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ROBOTIC ARM CONTROLLED BY LEAP MOTION

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M. Sc. Thesis

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ROBOTIC ARM CONTROLLED BY LEAP MOTION

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Mohanad Ahmed Mezher

DEDICATION

My Father, my Mother, Dr. Bassam H. Habeeb and My Friends Ahmed Salah, Bakir Kamal, who supported me unconditionally during my long educational journey. My father is my role model, who taught me how to write and act like a professional. My mother supported me with her wisdom and her unconditional love. I could not have completed this thesis without their love and support.

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much.

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Mohanad Ahmed Mezher

ABSTRACT

ROBOTIC ARM CONTROLLED BY LEAP MOTION

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Robotics offer a well-organized method in the development of assistive devices, due to their improved functionality. Statistics predict that by 2035, half of the population in Germany is going to be older than fifty, every third person even over 60. These ageing societies face numerous challenges in performing simple tasks in Activities of Daily Living "ADLs". Increasingly, a lot of research is being focused on Ambient Assisted Living "AAL" which presents a new approach that promises to address the needs of elderly people. An important goal of AAL is to contribute to the quality of life of the elderly and handicapped people and help them to maintain an independent lifestyle. The introduction of robotics and technology-supported environments will play a huge role in allowing elderly and physically impaired people to keep living a self-determined, independent life in their familiar surroundings. In this paper, the implementation of a novel intuitive and adaptive manipulation scheme is proposed, by developing a human-machine communication interface between the Leap Motion controller and the 6-DOF Jaco robotic arm. An algorithm is developed to allow an optimum mapping between the user hand movement, tracked by the Leap Motion controller, and the Jaco arm. The system should allow for a more natural human-computer interaction and a smooth manipulation of the robotic arm, by constantly adapting to the user hand tremor or shake. The implementation would specially enhance the quality of living, especially for people with upper limb problems,

and would support them in performing some of the essential Activities of Daily Living "ADLs". The applications of this human-robot interaction will be discussed in relation with Ambient Assisted Living, where some use case scenarios will be introduced



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1. INTRODUCTION

1.1 OUTLINE

At the meanwhile, there is an interaction between human and computer and it is in the main derived from the pointing or typewriter-style devices. This type of relations that accepted ways of treatment using the hands can be limited on it, so maybe it will result in a complication of simple tasks. Rotating a three-dimensional object is one of the over complicated control examples [1].

Using a mouse on a personal computer, a client needs to capture the object and go around it using that mouse, which going to be derived only in a two-dimensional space. The alternation process represented by the mouse's movement is unperceptive for humans and clients need a some attempts to recognize how it's going to work. In the real world, however, the rotation duty is natural thus it is simple how to rotate the objects in a preferred way by moving hands [2].

As soon as we speak on the subject of robots, societies lean to imagine that robots are simply appropriate to custom in the manufacturing or only for the inventor to examine regarding fresh machineries. On the other hand, the most important purpose of robots are to assist people in responsibility of their job moreover in the businesses or only serving out doing usual domestic tasks. To overpass the break of the ordinary insight of "robots are aimed at the activities only", internet will be procedure. Our job here in this work offerings the increase of an organized robotic arm [5].

The progress of the robot arm able to be controlled by a computer using the internet. This robot be able to be used to show that a robot be able to be used in a homebased for on an everyday basis person errands. The robotic arm is in charged through an Arduino Uno that boundary using the internet by means of Arduino Ethernet Shield. Double sorts of examination were accomplished on behalf of this project that is servo motor examination and exactness check [15].

The correctness exam displays that the consequences of the real productivity of the servo motor as associated to the input guide to Arduino Uno via internet is between 97% to 99%. This example of the robot displayed that the prepared remained positive. This client pleasant robot is predictable to bond the hole among robot and domestic errands [9].

For that reason, there must be require for more ordinary human-computer organizations. One of the planned approaches involves hand making a sign that are interpreted by a PC. Using hands in a human-computer border is carried by the fact, that they are still used for non-spoken communication, such as body speech or cipher. And one more benefit of hands is that scheming tasks achieved using hands in fact the world could be understood as a sequence of signs and used as computer input. For using smart robots, table upper article exploitation is one of the main ordinary responsibilities. It unites the abilities of the robot in visualization, object gratitude, image procession, hand-arm exploitation, etc. Nevertheless, the actual covered situation is far extra complex than trial circumstances. The idea of the robot from time to time can barely offer us sufficient data for positively performing approximately a few difficult jobs, such as pick, place or assemble nearly minor items. In those cases, it will be complicated to slice two objects when they are so close to each other's correctly; and furthermore, a few obstruction belongings often occur in real indoor environment. So, tele-operative manifestation technique is a well-organized manner to overwhelm these difficulties [3].

The latest sensors present a data that can be effectively used to be familiar with signs and then control a computer. Presently, there are quite a few devices that give way data useful for the signal identification. We can give Microsoft Kinect as a case of such a manager. It presents a three-dimensional spot cloud of the experiential sight, but was intended for applications that interpret the movement of the entire body of the user. That is why it lacks the needs accuracy for hand sign detection [1].

A further designed device that is used to path the arrangements of a hand and fingers is Leap Motion Controller developed by Leap Motion, Inc. been on markets on July 2013. The Leap Motion is a small device, which can be positioned in front of a PC. It stands for tremendous

finger detection accuracy up to 0.01 mm. The controller offers information about a location of each finger and a hand sensed in the observed space. The SDK found on the device lets to recognize three pre defined signals: a sphere motion with one finger, a swipe exploit and tapping on the virtual keys [30].

There is information about every sensed hand that The Leap Motion Controller offers us. That device spreads information with frequency over than 100 Hz. Leap Motion Controller is a feeler that can possibly insurgent the human-computer relations. We can consider this is the reason why the leap motion sensor is the ideal option to control the project and after getting the data from the sensor it will be sent to the Arduino microprocessor which controls **the** movement of the motors for moving the arm to the meant direction [32]. These expression methods have previously been used on developed robots for some years. For instance, the controller with switches or a six dimensional mouse are used to control the robot and tell the key positions and orientations, so that the robot can plan the path and correctly reach each key position with desired orientations and perform a smooth movement [14].

However, the interface of this kind of demonstration method is not efficient for a smart robotic system. And in the most of all schemes, the robot simply archives position and locations without expounding signals, accordingly these schemes are not appropriate to extra multifaceted tabletop object manipulation errands. An extra accepted technique founded on a kinesthetic edge is used for substitution. One know how to slog the robotic arm to track his activities, such as the researches on humanoid robots by Hersch et al. and Hwang et al. However, this process as well refers at the route following somewhat than at signal gratitude. What's more, is this is a characteristic interaction regulator technique in which a human workings indoors the similar environment as the robot. Therefore, it is hardly used in humanoid unfavorable settings. For this reason, non-contact tele-control methods are more appropriate for these situation. For example, some mechanical based, optical tracking based or vision based master-slave-device and tele-operation system are developed for robotic systems. Comparing with the mechanical devices, the optical and vision tracking systems are lower cost and easier to be mounted in difference environment. Arduino is an exposed supply prototyping summary stage stands on (easy-to-use) hardware and software. Arduino boards are capable to read inputs on a sensor, a finger on a button, or a Twitter letter and turn it into an output - starting a motor, spinning on an LED,

bringing out a few things online Robotic arm has been enclosed a diversity of meadows together with manufacturing production, medical treatment, security control and other application as we mentioned above [20].

It acts as an assistant, an operative or even a work associate ,like “Jarvis”!DFLG6DOF is a bionic robotic arm, it consists of six servo motors, matching to the arm, elbow, wrist (2 degrees of freedom), five joints and one rotating base in all. Every joint can progress in a convinced range, and the base can be rotated about 180 degrees. With 24 channel Veyron servo controller, all action can be controlled via PC software, supporting online clear up and wireless control. In an expression, this is a high cost routine, simple to employ robot arm. It is real a good robot expression schooling stage and DIY robotic arm. The servo can be linked in a straight line to the Arduino IO increase protect or the Romeo robot microcontroller, and Arduino servo library makes it easier to use [15].

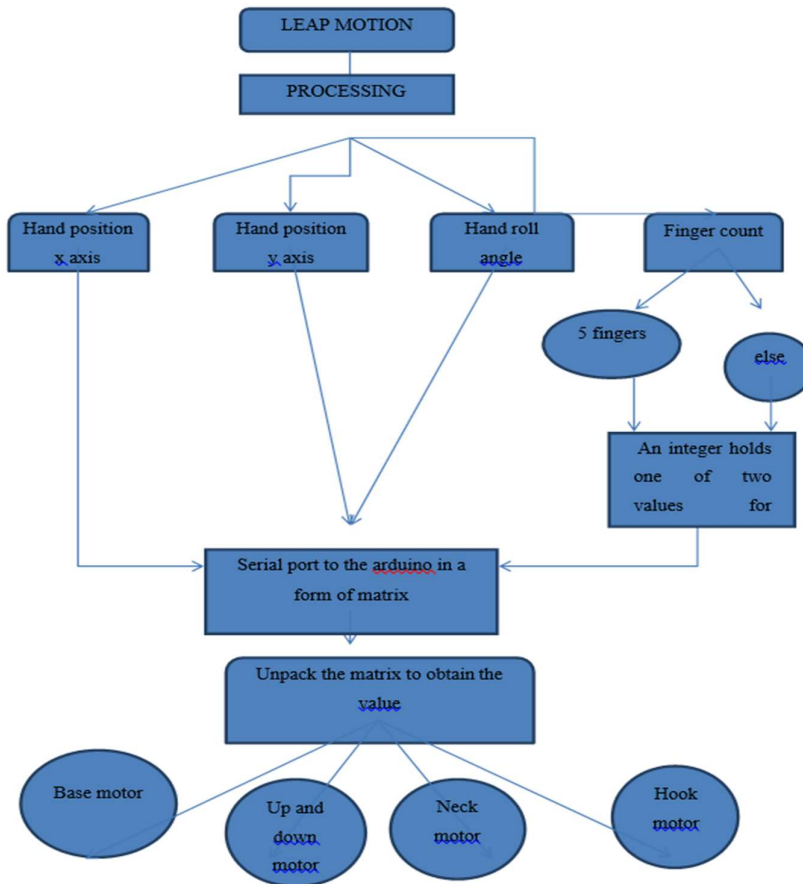


Figure 1.1: Block Diagram of Leap Motion

1.2 LEAP MOTION

As you can see from the hardware perspective the controller of the leap motion is somehow simple, The Device includes two cameras and three electromagnetic LEDs The path Ultraviolet bright with wavelength of 850 nanometers and those nanometers are outdoor the noticeable bright range. The Leap Motion controller is a little USB tangential expedient which is intended to exist situated on a bodily desktop, in front of upward. It can as well be mounted on top of an effective actuality headset. By means of two monochromatic IR cameras and three infrared LEDs, the device examines an approximately semi-circular region, to a distance of regarding 1 meter. The LEDs produce prototype fewer IR light and the cameras produce nearly 200 frames per second of reproduced information. This is followed by sending through a USB cable to the host PC, where it is considered by the Leap Motion software using "complex maths" in a way that has not been revealed by the company, in some way making 3D point data by evaluating the 2D frames produced by the two cameras. In a 2013 learn, the taken as a whole regular accuracy of the controller been exposed to be 0.7 millimeters [20].

The slighter examination part and advanced declaration of the expedient distinguishes the creation from the Kinect, which is better fitting for entire figure following in a interplanetary the amount of a bodily area. In an expression to CNET, the controller was revealed to execute tasks such as finding the way a webs, via tweak to increase signs on plans, extraordinary accuracy sketching, and employing compound 3D information imaginings. Leap Motion at the start dispersed thousands of components to developers who are paying attention in developing presentations for the expedient. The Leap Motion controller stayed originally transported in July 2013. In February 2016, Leap Motion unconfined a most important beta bring up to date to its core software. Called Orion, the software is intended for pointer pursuing in effective realism [33].



Figure 1.2: Leap Motion

1.3 PROCESSING

The Leap motion senses and pathways hands, fingers and finger like tools. The device activates in familiar vicinity with a good accuracy and following frame rate. The software of the leap motion checks the items practically in the device field of view. It identifies tools, fingers, and human hands, reporting both separate places and motion. The Leap field of view is an upturned pyramid that is located exactly on the middle on the device. The useful variety of the Leap extends from something like 25 to 600 millimeters over the device (1 inch to 2 feet).

Hand Positions (x and y) axis:-

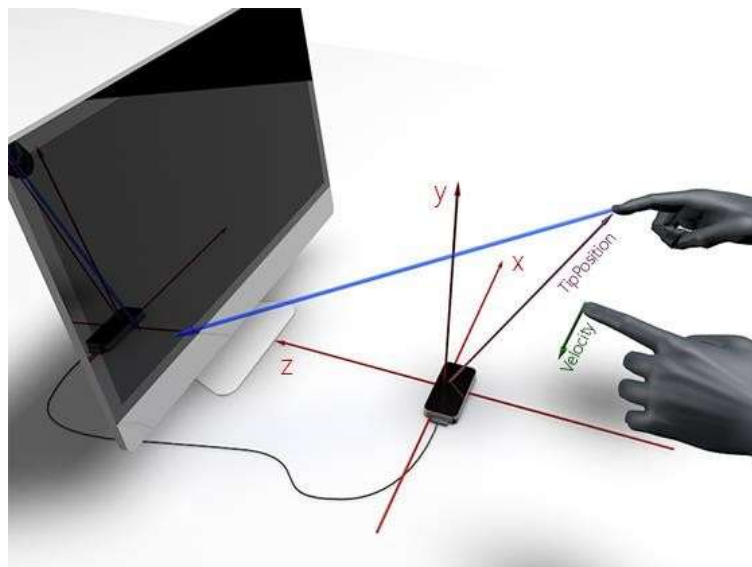


Figure 1.3: Hand Position

1.4 HISTORY OF ROBOTICS AND ROBOTIC ARMS

The primary programmable robotic device is invented through George Devol. He coined the period in 1954 of the Universal Automation. Two men one is called Devol and the other is Joseph and he was an engineer Engel Berger procedure the biosphere's first robot establishment, Unimation in 1956. Unimation is obtained by Condec companies and improvement of Unimate Robot organizations starts. American engine and Foundry, in a while identified as AMF Establishment, markets a robot, known as the Versatran, intended by Harry Johnson and Veljko Milenkovic in 1960. The initial manufactured robot was online in a General Motors sports car factory in New Jersey.

It was Devol and Engelberger's UNIMATE. It achieved spot welding and removed die castings in 1962 German corporation for robots, KUKA, produced the earliest industrial robot with six electromechanically determined axes known the Famulus in 1973. A robotic arm that completed tiny pieces assembly with criticism from tap and force sensors was planned. Professor Scheinman, the one who invented the Stanford Arm, forms Vicarm Inc. to promote an edition of the arm for engineering applications.

The new arm is controlled by a minicomputer in 1974. In 1495, Leonardo da Vinci made the extended and multi-colored antiquity of robots. He conceived a multifaceted social robot that it shows in his draughts possibly will execute humanoid similar motions such as meeting up, moving its hands and falsification its skull and neckline.

The robot will be shown to be a soldier or fighter, wearing clothes in German-Italian medieval shell. This was merely one of the quite a few hundreds of designs and practical drawings experienced again within the pages of two establish documents in 1950. There are quite a few specimens of robotic machines and motorized progress in mutually very ancient and extra contemporary past, but the initial really up-to-date robot to stand extra to the antiquity of mechanical device was designed by George C. Devol in 1954 as I mentioned before. This machine existed called Unimate.

In 1961, Unimate became the earliest industrial robot to labor at the congregation line of a New Jersey General Motors plant. Programmed to take die castings from machines and execute

fusing on auto bodies, Unimate was clearly very far from the idealistic notion of androids, or human-like robots.



Figure 1.4: Complex Humanoid Robot

1.5 LEAP MOTION HISTORY

At the beginning let me explain what is leap motion and what I mean by the word "MOTION" and then I will touch the whole leap motion history The Leap Motion is a scheme that employs the user fingers to plot a route in the region of the desktop devoid of essentially putting your finger at any material switches; it permits the client to manage the scheme by only checking the finger waves [18].

This idea of movement regulator is unique that has remained in the production for a protracted time, and this workout of a person as the manager has been in use dating reversely to the Industrial Revolution. Though, for the duration of that time era there were no computers or any up to date gear that we are going to be able to subordinate with nowadays wave to take the responsibility of using the devices. The earliest motion control devices used a foot holder measured by the user that mechanical method of pulleys and engines to end a procedure. An employer deficient physical procedures to develop programmed is what has inspired societies

to figure out and create the wave control skills that are in use nowadays. Engineers from the late 1800's used the push starting with the creation of these methods to give customers with the initial electronic technologies. Samples of these mechanisms cover: Edison's DC Producer in the 1870's, communal control and Tesla's AC motor in the 1880's, and the most primitive electrical tool in the 1890's. These projects showed the means for electronic laundry machineries and fridges by 1915. (History of Motion Control) In 1927, Harold Black completed a huge step in the performance that computerized developments be in trace by presenting the theory of undesirable response in loudspeakers. He was not the earliest human being to come up with the impression of response, but he did come to the conclusion that a insufficient of the additional feedback from the amplifier could be used in the input formula. On the years of 1940's and 1950's it developed to be obvious to the engineers of the point in time that mathematical consideration was a solution in scheming and educating wave regulator procedures. (History of Motion Control) The next periods offered these engineers with the chance to find out starting with interplanetary transportable and battle. These proceedings made the engineers capable of to design up several difficult procedures that might control procedures in a countless deal enhanced technique. As well this period era carried out the foundation of microcontrollers, which permitted all the occupations of a usual manager to get place in a significantly slighter element. In the 1990's DSP founded wave governor crops started to let complicated signal summarizing and numerical communication during sequential nets. The design of fiber optic communication appearances correspondingly made it acceptable for a lot faster communication progressions [10].

Now I'm moving back to my main subject the leap motion is the core device for this project, the technological things for Leap Motion in 2008 was initial or the first development, at the same time as co-founder David Holz was learning for a Ph.D. in mathematics. Subsequenting an early angle improvement, and in 2010 Holz co-founded the corporation with the hand of his friend Michael Buckwald. In 2011 on June to be more precised The corporation increased a \$1.3M seed funding overweight with savings from business enterprise capital firms Andreessen Horowitz, Founders_Fund, and SOSV, as well as quite a few angels' investors. Leap Motion announced a \$12.75M Series a funding round led by Highland Capital Partners in May 2012. In January 2013, Leap Motion stated an extra series B round of financial support for \$30M. ince 2010 Later with working in silence, widely Leap Motion been declared its initial invention to the whole world, formerly called *The Leap*, on May 21, 2012. The group started a software developer plan in October 2012 and dispersed approximately 12,000 units to

developers fascinated in making submissions for the expedient [25].

Although the device was recommended to launch in May 2013, full-scale shipping was in a while postponed until July. In March 2014, it was informed in TechCrunch that is nearly 500,000 units had been sold on markets, far short of first opportunity; as a result, Leap Motion announced layoffs for 10 percent of its workforce, mainly in sales and marketing.

In May 2014, Leap Motion released its version 2 software to developers in a public beta which is the same version that has been used in this project.

1.6 METHODOLOGY

I created this project to be trained about the essentials of how we can control an uncomplicated and at the same time a useful robotic arm. The robotic arm itself is a 6DOF robotic arm controlled by an Arduino device well-matched board. I used The Leap Motion as an input to my robotic arm. It can visualize in real-time the input as a form of motion in the metal arm. The Leap Motion controller was possible to be integrated to the processing IDE (Integrated Development Environment) regards to the Processing library (mentioned in the code). The servo data been sent by The app of the Processing because i used servo motors in my work to the Arduino well-matched board in a very simple format: `<servo_number,servo_angle>`. Let me give you a case in point sending the command "0, 90" make servo 0 (the base) rotate to the heart location.

1.7 SERVO MOTORS

A servomotor is rotating actuator or linear actuator that allows for a precise control of pointed or linear spot, speed and precipitation. It consists of a fitting motor attached to a feeler for position response. It as well necessitates a comparatively advanced controller, repeatedly a devoted component designed predominantly for practice with servomotors.

Servomotors are not a nominated group of motor even though the expression servomotor is repeatedly used to refer to a motor suitable for use in a secured loop control system.

A lot of uses for Servomotors in applications such as robotics, technology or programmed manufacturing.

There are such a many types of servos based on the rotation angle but the one that is currently being used in the project is 180 degrees.



Figure 1.5: Servo Motor

2. GENERAL THEORY AND MAIN COMPONENTS

2.1 6 DOF ROBOTIC ARM

The robotic arm is a mechanical piece of equipment that is typically and broadly useful in the robot knowledge regions nowadays, you can see it in engineering manufacturing, health check dealings, entertainment services, the teaching purpose, armies and space examination areas. In excess of the earlier period decades, intend and manage a robotic arm is not a simple work [9].

A lot of thoughts require to be in full care at the same time as scheming and calculating robotic arm. In adding, unlike robotic arm design possibly will guide to altered controller explanation. Additionally, it is hard for the robotic arm to chase the allocated geometry trail in great exactitude and correctness method. The research that we are doing now presents the project and progress of 6-DOF (degree of freedom) PC Founded Robotic Arm (PC-ROBOARM). The major circumstance with this learning is regarding a 6-DOF robotic arm, which is demonstrated as three relations, by means of every combined connected with an appropriate servomotor. The robotic arm design and control answer is applied by identity urbanized PC program which is called as SMART ARM. It is a workstation assisted project and be in charge of a way out for 6-DOF robotic arm which come with a customer approachable graphical client interface (GCI). It permits client to mock-up or invent practical robotic arm before connecting the actual one. Consequently, the user can guess the most favorable size of definite robotic arm at the beginning so as to reduce the building price and suite the sensible environment. Also, one time the actual robotic arm has been built, the user be capable of reusing the software to be in charge of the real robotic arm in a natural way devoid of killing time in constructing latest control solution [12].

The program as well delivers imitation characteristic. During imitation in the GUI, the program supports seriously in imagining the robotic arm route preparation. The PC ROBOARM is authentic robotic arm urbanized to show the imitation fallout. The 6-DOF robotic arm plan is based on PUMA (Programmable Universal Machine for Assembly) jointed arm model. Both point-to-point motion and incessant track action are verified in imitation and real arm panels [31].

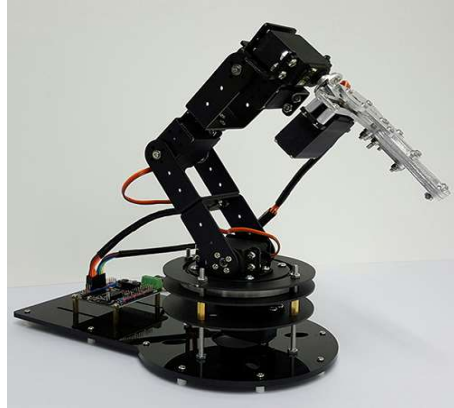


Figure 2.1: 6 DOF robotic arm

2.2 PROBLEMS WITH THE METAL ARM

The project faced some major issues regarding the two servo motors responsible for the moving the arm forward and backward and the other servo is responsible for lifting the arm up and down [34].

The only possible solution was to discard of them so now the degree of freedom of the arm has been reduced to four DOF here is an image of the customized

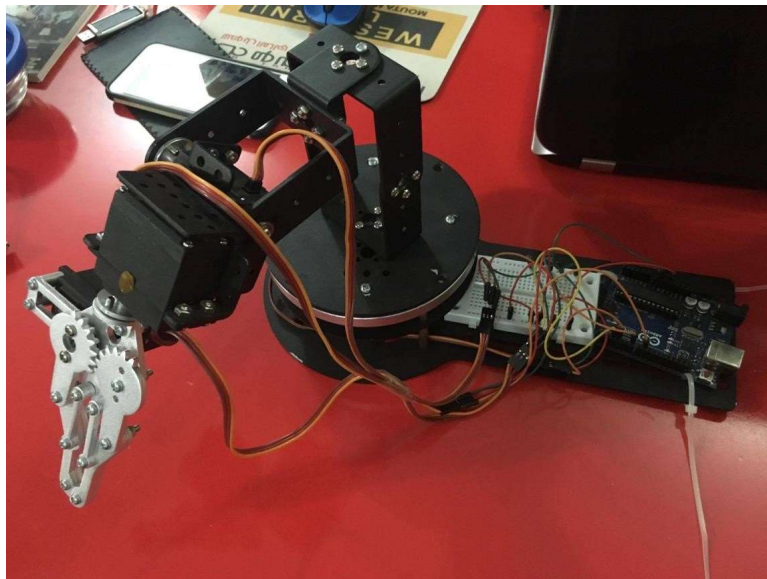


Figure 2.2: (6 DOF) My Robotic Arm

2.3 ARDUINO BOARD

There are two specific meanings that are an element of each Arduino plan: `system ()` and `Loop ()`. The `setup ()` is called once, as soon as the plan begins. It's a high-quality lay to do setup responsibilities like setting join forms or initializing libraries. The `loop ()` meaning is called over and over and is heart of main plans. It's important to contain both functions in your plan, even if you don't need them for something.

```
Void setup ()
```

```
{
```

```
statements;
```

```
}
```

```
void loop()
```

```
{
```

```
statements;
```

```
}
```

```
setup()
```

The `setup()` function is called once the program has started. Used to initialize the pin modes or begin serial communications.

```
Void setup()
```

```
{
```

```
    pinmode(pin number , output);
```

```
}
```

```
loop()
```

later than calling the `setup()` purpose the `circle()` do precisely what its name involves and loops in a row letting the program to alter reply and control the 18duino board.

```
Void loop()
```

```
{
```

```
digitalWrite (pin , high);
delay(1000);          //delay is in milliseconds
}
```

pinMode(), digitalWrite(), and delay()

The *pinmode ()* utility arranges a pin as moreover an input or an output. To employ it, you go by it the digit of the pin to organize and the steady INPUT or OUTPUT. When configured as an input, a pin be able to become aware of the situation of a sensor similar to a push button.

The *digitalWrite()* functions outputs a value on a pin. For example, the line:

```
digitalWrite(ledpin,HIGH);
```

The *delay()* makes a reason for the Arduino to hang around for the specified number of milliseconds earlier than continuing on to the subsequently line. There are 1000 milliseconds in a second, so the line:*Delay(1000);[5]*

Table 2.1: Arduino Board States

Reset	3v3	5v	Gnd	Vin	Analog In	RX/TX	Digital	PWM (^)	AREF
Resets Arduino Sketch On Board	3.3 volts in and out	5 vlots in and out	Ground	Voltage I for sources over 7V (9v-12v)	Analog inputs, can also be used as Digital	Serial Comm. Receive and Transmit	Input or Output, High or Low	Digital pins with output option of PWM	External reference voltage used for Analog

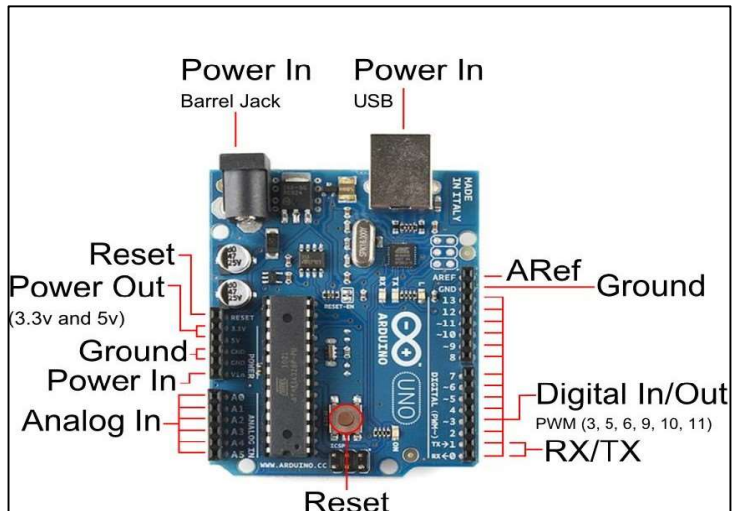


Figure 2.3: Arduino Uno

The Arduino Uno R3 is a microcontroller board based on a removable, dual-inline-package (DIP) ATmega328 AVR microcontroller. It has 20 digital input/output pins (of which 6 can be used as PWM Outputs and 6 can be used as analog inputs). Programs can be loaded on to it from the easy-to-use Arduino Computer program. The Arduino has an extensive support community, which makes it a very easy way to Get started working with embedded electronics. The R3 is the third, and latest, revision of the Arduino Uno [22].

2.4 LEAP MOTION SENSOR

Hardware:

Starting with a hardware view point, the Leap Motion Controller is really pretty easy. The spirit of the leap motion made of 2 cameras and three infrared LEDs. These path infrared light with a wavelength of 850 nanometers, which is outside the visible light spectrum [38].

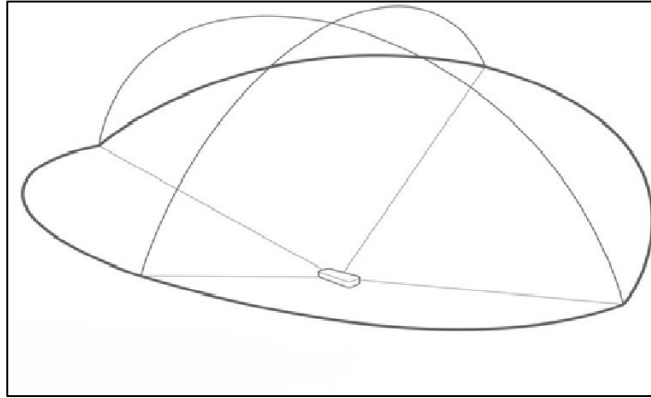


Figure 2.4: Leap Motion Interaction Area

Because of the lenses of the extensive point of view, the machine has a huge communication freedom of two cubic feet, which is taking the form of a reversed pyramid – the connection of the microscope cameras' fields of view (fov) [28].

The Leap Motion Controller's showing variety is narrow to barely (60 cm) higher than the device. This variety is narrow by LED light spread during a space, from the time when it becomes more difficult to suppose your hand's situation in 3D away from a convinced distance. LED light strength is at the end limited by the maximum current that can be drawn over the USB connection. Novel 3D achievement devices like strength cameras and the Leap Motion have lately arrived at the markets. Depth cameras permit to get a total 3D explanation of the framed prospect at the same time as the Leap Motion feeler is a device clearly targeted for hand sign identification and provides no more than a limited set of pertinent points [14].

Our job shows how to mutually develop the two types of sensors for precise gesture detection. An ad-hoc result for the combined calibration of the two devices is initially obtained [33].

After that a set of novel characteristic descriptors is introduced both for the Leap Motion and for depth data. A variety of systems based on the distances of the hand sections from the centroid, on the curving of the hand line and on the rounded hull of the hand shape are in work and the use of Leap Motion data to support characteristic mining is also measured [28].

The planned characteristic sets are fed to two special classifiers, one based on multi-class SVMs and one developed Random Forests. Singular characteristic assortment algorithms have as well been experienced in arrange to decrease the difficulty of the move toward. Untried results explain that an extremely high exactness can be gained from the proposed technique. The current completion is as well able to run in real-time [17].

On one occasion the figure information is streamed to your PC, its moment for a few serious mathematical elating. In spite of well-liked misconceptions, the Leap Motion Controller doesn't make a profundity chart – as a replacement for it applies higher algorithms to the untreated sensor data [22].

The Leap Motion examination is the software on your PC that practiced the situations. Subsequent to compensating for surroundings items (such as heads) and ambient ecological illumination, the descriptions are analyzed to rebuild a 3D symbol of what the device spots [21].

After that, the following level equals the information to take out following data for Example members and gears. Our following procedures understand the 3D facts and assume the locations of blocked substances. Sorting methods are realistic to make certain flat chronological rationality of the information. The Leap Motion Facility formerly feeds the consequences – articulated as a sequence of edges, or photographs, including all of the following information addicted to a convey procedure[12].

All the way concluded this procedure, the facility will be in touch with the Leap Motion Control Panel, as well as natural and web customer collections, during a restricted socket link (TCP for native, Web Socket for web). The customer archive systematizes the information addicted to an object-oriented API arrangement, achieves edge antiquity, and delivers assistant purposes and sessions. From there, the application logic draws into the Leap Motion input, letting a motion-controlled communicating involvement [17].



Figure 2.5: The Leap Motion Arm Positions

The capability to manage your PC with a jab of your finger assures to carry to lifetime the sign determined borders from sci-fi pictures such as *alternative statement*.

Unluckily there's quite an important space among the vision and the actuality, particularly if you're scheming a tool that wasn't in fact intended with handle and/or motions in attention. For a lot of citizens the Leap Motion won't present a great deal more than the innovation worth of playing touch-friendly games like Fruit Ninja and Censored the Line on your PC. Except if you discover a mainly decent routine for the Leap Motion, and if it acts this one, then it might be the piece of advanced technology you've ever dreamed of [5].

To make an arrangement for the Leap Motion you basically connect it into your laptop with a sub input and download the leap program since it's available on the Leap Motion website. Later than connection you are taken throughout a limited samples which allow you interrelate with things on the monitor and apply a little signs.

Expanding your hand to utilize the Leap Motion textures astonishingly instinctive, comparable to the earliest time you used a tap screen device. The first demos don't need any huge level of accuracy; they easily engage flapping your fingers nearby to cooperate with models on the monitor. It's as if you're alarming a mist of atoms balanced and placed just right in front of you [4].

here's a way to flapping your fingers that's positively tempting, nonetheless it's a disgrace that the installer doesn't do extra at this tip to make certain the Leap Motion is pleased with the

illumination circumstances. A tiny other support upfront might protect a lot of annoyances in the future [15].

One time you've pass over the connection you will be led to the Leap Motion's Territory main monitor. Here you'll discover a small number of application pre- installed, such as the Liquid Breakers screensaver and this allows you have fun with waves in a pool. You can as well install apps from the online Airspace market.

Nowadays you'll get around 120 apps for Windows and Mac. The most added apps are almost half of the apps are games, however there are moreover a trickle of learning, efficiency and originality apps to discover. The extended expression feasibility of the Leap Motion clearly based on tough third party hold, but in the small term it has larger usability matters to deal with [20].

The Leap Motion can be somehow trying to practice if the expedient isn't located properly and pleased with the illumination circumstances, yet despite the fact that you're given small direction in these regions. In less than most favorable circumstances you can still disorder through with games like Cut the Rope, but the sign border presently doesn't feel accurate enough to manage with much more. finding the way through Google Earth or revolving a DNA thread in the Molecules app can be an train in aggravation not supported by the details that the apps present so small aid in terms how to use the sign controls[25].

For the moment the Hand WAVE app presents essential gesture help for scheming the browser and media player, but it's so undependable that it would be not so difficult to merely arrive for the keyboard or mouse. Just like the signal controls made into Samsung's Smart TVs and Sony's Vaio Pro Notebooks, the Leap Motion generally looks additional suffering than its importance one time you achieve previous the innovation of touch approachable competitions. The Leap Touchless apps for Windows and Mac suggests a better level of controller, but although then you can't get past yet the point that desktop boundaries commonly weren't considered with motions and touch in mind[13].

Quantity of the difficulties is that the Leap system allows several apps work instantaneously, with no respect for in what way they might inhibit with each other. So you probably going to

be consuming PhotoScape to operate pictures and unexpectedly belongings go confused because Hand WAVE is keep working in the background. In the situations you may be able to deactivate the capability for background apps to obtain signal instructions, but an improved method would be to announce some form of intelligent app organization [11].

You can ultimately category out those application struggle problems, but this still doesn't report the detail that the Windows and Mac desktops are intended to be used with a keyboard and pointer. Signals probably will be useful for a handful of apps, but frequently they're further worry than they're means. Particularly if they're not dependable [16].

This fetches us to the prevalent issue with the Leap Motion. It's tremendously sensitive to intervention from noticeable and electromagnetic light. Inappropriately it's not identical at showing you when something is incorrect, or assisting you repair the trouble once you realize it. As a consequence approximately several people will sweep aside the Leap Motion in prevention [2].

Primarily I installed the Leap Motion with my MacBook Pro, sedentary on my dining room table with the feeler sitting on the table in front of the trackpad. Directly above were six downlights, and more bright upcoming in from the windows behind me. In this environment apps which necessary any level of exactness were unsatisfying to use, although the software said nothing to show there was an issue with the lighting [33].

Excavating over the Leap Motion list of options I figured out the option to recalibrate the device, which appeared like a respectable impression considering there was no declaration of standardization throughout the original set-up. Up till now the standardization instrument rejected to run. Seemingly the Leap Motion was consecutively in "Robust mode" this is the reason why the "existing lighting conditions may be inappropriate". That's clearly a main problem, however for some explanations the software didn't consider it was important enough to bring it to my consideration [14].

A Google exploration turned up a lot of persons wondering about in what way elaborate the Leap Motion can be in standings of illumination and in what way disappointing the fallouts are

once it noiselessly changes to Robust mode – something certainly not stated throughout the set-up procedure. Flowing the Leap Motion to a dissimilar area with a single downlight and no proximate window wasn't enough to escape robust mode yet. It wasn't up until I killed the overhead light and be seated exclusively in the radiance of the MacBook Pro's screen that I could run the standardization gears. This supported with the correctness, but only while the light continued off [14].

Furthermore I figured out that putting the MacBook Pro a little bit far after me and at that moment pulling my chairperson farther back from the table it assisted me as well. Here and now the Leap Motion placed at around member's distance. The set-up seminar obviously shows that positioning the Leap Motion among you and the keyboard is suitable, but getting over its arena of visualization to use the keyboard frequently activates it by accident. The Leap Motion seems well again matched to a desktop situation where you can set the feeler among the console and the display, thus it's available of the technique pending you get to for it in excess of the console.

For this idea I mounted the Leap Motion on my Windows 10 examination outfit, protected absent in the identical unique bright area with the feeler among the console and the screen so it would remain out of the mode. Directly absent a pop-up announcement expressed to me "exterior ultraviolet bright noticed, recompensing". At that moment I directly recognized that this destined appealing strong manner and plummeting the exactness the feeler, so one time again I killed the single downlight light and sat in the shady.

If you compulsory by hand to practice the Leap Motion each daytime it may produce on you, even though you may as well remain required to exist in the shady for keeping the feeler working good. I figured out smooth in places with old-style bright corms, relatively than downlights, the exactness and compassion of the feelerreleased once I switched the bright on [7].

The Leap Motion is an exciting idea and its developers have formed something wonderful, but retro-fitting signs to a fixed desktop border are trying practices. Particularly as soon as the sensor is less than dependable. If not the Leap Motion explains a meticulous trouble or brands an expert program calmer to practice, it isn't going to advance your computing knowledge at this point. It's one to save an eye on, but there's effort to remain completed already before signal taking the charge of sense at home on traditional desktops [29].

3. THE DEVELOPED ROBOTIC ARM

3.1 HARDWARE

This part of the project will take the hardware section, it was managed to put together four servo motors the hook, neck, up and down, the base motor each motor is responsible for a single movement of the arm. The hook motor is in charge of opening and closing the hook. The neck motor is in charge of rotating the whole body of the hook in 180 degrees. the hook and the up and down motor is in charge of lifting and dropping down both the neck motors based on the corresponding code. The base motor is in charge of rotating the whole metal arm to the left and to the right in an angle of 180 degrees.

3.2 CONNECTING THE CIRCUIT

This part discusses the circuit connection of the servo motors to the arduino and the breadboard. The arduino and the leap motion sensor are connected to the laptop. Each servo motor has three input wires red, brown and orange. The red wire is the input voltage line for the servo motor. The brown wire is the ground line for the servo motor. The orange wire is the data line received from the arduino going to the servo motor. For the voltage source the four servo motors described in the previous section are connected in parallel using a breadboard. The ground is common between all the motors and the arduino. As for the data pins each data wire from the servos is connected directly to a digital pin of the type PWM in the arduino from which they get the data in a form of integer values. These integer values are basically the angles that the servo reacts to, to change their rotation angle. The leap motion sensor is directly connected to one of the USB ports from which the arduino gets its data that in turn sends it back to the servos. The data received from the leap motion sensor is basically:

1. Hand's position.
2. Hand's angle.
3. Number of fingers...etc.

3.3 SOFTWARE WORK

This part of the project talks about the used programs, software language, libraries and the functions used to build the program code.

3.4 PROGRAMS AND PROGRAMMING LANGUAGE

The programs used to write the code are processing PDE and the Arduino IDE, both are open source programs that let the developers program any electronic circuit. The Arduino IDE itself was created using the processing IDE. The language used in the code is JAVA it made it easier to use the serial ports more efficiently. The JAVA language has predefined functions that were very useful in writing the codes such as converting a float into an integer. The Processing Development Environment (PDE) creates it simple to inscribe Dispensation plans. Plans are printed in the manuscript publishing supervisor and in progress by clicking the Track key. In Treating, a PC database is named a *draught*. Draughts are saved in the *Sketchbook*; it is a file on your PC. Drafts can draft two- and three-dimensional graphics. The original renderer is for sketching two-dimensional graphics. The P3D renderer formulates it achievable to sketch three-dimensional graphics, which contains scheming the camera, illumination, and resources. The P2D renderer is quick, but few precise renderer for drawing two- dimensional graphics. Both the P2D and P3D renderers are speeded up if your PC has an OpenGL well-matched graphics card [11].

The abilities of indulgence are protracted with *Collections* and *Outfits*. Libraries build it achievable for plans to achieve possessions away from the *essential* Treating cypher. There are hundreds of libraries added by the Processing society that can be added to your sketches to permit fresh effects like playing sounds, doing computer vision, and running with advanced 3D geometry. Tools expand the PDE to assist craft creating sketches simpler by as long as interfaces for tasks like choosing colures [10].

Treating has special *software design manners* to make it probable to arrange draughts on dissimilar stages and database in changed ways. The Java mode is the default. Other programming modes may be downloaded by choosing "Add Mode..." from the menu in the upper-right corner of the PDE [15].

3.5 LIBRARIES AND FUNCTIONS

In the processing IDE the libraries included were the leap motion library and the Processing. Serial library.

The leap-motion library has a lot of functions that make use of the hand tracking Abilities such as:

`Palmposition()` returns the position of the hand in XYZ plane

`Fingers().extended().count()` returns the number of fingers that are open in any instant. `palmNormal().roll()` returns the angle roll of the hand. The processing.serial library enables the communications between the processing IDE and any USB port in the laptop.

Using this line for example

```
Port = new Serial(this, "com3", 9600);
```

`Com3` is the communication port on the device. `9600` is the rate of the data transfer between Processing and Arduino IDE. In the arduino IDE the library `Servo.h` was used.

It enables the programs to talk to each and every other servo by sending those numbers that indicate the rotation of the servos.

For example:

`hook.write(120);` means that the servo hook will rotate with an angle of 120 degrees from the X axis.

3.6 ROBOTIC'S CONTROLLING CODE

Processing sketch

```
import com.leapmotion.leap.*;
```

```
import processing.serial.*;
```

```
Serial port;
```

```
Controller leap; //define the leap motion controller int
```

```
cc;
```

```
void setup() {
```

```

size(300, 200); //set the app window size

  leap = new Controller(); // initialize leap motion controller port
= new Serial(this, "com3", 9600);

}

void draw()

{

//leap motion

HandList hands = leap.frame().hands(); Hand
hand = hands.get(0);

Vector hp = hand.palmPosition();
if(hp.getX()<-120) hp.setX(-120);
if(hp.getX()>120) hp.setX(120);

float bbb=map(hp.getX(),-120,120,160,8);
int br=(int)bbb; if(hp.getY()<100)
hp.setY(100);

if(hp.getY()>250) hp.setY(250);
float UD =map(hp.getY(),100,250,70,0); int
ud=(int)UD;

FingerList fl = leap.frame().fingers(); int fc
=fl.extended().count();

float roll = hand.palmNormal().roll()* 100; // get roll float
rv=map(roll,-90,100,160,6); // map roll if(rv<6)rv=6;

if(rv>160)rv=160; int
v4=(int)rv; if(fc==0)

```

```

cc=69; else
cc=7;

println(v4+" "+fc+" "+cc+" "+br+" "+ud); byte
out[] = new byte[4];

out[0] = byte(v4);
out[1] = byte(cc);
out[2] = byte(ud);
out[3] = byte(br);

port.write(out); background(205);
fill(0,0,150); // text color
textSize(height/2); // text size
text(ud,150,150);
}

```

That was for Processing Code

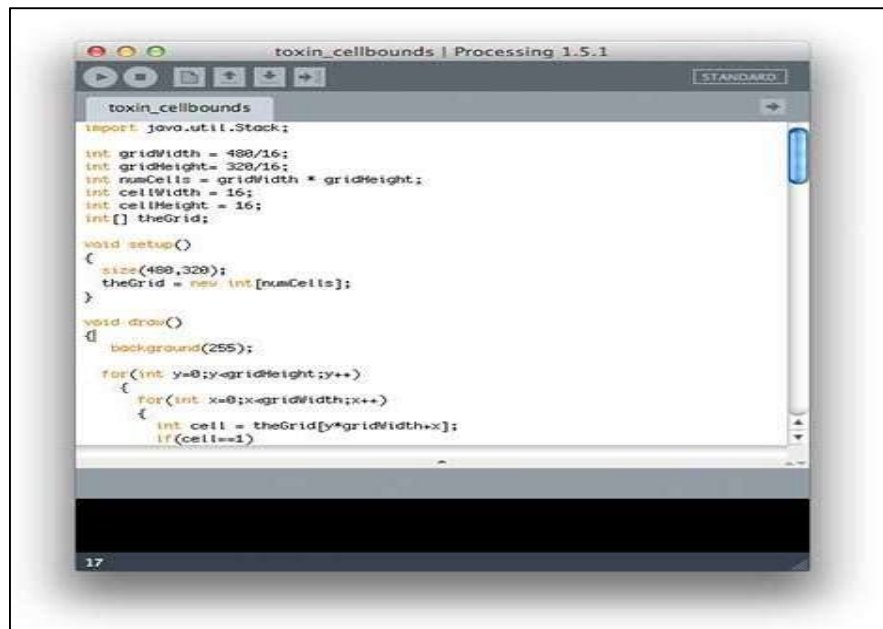


Figure 3.1: a Screenshot from Processing App.

Now *for Arduino*

Arduino sketch

```
#include <Servo.h>

Servo hook; // create servo object to control a servo Servo
neck;

Servo Base;
Servo UD; int
n,h,u,b;

int currentValue = 0; int
values[] = {0,0,0,0};

    void setup()
{
Serial.begin(9600);
hook.attach(9);
neck.attach(6);
Base.attach(5);
UD.attach(3);
hook.write(6);
neck.write(70);
Base.write(80);
UD.write(10);
}

void loop()
{
```



```
//serial available and working
if(Serial.available()){

int incomingValue = Serial.read();
values[currentValue] = incomingValue;
currentValue++;

{

n=values[0];
h=values[1];
u=values[2];
b=values[3];
hook.write(h);
neck.write(n);
Base.write(b);
UD.write(u); }}
```

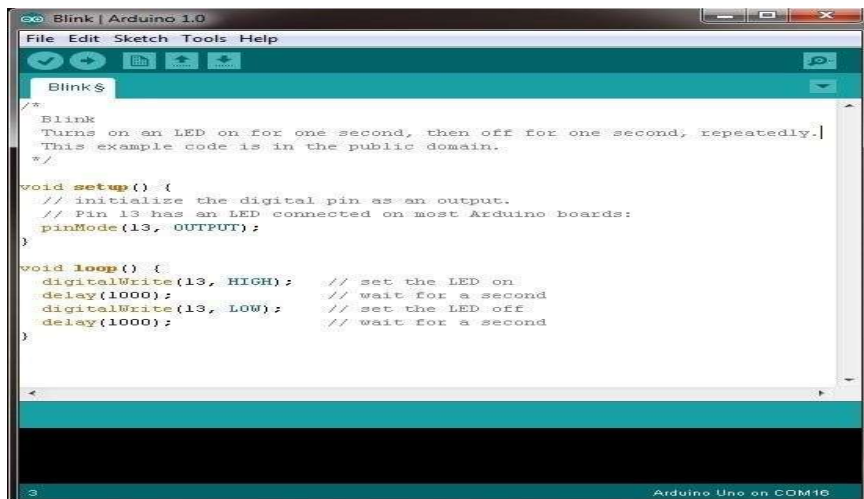


Figure 3.2: a Screenshot from Arduino

4. RESULTS AND SCHEMATICS

4.1 PRACTICAL RESULTS

The first build of the project could not make movement properly the two servos Responsible for moving the metal arm forward and backward could handle the Weight of the arm, because the torque of the servos was small compare to the Weight of the metal arm. The two failed servos had to be removed [32].

The metal arm was reconstructed with four servo motors, so the degree of freedom of the arm was decreased into 4 DOF otherwise the arm would not be able to move properly because if any servo was rotating against its will it will automatically open the circuit and therefore everything will be turned off. After removing the two motors the arm worked properly [3].

Now for the leap motion sensor readings:

Based on the code the leap motion returns the data for the desired parts like the hand position in an XYZ plane you can take whatever data you want for example the X axis data which was used to move the base, so if you move your hand to the left or to the right the motor will rotate correspondingly [11].

Now for the up and down motor if you raise your hand or lower it the servo will rotate and move the hook and neck motors up and down.

And finally for the hook and neck motors the neck motor responds to angle of the hand the roll angle to be specific and the vector for that angle is the palm normal vector as it was predefined from leap motion developers here is an image of the palm vectors [9].

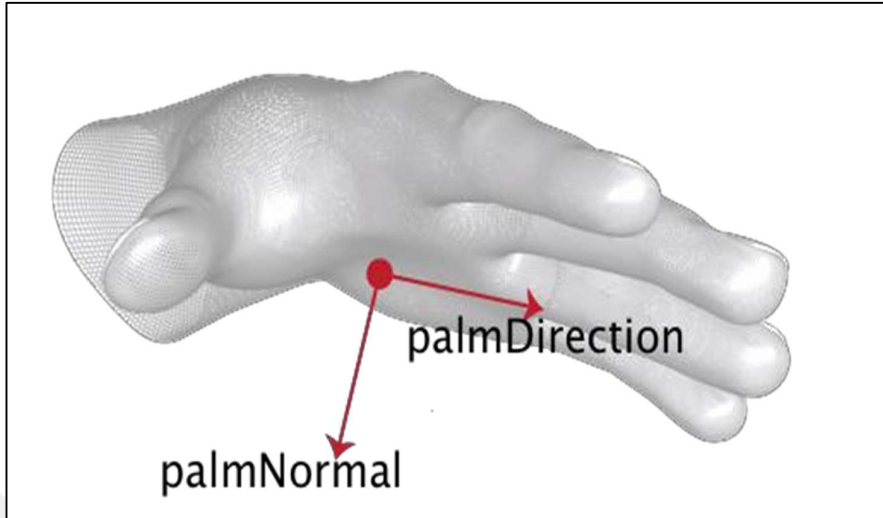


Figure 4.1: Palm vectors

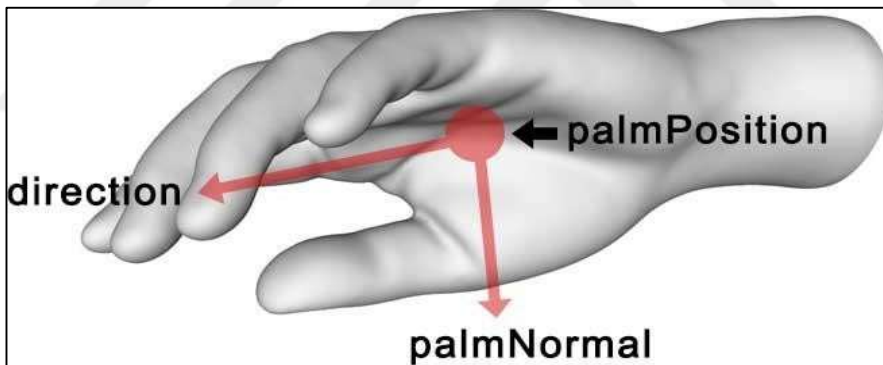


Figure 4.2: Palm Positions

As for the hook motor it responds according to the number of fingers visible to the leap. The hook will only be close if there was no finger visible to the sensor if there was one or more the hook will be open.

4.2 CONTROLLING SCHEMATIC

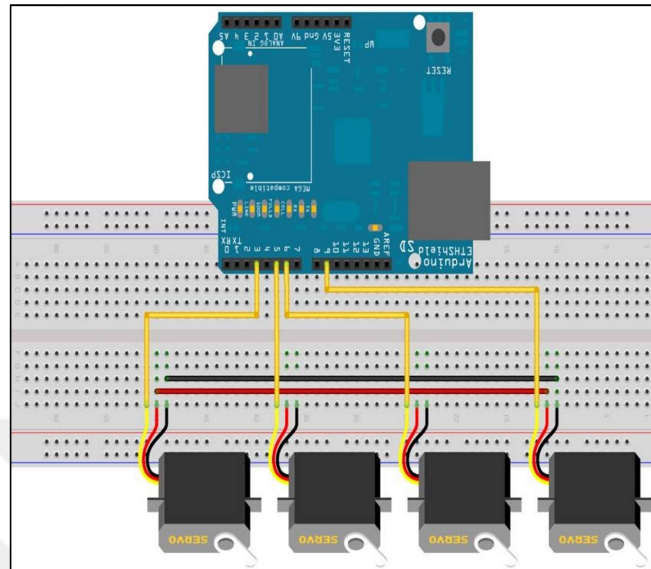


Figure 4.3: Project circuit schematic

4.3 COMPARISON WITH THE PREVIOUS WORKS

4.3.1 Previous Works

At the previous works all the scientists and the students did it with another Sensors or without sensors they could take the coded signal directly for the PC with a USB cable connected directly to the robotic arm for example: 2nd Generation OWI Robot Arm trainer, 100g lifting capacity!, Wired control of Gripper, wrist, elbow, base rotation and gripper LED shown in figure below:



Figure 4.4: The 2nd Generation of OWI Robot

And another example we have the hydraulic robotic arm this development emphasizes on the values of hydraulic actions. To do that they completed a slight scale project of a Robotic Hydraulic Arm. They achieved to do some pretty cool tasks with their "Arm" shown in figure below:

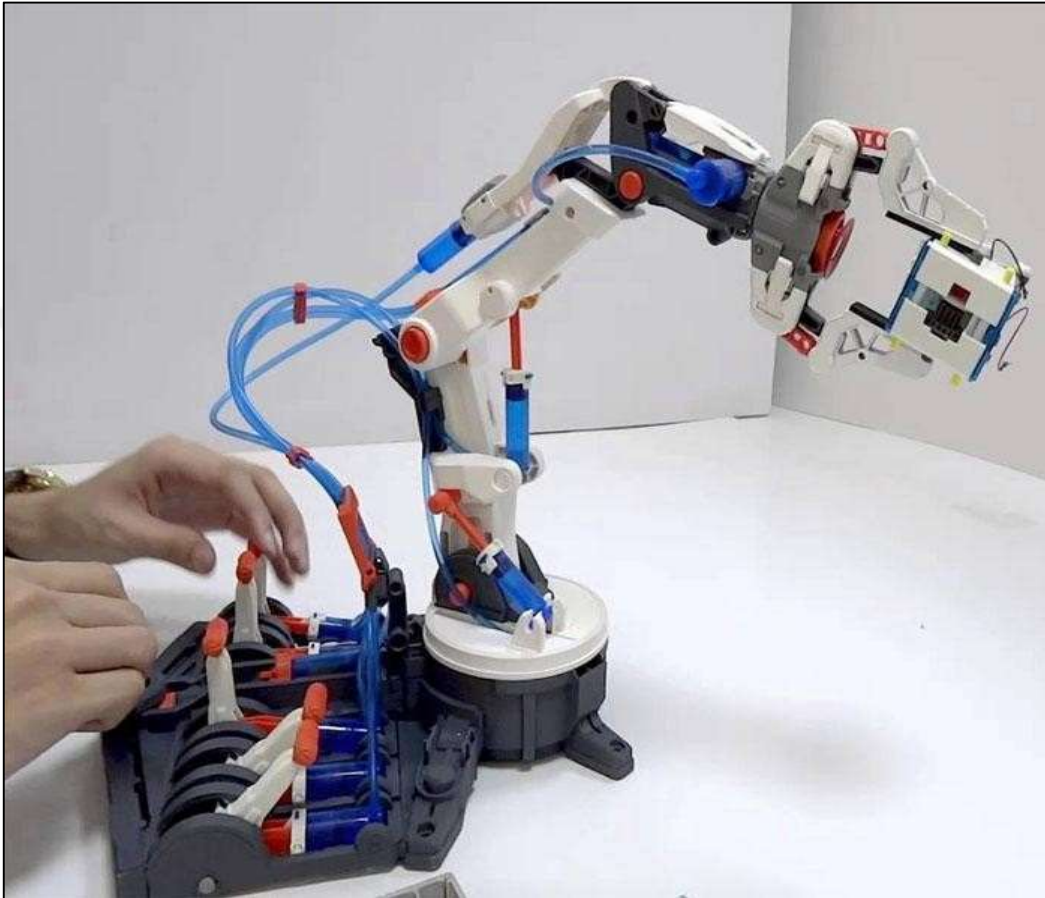


Figure 4.5: hydraulic Robotic Arm

4.3.2 Our Work

I did coded 6 movements with the arm now it goes (up, down, left, right, closing the fingers, opening the fingers) with the leap motion that we can barely find a robotic projects with this sensor



Figure 4.6: Robotic Arm Controlled With Leap Motion

5. CONCLUSIONS

For a Recommendation

The project seems to be facing a lot of issues regarding the torque of the servo motors so there are two possible solutions either to change the material of the arm like making it of plastic or something else lighter ,the other solution would be to change the motors with others that have bigger torque.

And another issue was with the power of the arm I made the job with only 5v so sometimes particularly when we move our hand to the left side above the sensor the robotic arm may be switch itself off.

The delay of the performances (The Actions) and the command is 0.0052 Ms.

These solutions could not be done because the time was short. So when we compare between my our Robotic arm controlled with leap motion with other robotic arms we can see that our robotic arm is easier and smoother to use than the others and we can do other than the 6 movements we made in our project by coding the new movements with our programming language which is java.

So as it was discussed in the previous chapters the only solution to these problems was to dispose of two servo motors.

Table 5.1: Comparison between Robotic Arms

The Robotic Arm type	Specs	Delay	Success	Accuracy
6DOF Controlled with Leap Motion	4 servo motors with Arduino UNO and sensor	500 Ms	6 Movements Succeed	Very Accurate
The 2nd generation of OWI robot	Wired control of gripper 100g lifting capacity	1000 Ms	4 Movements Succeed	Poor Accuracy
The hydraulic robotic arm	Generator, electric motors and combustion engine	900 Ms	4 Movements Succeed	Good Accuracy
The cartesian robotic arm	Linear Joints and Linear Motors	750 Ms	2-3 Movements Succeed	<i>Very Accurate</i>

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