



An-Najah National University
Faculty of Engineering & Information Technology
Computer Engineering Department



Mobile Robotic Arm

Prepared By: Sanaa Mohammad Yahya, Azhar Dibie

Introduced to: Dr. Sufyan Samara

Dr. Hanal Abu_Zant

DATE: 30-4-2015

Presented in Partial fulfillment of the requirement for Bachelor degree in Computer Engineering

Acknowledgements...

We would like to thank almighty God, to reconcile us at each step and for giving us everything to make our work continuous without laziness and foil.

We would like to express our gratitude for everyone who helped us during the graduation project starting with endless thanks for our supervisors Dr. Sufyan Samara and Dr. Hanal Abu Zant who didn't keep any effort in encouraging us to do a great job, providing our group with valuable information to be better each time. Thanks for the continuous support and kind communication which had a great effect regarding to feel interesting about what we are working on.

We cannot express enough thanks to our loving and supportive families for their continued support. Our completion of this project could not have been accomplished without the support of them.

Finally, we convey our warmest thanks to our friends and all the people who helped, supported and encouraged us to successfully finish the graduated project whether they were in the university or in our special lives.

Disclaimer statement.

This report was written by Sanaa Yahya and Azhar Dible at the computer Engineering Department, Faculty of Engineering, An-Najah National University. It has not been altered or corrected, other than editorial corrections, as a result of assessment and it may contain language as well as content errors. The views expressed in it together with any outcomes and recommendations are solely those of the student(s). An-Najah National University accepts no responsibility or liability for the consequences of this report being used for a purpose other than the purpose for which it was commissioned.

Table of content

Acknowledgements.....	2
Disclaimer statement.	3
Table of content	4
Table of figures.....	5
Abstract.....	6
Ch.1: Introduction	7
Ch.2: Constraints and Earlier course work	8
2.1 Constraints	8
2.2 Earlier coursework.....	8
2.3 Standards/Codes.	8
Ch.3: Literature Review.	9
Ch.4: Methodology.....	9
4.1 Parts Used.	9
4.2 Procedures.	10
4.2.1 Arduino UNO.	11
4.2.2 Robotic Arm.....	12
4.2.3 Servo motor.....	13
4.2.4 DC motor	14
4.2.5 IP Camera	16
4.2.6 Bluetooth module.....	20
4.2.7 L298N motor driver	21
4.2.8 Android mobile application.	23
Ch.5: Results and Analysis	26
Ch.6: Discussion.....	27
Ch.7: Conclusions and Recommendation	28
References.....	29
Bibliography	29

Table of figures

Figure 1Arduino UNO	11
Figure 2Robotic Arm.....	12
Figure 3 servo motor	13
Figure 4 Dc motors	15
Figure 5 Ai-ball running	16
Figure 6 Ai-ball.....	19
Figure 7 HC-05 Bluetooth module.....	20
Figure 8 L298N Motor Driver.....	21
Figure 9 Circiut of the Project.....	22
Figure 10 Mobile Application Interface	24
Figure 11 The Whole Project	25

Table of tables

Table 1Parts Table	9
--------------------------	---

Abstract...

Robotic Arm is designed to develop a robotic vehicle which is used to pick up an object with a soft catching gripper. The most important part in this project is controlling the movement of the arm by using mobile phone application. For the vehicle side we used Arduino to control the movement of the arm and the vehicle. The Android mobile application controls the movements wirelessly.

Robotic Arm project is very useful for people who are crippled and have problem moving freely to take something far away. This project could also help scientists and people who work in places that are inaccessible. Further the project can be enhanced by interfacing it with a camera so that the person controlling it can view operation of the arm and gripper remotely.

Ch.1: Introduction

Robots are smart machines that can be programmed and used in many areas such as industry, manufacturing, production lines, or health, etc. These robots perform hard, dangerous, and accurate work to facilitate our life and to increase the production because they can work 24 hours without rest, and can do works like human but more precisely and with less time. Assistive mobile robots that perform different kinds of work over everyday activities in many areas such as industry, manufacturing, production lines, or health, etc. are very commonly used to improve our life.

The idea of this project is to exploit robotics usage on healthcare field to help mobility disabled people. Smartphones are a more affordable and efficient hand held devices which can be used to support collaborative activities in a community. This project combines the capabilities of robots with the Android mobile phone platform via Bluetooth connection. This provides an interactive system by which disabled people can control an assistant robot with simple touches on user friendly interface, within the range of Bluetooth signals (10meters) to get objects from the surrounding area. The user will be able to control the movement of the robot and perform actions of catching different kinds of objects. The project also supported with ip camera for viewing real-time video in order to facilitate the vehicle and arm movement, also to increase accuracy in places that are not visible to the eye.

Ch.2: Constraints and Earlier course work

2.1 Constraints

We faced a lot of constraints in this project. Some of them related to the limitation of the resources and others related to the way in which the resource employed.

Our project constraint was the following:

- At the beginning of our project the tank module was not available so, we forced to wait for three weeks until we get them.
- Also the Arm and servo motors took us about one month to find the suitable one and to get it so that also caused a long delay for the work.

2.2 Earlier coursework

To do this project, we used C++ course which we used in programming the Arduino. Also microcontroller course help us in using Arduino chip, moreover electronic and circuit courses to be able to understand, design and build our circuits also to know how to use lab instruments. Beside that we benefit from online Android course for Abdallaheid.net that helped us a lot in programming the android mobile application that controls the movements of the tank and the arm.

2.3 Standards/Codes.

This project is built using Arduino and Android programming languages.

Ch.3: Literature Review.

As we all know that this project is not the first. There are many projects that give similar functionality of the tank and the camera in our project just like BT Bot Control & IPCam Bot. But till now there is no project that is exactly similar to our project because we added the arm part that does not exist in any of them.

Ch.4: Methodology.

4.1 Parts Used.

Table 1Parts Table

Part	Quantity
Arduino UNO	1
Robotic Arm	1
Servo motor	2
DC motor	2
IP Camera	1
Bluetooth module	1
L298N motor driver	1
Android mobile phone	1
Power source	1
Tank	1
wires	many

4.2 Procedures.

First we search a lot about previous work that we could benefit from and learn how to build the circuit and write the software that controls our circuit to get started with the project.

After deep search and work we started with tank movements which are running the two DC motors connected with it. This was using Bluetooth module, Arduino to install the software on, tank with the connected Dc motors and the mobile application.

Then moving to the next step which is the Camera that is assigned with the project as mentioned in previous chapters. We used IP Camera which is Ai-ball Camera that works in many modes. The mode that we used is access point mode in which the camera acts as an access point and the only thing you need to do is connecting with this AP and type the specified URL for the camera which is <http://ai-ball.com> the camera then will start viewing real time video.

All previous work was been tested using different mobile applications that are already built. But the problem was that there wasn't any application that could gather all the functionality we want properly so the next step was building our own Android mobile application for our project which wasn't easy because Bluetooth consumed a lot of time to work properly.

Finally the only thing that remained to do and accomplish is controlling the movements of the robotic arm by controlling the movements of the two servo motors one for the hinge and the other for the gripper.

4.2.1 Arduino UNO.

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. [1]



Figure 1 Arduino UNO

In our project we used the Arduino as a microcontroller to control the hardware movements. The code that we installed on it is also Arduino code includes both codes for controlling the movement of the two DC motors that are connected with the tank and the two servo motors that are connected with the arm.

We connect the Arduino with the motor driver, the servo motors and the Bluetooth module.

4.2.2 Robotic Arm.

A robotic arm can be any of a number of mechanical, programmable devices that are designed to manipulate objects in a way that is similar to the human arm. The robotic arm is one of the most useful pieces of technology to be introduced in the 20th century, and quickly became a cornerstone in many areas of manufacturing. It can be used for many different jobs and functions that may be too tedious, difficult or dangerous for a human to do. You might first think of the automobile industry when thinking about robotic arms, but they can be used for many other useful tasks besides welding and painting auto parts. [2]



Figure 2 Robotic Arm

In our project the Arm is the main part that gives the project its importance. We used the arm with only two servo motors one on the wrist bone that joins the two parts of the arm as shown in figure 2 and the other is connected with the gripper for open and close. As we said before that the Arduino microcontroller will take the responsibility for moving the arm according to the data received from the mobile application.

4.2.3 Servo motor.

A servomotor is a rotary actuator that allows for precise control of angular position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

Servomotors are not a specific class of motor although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system.

Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing. [3]



Figure 3 servo motor

Again with the servo motors and its functionality to move the arm parts in the project. The servos are connected with the Arduino and controlled according to the code that makes the servo moves in specific angle circularly.

4.2.4 DC motor

A DC motor is any of a class of electrical machines that converts direct current electrical power into mechanical power. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor. Most types produce rotary motion; a linear motor directly produces force and motion in a straight line.

DC motors were the first type widely used, since they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight motor used for portable power tools and appliances. Larger DC motors are used in propulsion of electric vehicles, elevator and hoists, or in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications. [4]

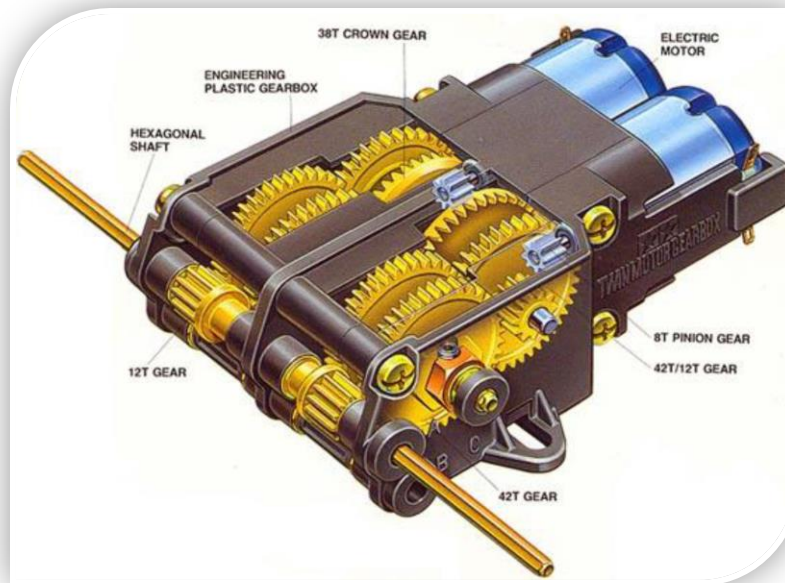


Figure 4 Dc motors

These two Dc motors are enabled to move left, right, forward, backward using H-bridge. Each of which has two lines that are connected with the H-bridge and need 9 volt to work properly. To move forward we have to run both motors in the same direction which forward. To move reverse is similar to forward but in reverse mode. To move either left or right one of the motors should be in the opposite direction of the other. As we mentioned that these two motors are connected with the tank and control the movement of its two sides' tracks.

4.2.5 IP Camera

We used a special kind of IP Camera which is the Ai-Ball. The Ai-Ball is an ultra-portable, wireless camera module that allows users to view and record audio and video wirelessly on their PC or smartphones. With its 802.11 b/g Wi-Fi interface, the Ai-Ball allows you to stream and record audio video images through your mobile devices such as your smartphones (iPhones or Android devices) and laptops on the go. Powered by a CR2 battery and coupled with its compact design(30mm in diameter and 35 mm in length + weighing just 100g with battery), you can easily carry the Ai-Ball around or hang it as a keychain. [5]

After you configure the Ai-ball you can easily use it as shown in the figure below. All you need is to turn it on and turn on the Wi-Fi on your device and it could be anything that opens web browser on it then you should type the specified URL for the camera which is <http://ai-ball.com> and enjoy recording videos and capturing photos.

3 Simple Steps



Figure 5 Ai-ball running

♣ SPECIFICATIONS OF AI-BALL.

Camera Specifications

- VGA 640x480, QVGA 320x240, QQVGA 160x120, up to 30fps
- F2.8
- View Angle: 60 degree
- Focusing: 20cm to Infinity

Video Recorder

- Motion JPEG
- Compression mode : standard, high
- Typical bit rate: (VGA): standard (2500 kbps), high (1600 kbps)
(QVGA): standard (1100 kbps), high (800 kbps) (QQVGA): standard (600 kbps), high (400 kbps)

Video Snapshot

- JPEG
- Compression mode : standard, high

Wireless Interface

- IEEE 802.11b/g 2.4GHz ISM Band

Wireless Security

- WEP 64/128, WPA, WPA2

Wireless Range

- Infrastructure: 20m (Typical)
- Adhoc: 7.5m (Typical)

Wireless performance*

- Infrastructure: 54Mbps max. Connection rate
- Adhoc: 11Mbps max. Connection rate
- Note: Wireless performance varies with distance and access point usage.

Antenna

- Single, internal

Dimension / Weight

- 30mm (Diameter) x 35mm (L)
- 100g

Power Supply / Consumption

- Battery operated
- Voltage: 3.0V
- Power: 750mAH (CR2)
- Current consumption: 320mA (typical); 350mA (maximum)

RoHS

- RoHS Compliant

User interface

- Menu driven via Embedded Web server on module



Figure 6 Ai-ball

4.2.6 Bluetooth module.

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Bluecore 04-External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature). It has the footprint as small as 12.7mmx27mm. Hope it will simplify your overall design/development cycle. [6]

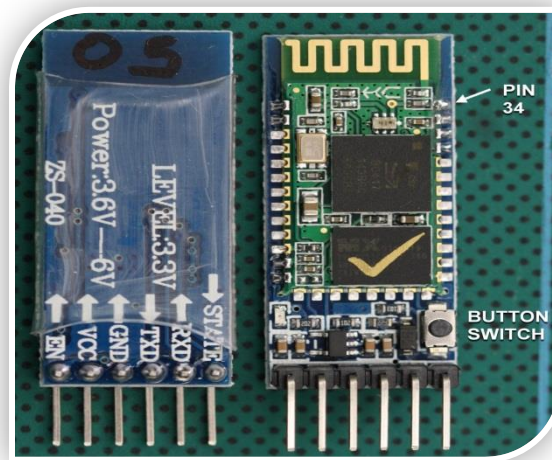


Figure 7 HC-05 Bluetooth module

The Bluetooth module has to be connected with the Arduino physically by the Rx and Tx pins in both chips. But pay attention to connect the Rx with the Tx not the Rx with the Rx in different chips. This Bluetooth module also must be connected with the mobile phone that has the Android application and in this case the application will send data through the Bluetooth to the Arduino. For the sake of this we used a library which is Android.Bluetooth that allows all these actions in the mobile application side.

4.2.7 L298N motor driver

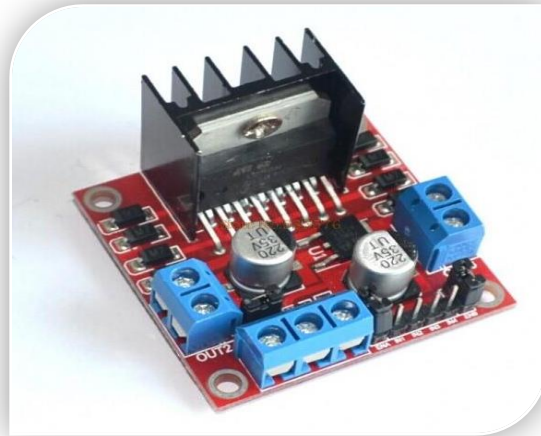


Figure 8 L298N Motor Driver

To control the two DC motors in our project that are connected with the tank first we connected each motor to the A and B connections on the L298N module.

Next, we connected our power supply - the positive to pin 4 on the module and negative/GND to pin 5. And of course we didn't forget to connect Arduino GND to pin 5 on the module as well to complete the circuit.

Now we will need four digital output pins on our Arduino to be attached with the driver module. In our project we have two DC motors, so digital pins D2, D3, D4 and D5 will be connected to pins IN1, IN2, IN3 and IN4 respectively.

The motor direction is controlled by sending a HIGH or LOW signal to the drive for each motor (or channel). For example for motor one, a HIGH to IN1 and a LOW to IN2 will cause it to turn in one direction, and a LOW and HIGH will cause it to turn in the other direction.

However the motors will not turn until a HIGH is set to the enable pin. And they can be turned off with a LOW to the same pin(s).

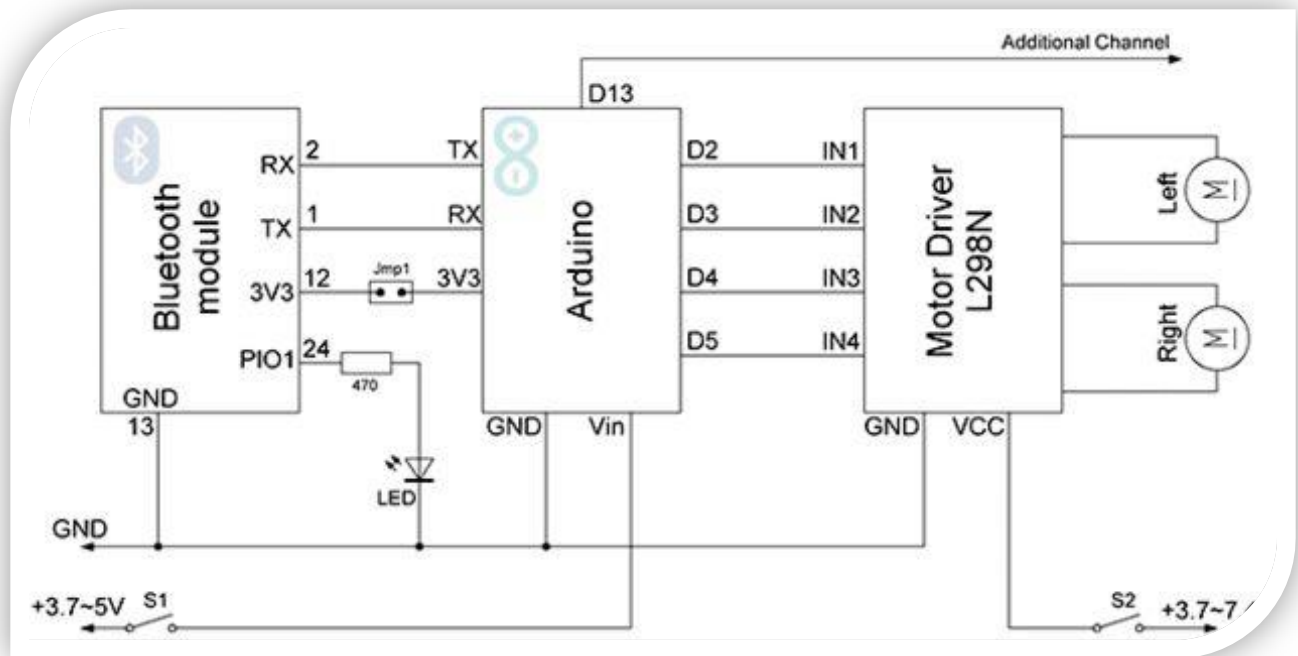


Figure 9 Circiut of the Project

4.2.8 Android mobile application.

The android mobile application is also an essential part of our project. As we explained before that smartphones are very used nowadays, the need for moving every single detail in our life to be controlled easily by our smartphones and from here we came up with our project idea to choose the mobile application instead of a remote controller.

For the application it can be divided into three parts. The first is for controlling the IP-Camera by attaching its IP to the application and connecting with its access point as mentioned before. The second is the part that controls the movements of the tank ' forward, reverse, left, right and stop '. This section is just buttons that sends data via Bluetooth when clicked on them. These data sent are received in the Arduino part to take the action corresponding to it. For example if you clicked the forward that means '1' and the mobile application will send the data '1' via Bluetooth to the Arduino that will take the action related to the variable '1' which turning on the Dc motors in the forward mode. Finally the third part which almost similar to the second one but here we control the movements of the arm not the tank. The functionality is the same in the Android application which is the movements by clicking on the buttons. However there is a bit difference which is we are controlling servo motors not Dc motors. But if we moved to the Arduino code it could be different of course since we are controlling servos not DC motors.

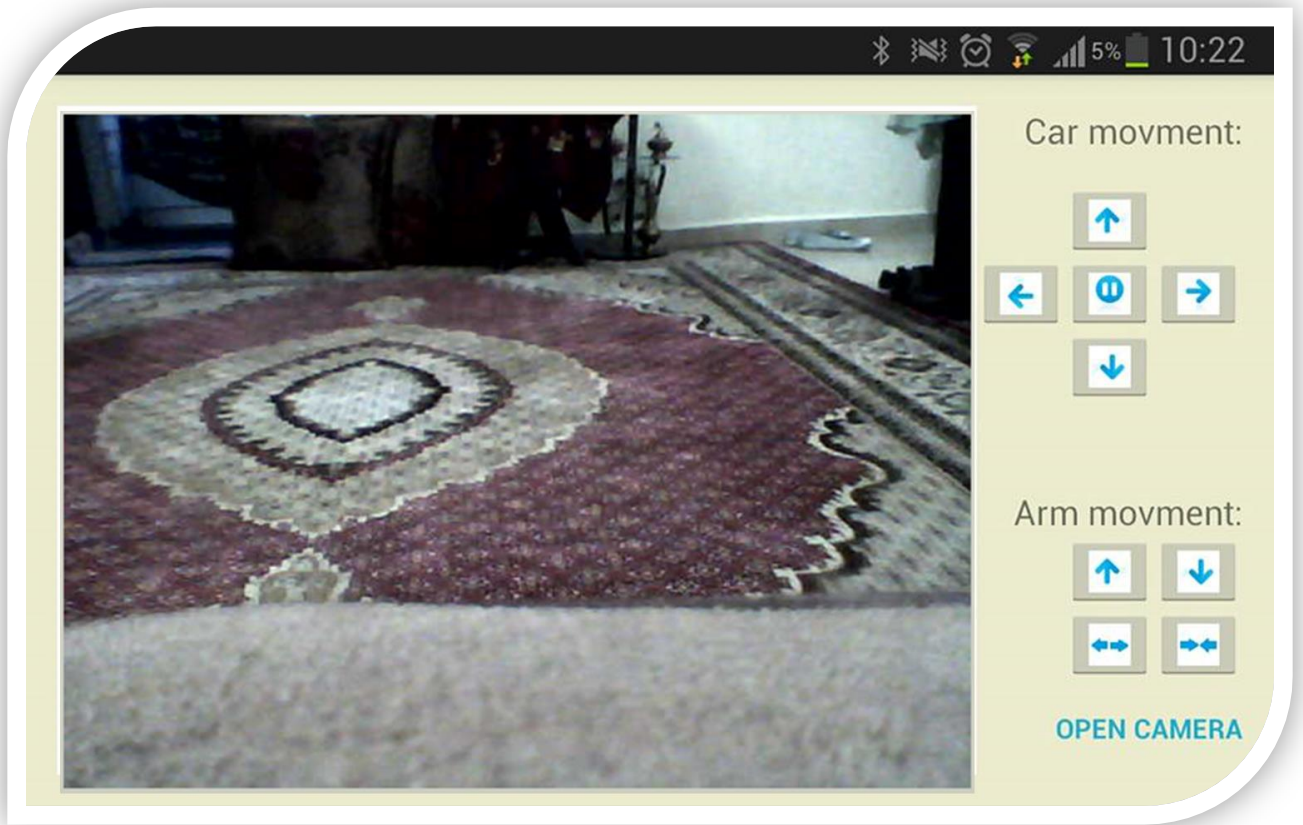


Figure 10 Mobile Application Interface

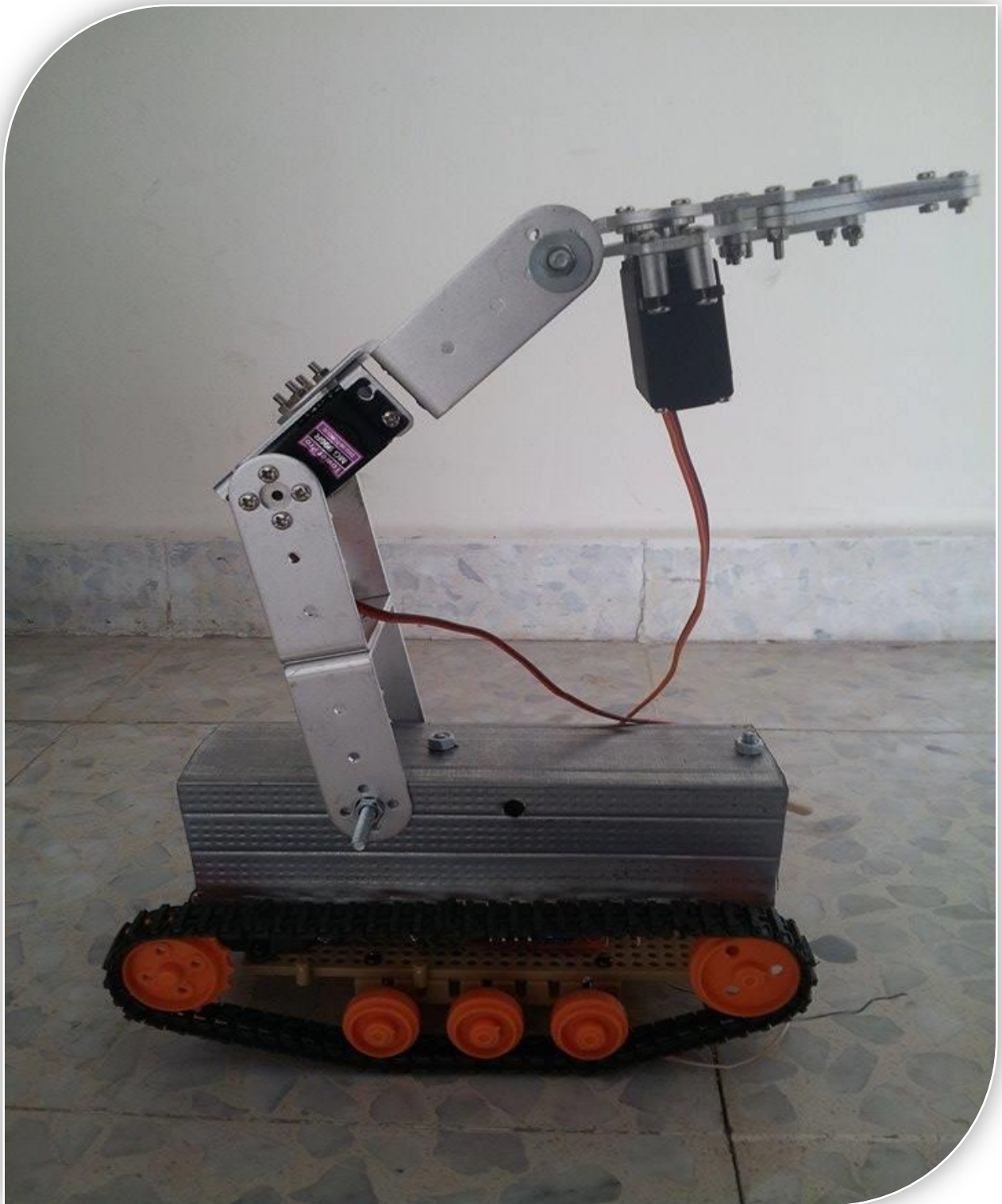


Figure 11 The Whole Project

Ch.5: Results and Analysis

After very hard work we came out with the Robotic Arm project that facilitates getting thing from far away in the room and serves the disabled easily. Well as known that this is controlled by a mobile application and supported with a camera that views the way in which the vehicle walk on to make the project more convenient.

Ch.6: Discussion

We expect the project to be usable across wide variety of users especially disabled people and scientists that work on the labs. The project is very user friendly and easy to get used to and learn how to use. It is also convenient as it is attached with a camera.

Ch.7: Conclusions and Recommendation

The importance of the university graduation project as an integrator of vocational and academic education should be recognized. Our case study shows its possible curricular standing that involves the student in a purposeful intensive learning of design and technology.

The project was a robotic arm that attached to a vehicle and supported by a camera. This is all controlled by a mobile application and Arduino UNO microcontroller.

This project was very useful. We learned so much about software and hardware. We also learned the importance of managing our budget and making tradeoff between quality and price. The Camera and Arm for example, were surprisingly very expensive. We had to make a lot of research to find elements that would satisfy our budget.

References

Bibliography

- [1] [Online]. Available:
<http://www.arduino.cc/en/Main/ArduinoBoardUno>.

- [2] [Online]. Available: <http://www.wisegeek.com/what-is-a-robotic-arm.htm>.

- [3] [Online]. Available: <http://en.wikipedia.org/wiki/Servomotor>.

- [4] [Online]. Available: http://en.wikipedia.org/wiki/DC_motor.

- [5] [Online]. Available: <http://www.thumbdrive.com/aiball/intro.html>.

- [6] [Online]. Available:
<http://www.electronica60norte.com/mwfls/pdf/newBluetooth.pdf>.