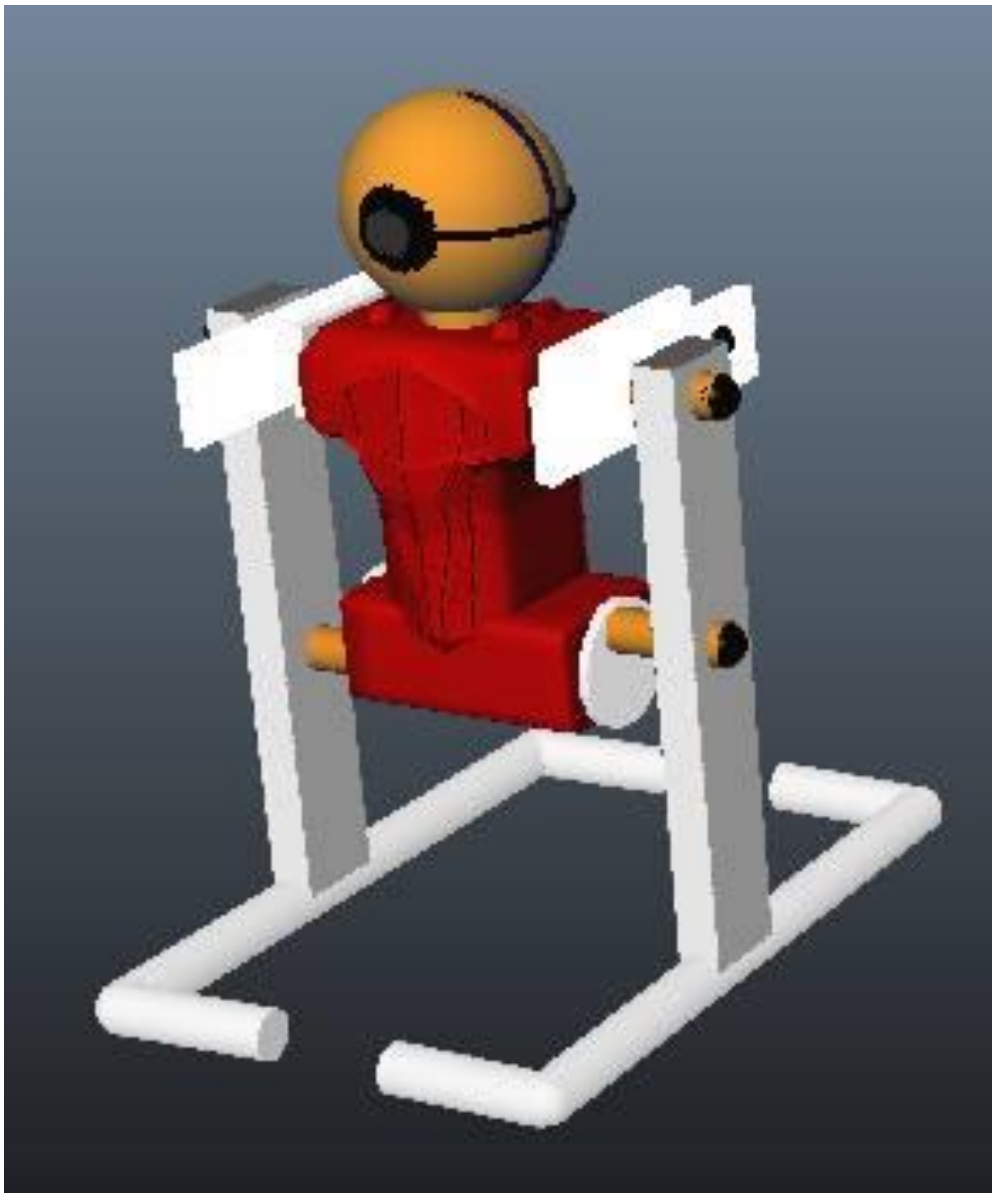

**Figure 5.2.1 3D Design of the Robot**

**Figure 5.2.2 3D Design of the Robot**

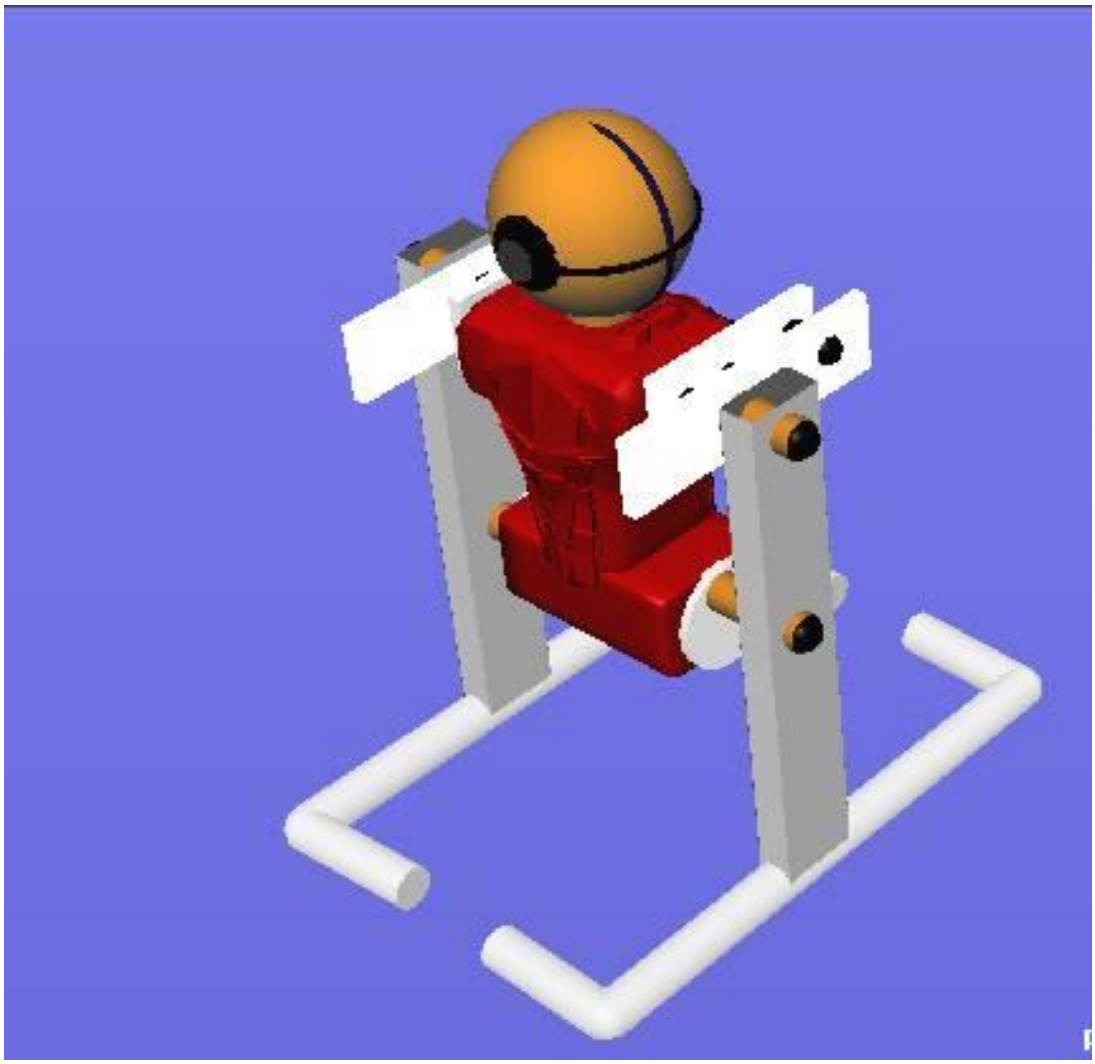

**Figure 5.2.3 3D Design of the Robot**

### 5.3.2 User Interfaces

These are the interfaces of the Android Application of this project.


**Figure 5.2.2 User interface**

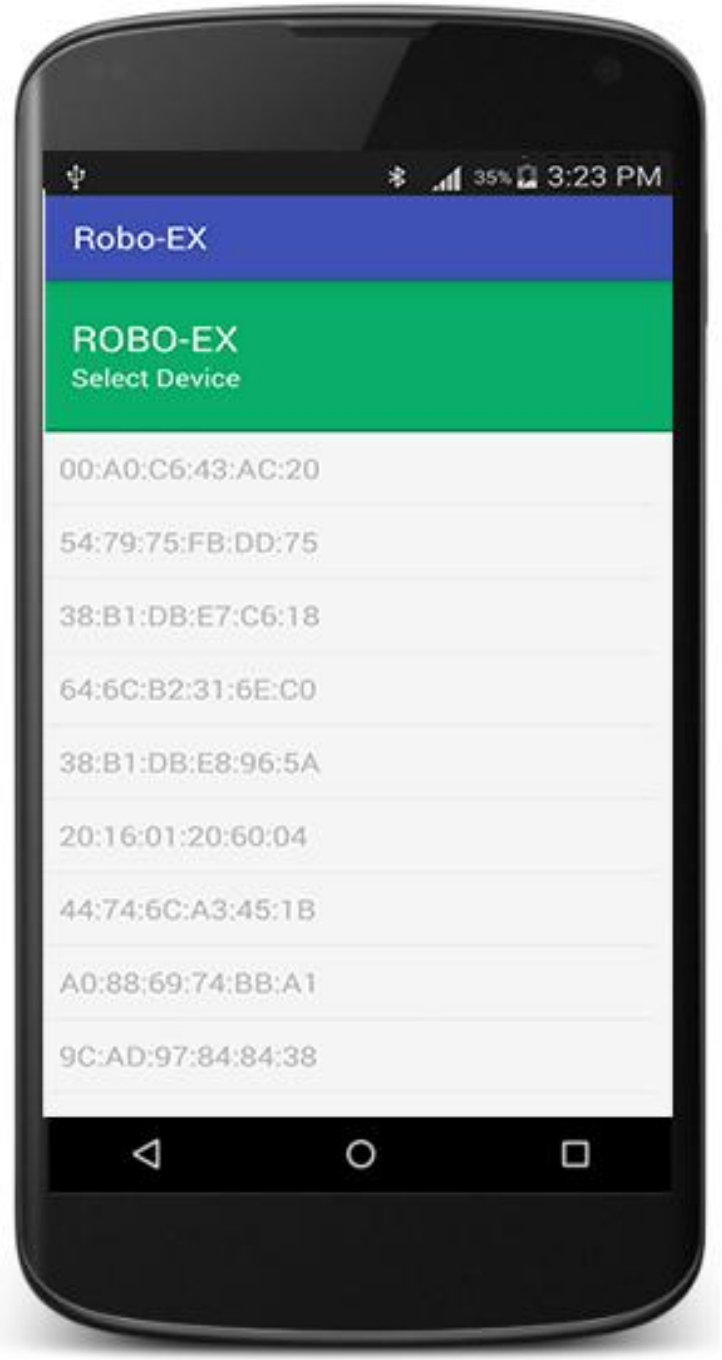


**Figure 5.2.3 User interface**

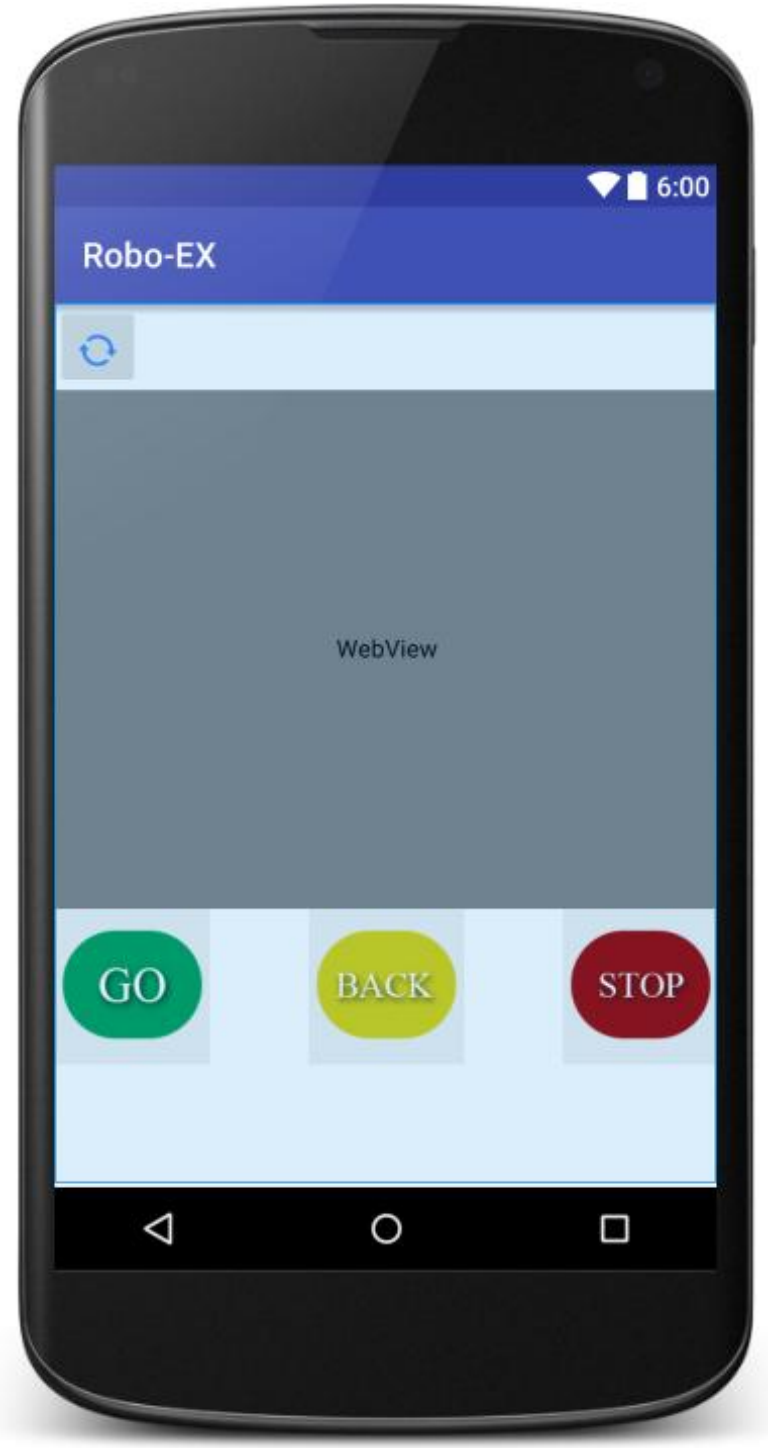


**Figure 5.2.4 User Interface**

# CHAPTER 6:

# TESTING AND TOOLS

# 6 CHAPTER 6: TESTING, TOOLS AND EVALUATION

This chapter will illustrate the last phase of the project, which is Testing and Tools. In the testing phase, the performance testing and functionality testing performed.

## 6.1 TESTING

Two types of testing was performed to test the robot and mobile App. These tests were mainly performance testing and functionality testing.

### 6.1.1 Performance Testing

After structuring the Robot and building the software application, we had some major problems with the hardware component, we installed the application on Note 2 Samsung Android Mobile, then we tested the connectivity of Wi-Fi between the mobile, router and the Robot, the connection was established and all the connections and functions were operating well.

## 6.2 TOOLS AND TECHNIQUES

| Phase | Activity | Sub-activity | Software/Hardware |
|---|---|---|---|
| Requirements Analysis | Defining User Requirements | E- Survey | SPSS |
| | | Interviews | |
| | Analyzing User Requirements | User Case Diagram | Edraw Max 7.0 |
| | | Sequence Diagram | Edraw Max 7.0 |
| | | Activity Diagram | EDraw Max 7.0 |
| | | Block Diagram | Edraw Max 7.0 |
| Designing and Implementation | Develop the Software Application | Designing the Android Application structure using XML | Android Studio |
| | | Designing the Application Using Android | Android Studio |
| | Develop the Hardware electronics | Programming the Arduino Chip using C Programming Language | Arduino |
| | | Building the Robot | Workshop tools |

| | | | |
|---|---|---|---|
| Testing and Evaluation | Testing the Android Application | Validating the Application file | GenyMotion Emulator, Note 2 Samsung Mobile |
| | Testing of the Electronics and Hardware | Validating the Programming of Arduino | Arduino |
| | | Testing the Connections and the power | Kit Board |
| | | Testing the Camera View and Motion | Tp-Link Router |

**Table 6.2 Tools and Techniques**

## 6.3 EVALUATION

Since the system has two parts (Hardware, Software), a sample of end-users and Robotics specialists were consulted to evaluate the Robot and mobile App.

### 6.3.1 Usability Evaluation

The usability is considered an important attribute of software quality and is referred to as the efficiency, effectiveness and satisfaction with which users can perform tasks with a tool. The term is used to describe the quality of a user's experience when interacting with a system whether a hardware, a software application. A usable system is one that enables users to perform their job effectively and efficiently, (Alzaza, 2012). Evaluating usability is considered an essential part of the system development process and there are different methods to support the human factors professionally.

Traditionally, the concept of usability has been defined in multiple different ways, basically on one of the following bases:

- **Semantics:** usability is equated to terms such as 'ease of use' or 'user-friendliness', without formal definition of the properties of the construct.
- **Features:** usability is equated to the presence or absence of certain features in the user interface such as Windows, Icons, Menus or Pointing devices.
- **Operations:** defined in terms of performance and affective levels manifest by users for certain task and environmental scenarios.

### 6.3.2 End-Users' Evaluation

To evaluate the system based on the customers, 30 disabled participants of (Disabled People Association) In Gaza were selected and asked to use the system. After they finished, they were asked to assess the system using a questionnaire designed for that purpose. The questionnaire was divided into two parts. The first part includes general information about the participants including, their gender, age, qualifications. The second part was used for the evaluation of the system, evaluate the participant's opinion about specific consideration about the system. The questionnaire data was then entered, filtered, coded and analyzed using SPSS.

As shown in Fig. 6-2, the male participants were about 56% while the female were about 43%. On the other hand, about 40% of them were between 25-30 years old, 30% between 19-24 years old, 20% above 30 years old and finally, 10% of them were between 15-18 years old, as shown in Fig. 6-3.

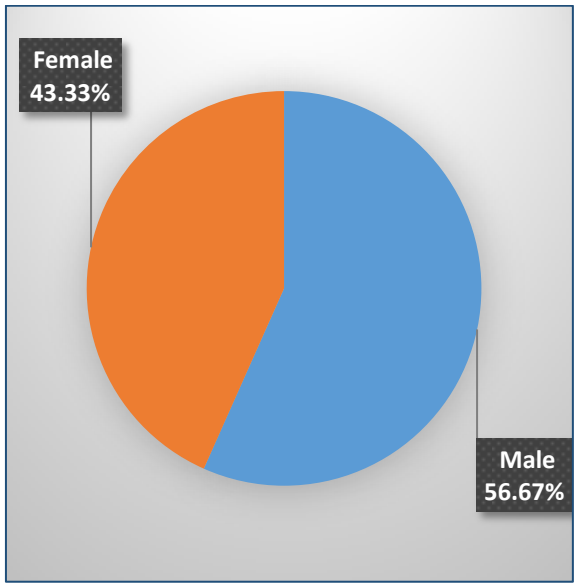


***Fig. 6-1:*** *Distribution of end-users according to gender*

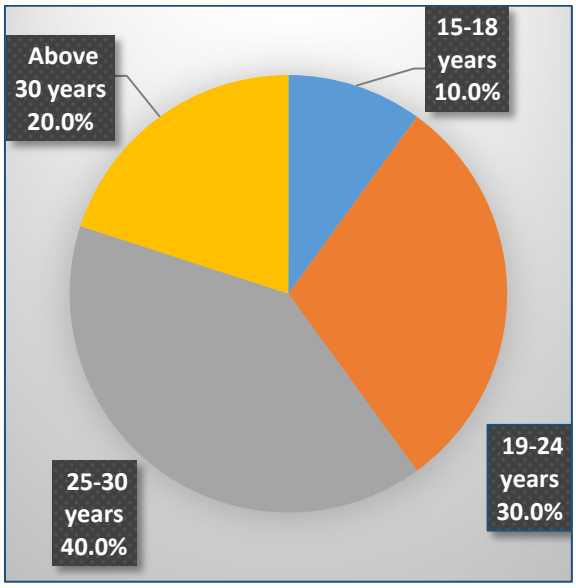


***Fig. 6-2****: Distribution of end-users according to age group*

Regarding the qualifications of the end-users participated in the evaluation process, 30% of them holds a bachelor degree, 20% were university students, about 16% of theme hold master degree and the others were distributed between secondary school students, PhD and diploma holders, as shown in Fig. 6-4. This diversity in the qualification of the users make the evaluation process more consistent and reliable.

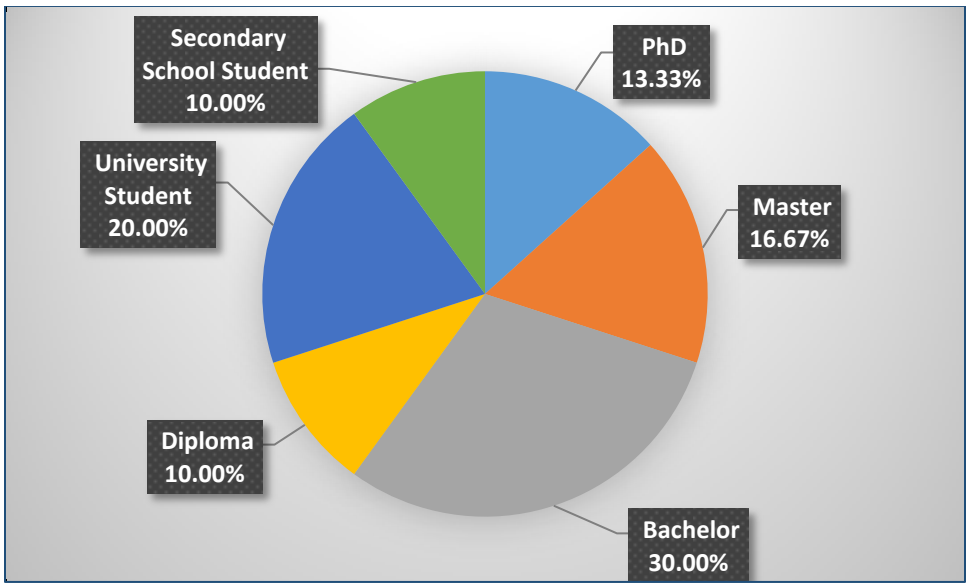


***Fig. 6-3**: Distribution of end-users according to qualifications*

The end-users were also chosen according to their experience in using mobile Apps. This was considered important criteria in the selection of the users because the users of the system must be familiar with this technology. As shown in Fig. 6-6, the half of the participants uses internet and mobile Apps since more than 10 years. The second half of them are distributed among those whose experience between 5-10 years and less than 5 years.

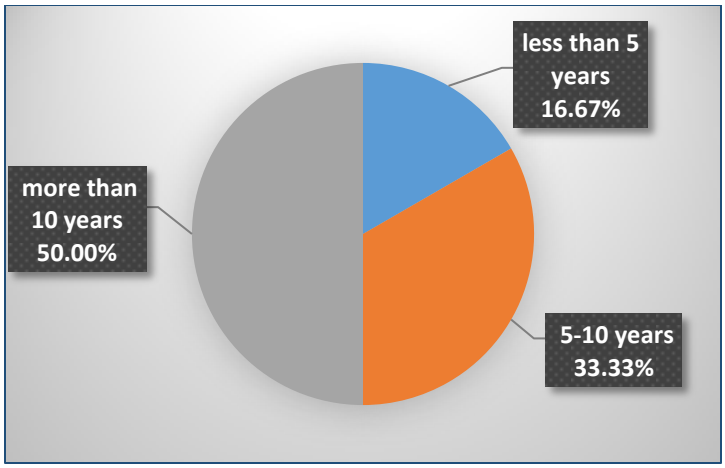


***Fig. 6-4:*** *Distribution of end-users according to their experience in internet and mobile Apps*

Regarding the importance of the system, participants were asked to evaluate the importance of the system from their point of view and after using the system. About 37% of them strongly agree that the system would help them to save their effort and reduces time, 40% of them agree and the rest were neutral for this point, as shown in Fig. 6-6. On the other hand, 40% of them strongly agree that the system would help them to reduce the effort and about 37% were strongly agree that the system will make them more satisfy about their expectations.

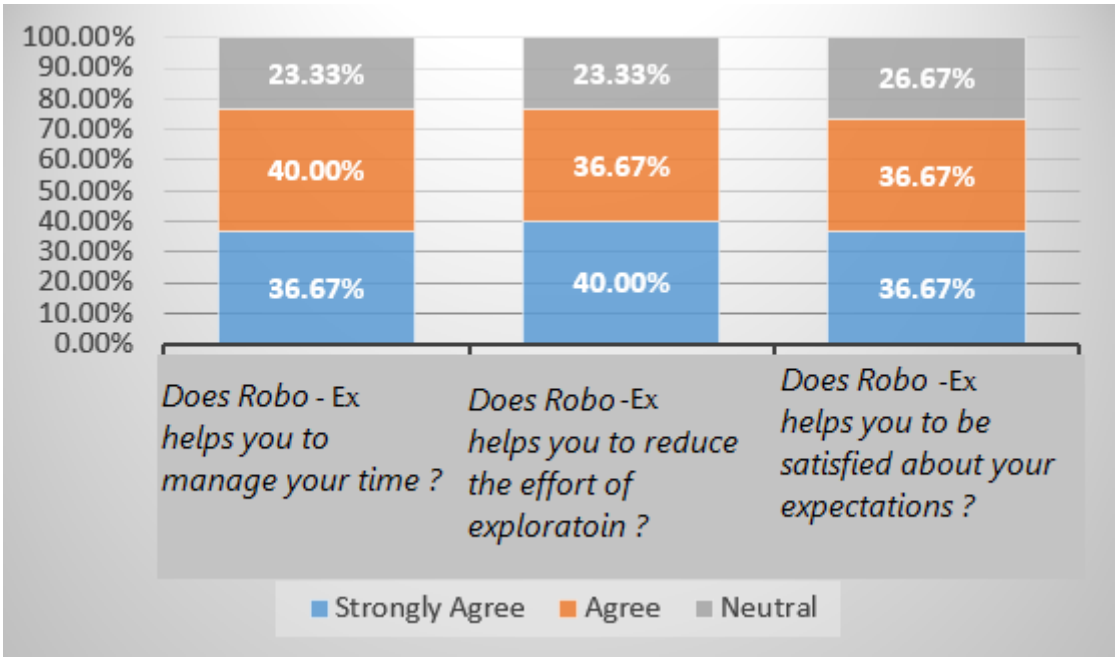


***Fig. 6-5:*** *End-users' perceptions about the importance of the system*

In relation to the easiness of the system, 43% of the users strongly agreed on the point that the system is easy to use, about 37% of them agree that the system is easy to use and the rest were neutral about this issue. In addition, about 47% of the users agreed that the system is flexible and interactive, while 23% strongly agreed. Further, about 37% of the users agreed that it is easy to become familiar with the system, as shown in Fig. 6-7.

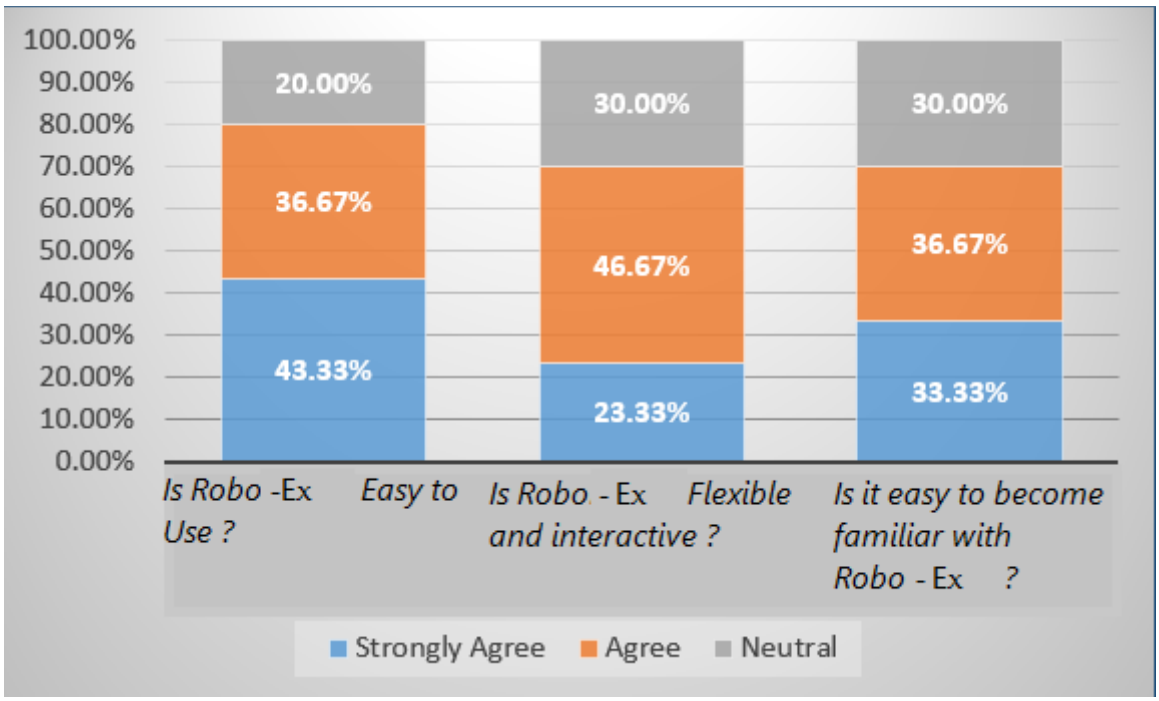


***Fig. 6-6:*** *End-users' perceptions toward the easiness of the system*

Concerning the ease of learning the system, about 47% agreed that the system is easy to learn. On the other hand, 43% of them strongly agreed that it would be easy to remember the steps, as shown in Fig. 6-8

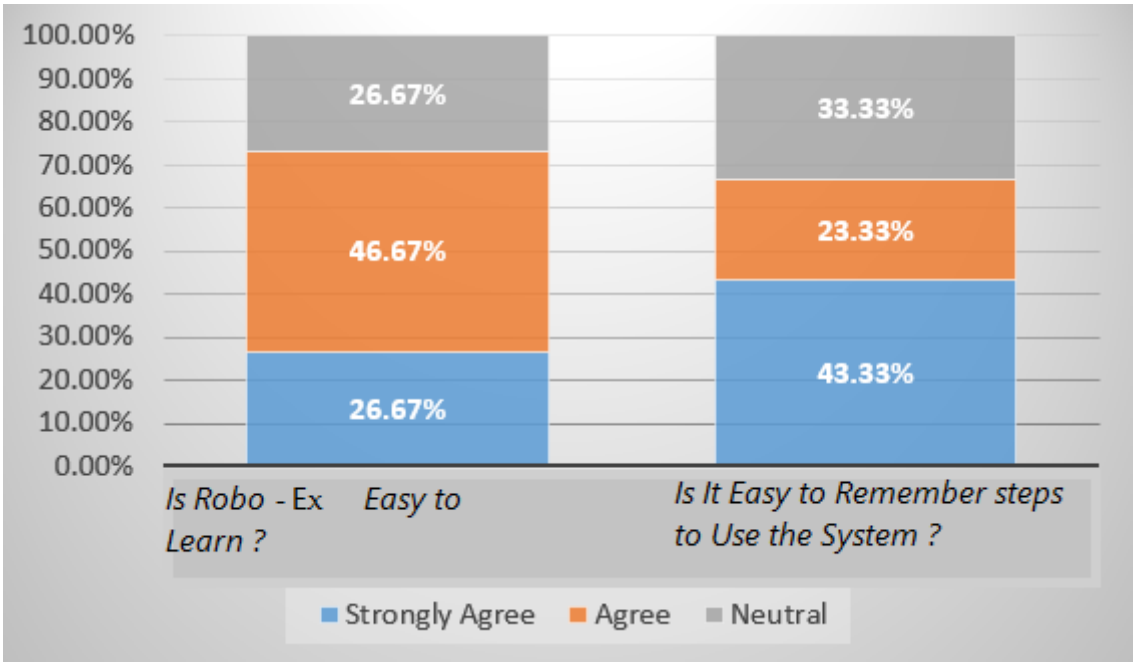


***Fig. 6-7:*** *End-users' perceptions towards the ease of learning of the system*

The last group in the evaluation was about the satisfaction of the end-users about the system. As shown in Fig. 6-9, 50% of the users strongly agree that the services provided by the system is enough, 33% of them agree and 17% were neutral about this issue. Further, about 43% of the users strongly agree that the system is useful and attractive and 30% agree on this issue. Moreover, the results showed that about 37% of the users strongly agree on the point that the system works the way they expected and want.

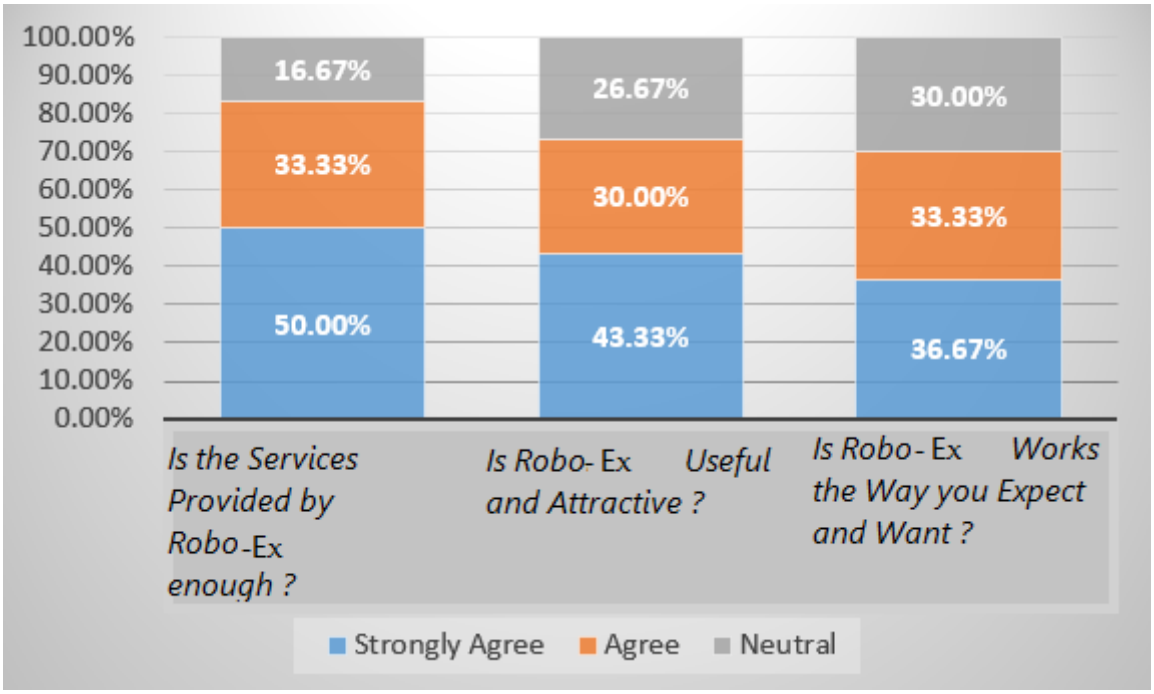


***Fig. 6-8**: End-users' perceptions about their satisfaction towards the system*

## 6.4 MAINTENANCE

This is the final stage after the installation of the Project. At this stage, maintaining, enhancing and updating the system will take place, which involve all the errors that are met through the usage of the developed system which will result in an updated and enhanced system.

We are maintaining both the Software application and the hardware components, variables in the hardware can be changed to create a totally new values of change, so all the components are linked together, if any value has changed, the whole system will be affected by any simple change and we will have to adjust all the values again depending on the Changing Value. This can lead the need of experience to maintain the components whenever something changes.

## 6.5 CONCLUSION

In recent years, with the pace of technological development, people have become more and more demanding in terms of quality of life. Today we find most robots working for people in industries, factories, warehouses, and laboratories.

Robots are useful in many ways. For instance, it boosts economy because businesses need to be efficient to keep up with the industry competition. Therefore, having robots helps disabled people to make their life's easier and happier, moreover, robots can help business owners to be

competitive, because robots can do jobs better and faster than humans can, e.g. robot can build, assemble a car.

Yet robots cannot perform every job; today robot roles include assisting research and industry. Finally, as the technology improves, there will be new ways to use robots which will bring new hopes and new potentials.

## 6.6 FUTURE WORK

We have a clear vision for the future of this project, we can explain this vision within these points:

1- The Robot Hardware will be implemented with higher quality and well-shaped pieces of content.
2- The Objectives of the Project will be expanded into much more than surveillance and exploration; it will be capable to do some smart functions that can help more segments of people.
3- The motion of the Robot will be more flexible and easier to control and respond time.
4- Mobile Application will be developed matching up these new functions of the Hardware Robot, Also The application will be much friendly and easy to use.

# REFERENCES


[1] Salah El-Deen, 2014. The security Robot, Graduation project of Engineering collage in Al-Shariqa University.

www.alkhaleej.ae/

[2] Arab inventions Website, 2013). The first exhibition of Engineering faculty graduation in Taez University.

www.arabinvent.com

[3] Al-Shaer, 2013. Auto Robot with young Palestinian fingers.

www.safa.ps/

[4] Alzaza, N., (2012), "**Research Methodology in Information Technology**", 1st edition.

[5] Webster M., (2013) "**The Robot Definition**"

www.merriam-webster.com

[6] Arduino official Website www.Arduino.cc "**Using Arduino**", "**Why Arduino?**"

[7] Jaeger, Robert J. 2006. "**Rehabilitation robotics research at the National Institute on Disability and Rehabilitation Research**. "Journal of Rehabilitation Research & Development, August. xvii-xx. Academic Search Complete, EBSCOhost (accessed April 8, 2013).

[8] Gary, Rotstein (14 November 2007). "**Robotic aids for the disabled and elderly**". Pittsburgh Post-Gazette. Retrieved 9 April 2013.

[9] Ministry of Health, 2014 "**The number of disabled people on Palestine**"

www.felesteen.ps

[10] Android Developers Guide. Android Architecture. [online] 2013. URL: http://.android.com/about/versions/index.html.

[11] Arduino, iOS, android and technology tit bits, http:// sree.cc/google/android/Using-Wi-Fi-in-android

[12] Smart phones android operated robot, http://www.sooxmatechnologies.com

[13] R. Jubeh, "**Simple robotics with Fujaba**," in Fujaba Days. Technische Universit¨at Dresden, Sep. 2008

[13] INEEL website [online]. Available from: http://www.inel.gov/adaptiverobotics/humanoidrobotics/ Access 12 June 2005.

[14] Foerst Anne, (1999) Artificial sociability: from embodied AI toward new understandings of personhood, Technology in Society, 21, pp. 373–386. T209 Resource CD-ROM, Cyborg, part 2 – Robotics.

[15] ASIMO Honda [online]. Available from: http://world.honda.com/HDTV/ASIMO/ Access 11 June 2005.

[16] MIT website [online]. Available from: http://www.ai.mit.edu/projects/humanoid-robotics-group/ Access 11 June 2005

[17] Jones, A.C. (2002) 'Minds, matter and machines', T209 Resource CD-ROM, Cyborg, part 1 – Robotics.

[18] NASA website [online]. Available from: http://www-aig.jpl.nasa.gov/public/planning/dist-rovers/ Access 12 June 2005.

[19] Bruce, I.S. (1998) 'Man Made', The Scotsman, December 1, Spectrum, p. UP4, T209 Resource CD-ROM, Cyborg, part 1- Bionics.

[20] Android Developers Guide. Android Architecture. [online] 2013. URL: http://.android.com/about/versions/index.html.

[21] Heidi Monson (1999) Bluetooth technology and implementations, John Wiley & Sons.

[22] Piyare, R. and Tazil, M. (2011) "Bluetooth based home automation system using Android phones". IEEE 15TH International symposium on consumer electronics (ISCE), 14-17 june 2011, Singapure.

[23] Potts, J. and Sukittanon, S. (2012) "Exploiting Bluetooth on android mobile mobile devices for home security application", proceedings of southeast can, 15-18 March 2012, Orlando, fluorides.

[24] HC-06 Bluetooth module, http://www. Lanwind.com/files/hc-06 en,pdf.

[25] Arduino, iOS, android and technology tit bits, http:// sree.cc/google/android/Using-Bluetooth-in-android.

[26] Smart phones android operated robot, http://www.sooxmatechnologies.com [8] Bluetooth based android phone/tablet controlled robot, http://www.robokits.co.in and http://www.robokitsworld.com

# APPINDICES

# APPENDIX A: REQUIREMENT ASSESSMENT QUESTIONNAIRE FOR DISABLED PEOPLE ASSOCIATION - GAZA

**استبيان**

**جمعية المعاقين حركيا – قطاع غزة**

تهدف هذه الاستبانة لمعرفة مدى رضاك وقبولك لاستخدام نظام اختبرني الخاص بالامتحانات الالكترونية. مشاركتكم في الإجابة على هذا الاستبيان تساهم في ضمان نجاح هذه الدراسة، علما أنه سيتم التعامل مع كافة المعلومات التي تقدمها بأكبر قدر ممكن من السرية.

**شكراً على تعاونك معنا،،،**

للتواصل والاستفسار

وسيم عايش – محمد الوكيل

جامعة فلسطين -مدينة الزهراء – غزة – فلسطين

**اولا : معلومات عامة :**

**هذا القسم يتعلق بالمعلومات الشخصية الخاصة بك، لذا يُرجى ملئ الفراغات ووضع علامة (√) حول الإجابة المناسبة (يُرجى وضع علامة واحدة فقط).**

1- الجنس ذكر [ ] أنثى [ ]

2- العمر اقل من 25 [ ] من 25 الى 45 [ ] أكثر من 45 [ ]

3- المستوى التعليمي [ ] متدرب [ ] دبلوم [ ]

بكالوريوس [ ] ماجستير [ ] أخرى _____

**- تجربتك مع الهواتف واستخدام الانترنت ؟**

[ ] لم اتعامل مع الهواتف والانترنت

[ ] أقل من ثلاث سنوات

[ ] ثلاث إلى خمس سنوات

[ ] خمس الى عشر سنوات

[ ]اكثر من عشر سنوات

**ثانياً: عوامل قبول نظام اختبرني**

بعد قراءتك للخيارات أدناه، يمكنك استخدام الأرقام من 1 إلى 5 كالتالي:

( 1 = معارض بشدة ، 2 = معارض ، 3= محايد ، 4= موافق ، 5 = موافق بشدة )

| | | | | | | |
|---|---|---|---|---|---|---|
| **1. تهدف هذه المجموعة من الأسئلة لفهم وجهة نظرك تجاه الفائدة من استخدام النظام** | | | | | | |
| **1.** | استخدام هذا النظام يمكنني من انجاز المهام بسرعة | 1 | 2 | 3 | 4 | 5 |
| **2.** | استخدام هذا النظام يسهل علي حياتي اليومية | 1 | 2 | 3 | 4 | 5 |
| **3.** | استخدام هذا النظام يزيز من انتاجيتي | 1 | 2 | 3 | 4 | 5 |
| **4.** | هذا النظام يساعدني في تعزيز الفعالية في بيئة التعليم | 1 | 2 | 3 | 4 | 5 |
| **5.** | هذا النظام يساعدني على الانخراط في الحياة العملية | 1 | 2 | 3 | 4 | 5 |
| **6.** | اجد الفائدة في استخدام هذا النظام في حياتي اليومية | 1 | 2 | 3 | 4 | 5 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **2. تهدف هذه المجموعة من الأسئلة لفهم وجهة نظرك تجاه سهولة استخدام النظام** | | | | | | |
| **.1** | اجد سهولة في تعلم كيفية استخدام هذا النظام | 1 | 2 | 3 | 4 | 5 |
| **.2** | التفاعل مع هذا النظام واضح ومفهوم | 1 | 2 | 3 | 4 | 5 |
| **.3** | اجد في هذا النظام سهولة ومرونة في التعامل | 1 | 2 | 3 | 4 | 5 |
| **.4** | من السهل بالنسبة لي ان اصبح ماهرا في استخدام النظام | 1 | 2 | 3 | 4 | 5 |
| **.5** | بشكل عام, هذا النظام سهل في الاستخدام | 1 | 2 | 3 | 4 | 5 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **3. تهدف هذه المجموعة من الأسئلة لفهم مدى قابلية تعلم النظام** | | | | | | |
| **.1** | كان من السهل تعلم هذا النظام | 1 | 2 | 3 | 4 | 5 |
| **.2** | احتجت لقراءة الكثير من المعلومات قبل ان اتمكن من استخدام هذا النظام | 1 | 2 | 3 | 4 | 5 |
| **.3** | المعلومات التي قدمها هذا النظام سهلة الفهم | 1 | 2 | 3 | 4 | 5 |

| 4. تهدف هذه المجموعة من الأسئلة لفهم النتائج المترتبة على استخدام النظام في المستقبل | | | | | | |
|---|---|---|---|---|---|---|
| .1 | كنت قادرا على إكمال المهام الخاصة بي بسرعة باستخدام النظام | 1 | 2 | 3 | 4 | 5 |
| .2 | تمكنت من إنجاز مهامي باستخدام النظام | 1 | 2 | 3 | 4 | 5 |
| .3 | كنت قادرا على إكمال المهام بكفاءة باستخدام النظام | 1 | 2 | 3 | 4 | 5 |
| .4 | اعتقد انني سوف اصبح عنصرا منتجا بسرعة باستخدام النظام | 1 | 2 | 3 | 4 | 5 |
| .5 | من تجربتي الحالية مع النظام , اظن انني سوف استخدم هذا النظام بشكل منتظم | 1 | 2 | 3 | 4 | 5 |
| .6 | اوصي باستخدام هذا النظام | 1 | 2 | 3 | 4 | 5 |

**بإختصار, هل لديك اي تعليقات اخرى :**

_____

_____

_____

**شكرا لتعاونك معنا**