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Radio Frequency Detection & Ranging

اكتشاف وتحديد موجات الراديو

A Research Submitted in Partial fulfillment for the Requirements of the Degree of B.Sc. (Honors) in Electronics Engineering

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قال تعالى:

(تَبَارَكَ الَّذِي بِيَدِهِ الْمُلْكُ وَهُوَ عَلَى كُلِّ شَيْءٍ قَدِيرٌ { ١} الَّذِي خَلَقَ
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صدق الله العظيم

سورة الملك الآية (١-٣)

الإهداء

إلهي لايطيب الليل إلا بشكرك ولايطيب النهار إلا بطاعتك .. ولاتطيباللحظات إلا بذكرك .. ولا تطيب الآخرة إلا بعفوك .. ولا تطيب الجنة إلابرؤيتكالله جل جلاله

إلى من بلغ الرسالة وأدىالأمانة .. الأمة .. إلى نبي الرحمة ونور العالمين

محمد رسول الله

إلى من كلله الله بالهيبةوالوقار .. إلى ... عطاء بدون انتظار .. إلى من أحمل أسمه بكل افتخار .. أرجو من الله أن يمد في عمرك لترى ثماراً قد حان قطافها بعد طول انتظار وستبقىكلماتك

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Abstract

In this project, we examine the RSSI measurement modelTo detected the direction of illegal broadcasting. We also showhow to use Directional antenna efficiently to detect the position of the Received signal strength indication (RSSI) module by sampling multiple readings from the module by Arduino. The results of the simulation of our method in Proteus indicate that the location of the module can be detected in a small amount of time and that the quality of the solution is competitive with previous approaches.

المستخلص

تناولت هذه الدراسة كيفية تتبع الإشارة وتحديد إتجاهها ، وتم ذلك في خمسة أبواب ، وتم عمل مقدمة عن المشروع والمشاكل التي يجب ان تتم معالجتها وذلك في الباب الأول ، وفي الباب الثاني تم تناول الأبحاث والأوراق العلمية التي تحدثة عن هذا الموضوع ، وتم شرح الدائرة العملية وطريقة العمل بشكل أكثر تفصلاً بالإضافة الى مكونات الدائرة في الباب الثالث ، وتم محاكاة الدائرة العملية بإستخدام أحد برامج المحاكاة وعرض النتائج وذلك في الباب الرابع ، وتم كتابة خلاصة الموضوع بلإضافة الى مايمكن وتحديثة وإضافتة للمشروع في المستقبل.

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Introduction

Many people call telecommunication the world's most lucrative industry. Added cellular and PCS users,1 there are about 1800 million subscribers to telecommunication services worldwide (1999). Annual expenditures on telecommunications reach 900,000 million dollars in the year 2000.

1.1 Early Radio Technologies

"Electromagnetic wave–based communications have been utilized for many decades. In fact, radio and television both depend on these electromagnetic waves. Additionally, these electromagnetic waves—or *radio waves*—have been used for purposes such as wireless voice conversations (today, we call these cell phones) and data communications. The military has used wireless communications for many decades, and expensive proprietary equipment has also been available. You could say that wireless communications over great distance all started with the letter *S*. It was this letter that Guglielmo Marconi transmitted, received, and printed with the Morse inker across the Atlantic in the first decade of the twentieth century. Though Marconi was not the first to communicate over a distance without wires, this event started a greater stirring through the government and business communities that resulted in the many uses of wireless technology we see today. Radio Frequency and Antenna Fundamentals By the 1920s, radio waves were being used for telecommunications. In fact, the first transatlantic telephone service became available in 1927from New York to London. Twenty-one years earlier, in 1906, Reginald Fessenden successfully communicated from land to sea over a distance of 11 miles using radio waves to carry voice communications. Bell Laboratories had created a mobile two-way voice-carrying radio wave device by 1924, but mobile voice technology was not really perfected and used widely until the 1940s."[1]

1.1.1 Radio Frequency detector

"An RF detector monitors or samples the output of an RF circuit and develops a dc output voltage proportional to the power at that point .RF detectors are used primarily to measure and control RF power in wireless systems .RF power, rather than voltage, is the primary measure of a wireless signal. In a receiver, signal strength is a key factor in maintaining reliable communications. In the transmitter, the amount of power transmitted is critical because of regulatory guidelines. It’s also important for maintaining the range and reliability of the radio link. Transmitter output power measurement is the primary application. It is essential to know the RF output power because the application specifies it in most cases, and certain maximum values must not be exceeded according to Federal CommunicationsCommission regulations. In many cases, the transmitter power is controlled automatically. As a result, the output power is measured and compared to a set point level in a feedback control circuit so power can be adjusted as required. In receivers, power measurement is usually referred to as the received signal strength indicator (RSSI). The RSSI signal typically is used to control the gain of the RF/IF signal chain with an automatic gain control (AGC) or automatic level control (ALC) circuit to maintain a constant signal level suitable for analog-to-digital conversion and demodulation."[2]

1.2 Problem statement

Broadcasting is the distribution of audio or video content to a dispersed audience via any electronic mass communications medium .Illegal broadcasting otherwise known as a pirate radio is the operation of a licensed and unregulated radio station. Illegal broadcasters use radio transmitters which can cause interference to legitimate users, they also have the potential of critical services such as the emergency services and traffic control .so that the main problem is Illegal broadcasting.

1.3 Project approach

In this project we are going to design RF detector device ,the block diagram consist of directional antenna, arduino ,two stepper motors two drivers, LCD and serial board. The antenna receive the frequency to stop the stepper motors after the arduino compare between the receive frequency and the standard frequency (27MHZ) in order to detect the direction of broadcasting . The detailed methodology included in chapter three.

1.4 Objective

- Detect the direction of illegal broadcasting.

- Design a circuit that control directional antenna connected to stepper motor

- Write a program that stops the stepper motors based on a certain signal

- Design a circuit that receive a certain frequency

1.5 Thesis Outlines

This project consist of five chapter, chapter one includes an introduction and overview about radio frequency detection and ranging. Chapter two includes background and literature review about all rf detector projects . Chapter three includes the block diagram, components, code and the method of the design rf detector techniques. Chapter four includes the simulation and results. Finally chapter five includes conclusion and recommendation

Chapter Two
Background
&
Literature Review

Chapter Two

Literature Review

2.1 Radio Frequency Identification (RFID)

"During the last decades bar codes have probably been the most successful identification technology, as other procedures didn't yet exist or were too expensive to be deployed recently, although technologies like RFID have many advantages. RFID technology is cheap, fast, does not require line of sight and supports simultaneous reading of several tags at once over distances ranging from few centimeters to hundreds of meters. Due to technological progress the technology behind RFID has improved, lowering the costs to reasonable levels allowing it to enter the mass market. Every RFID system consists of a reader, a transponder, and an application software. The transponder is a data-carrier which is commonly called tag.

They come in various shapes and sizes, mostly in form of a so called smart cards or smart labels, which are sticky and can easily be attached to objects. Widespread applications can be found in the else anti-theft, access control, logistics, supply chain management, animal identification and tracking, and electronic payment systems, to name few examples for the countless uses of RFID. In the next section the history of RFID technology is presented, followed by an introduction to the principles and components of RFID systems along with important standards, which specify the basics of RFID. Afterwards modern applications are analyzed before introducing possible risks and attack vectors which can result out of the use of RFID technology.

The invention of radar in the mid-1930s made it possible to detect aircraft from vast distances, but during World WarII the issue of distinguishing friendly from enemy planes became problem. For this purpose the Germans would upside-down on command before entering friendly airspace, altering the rejected radio signal to identify the aircraft as friendly. One can call this the rst passive RFID system, which was simplistic to spoof by Allied forces. This called for a more sophisticated methods of identification and as a result IFF (Identify Friend or Foe) systems were developed, for example the German FuG 25a "Erstling" manufactured by GEMA in 1941 which sent back a pre-dened signal to ground radar stations when asked for identification. This method of automatic identification via radio-frequency signals is one of the rest active RFID systems. In 1948 Harry Stockman described in his publication "Communication by Means of Reacted Power" basic theoretical principles for passive RFID systems and suggested more active foundational research in this area. [3]

Radio-frequency identification was invented. More experimental work followed in the upcoming decades, such as Donald B. Harris' "Radio Transmission Systems with Modula table Passive Responder" in 1960. Harris patented wireless communication system similar to the military 's"Walkie Talkie" systems with the main divergence that only one station needs an external power source whereas the portable station draws the required energy to reply out of the received radio signals. Another RFID-related development was Robert M. Richardson's invention "Remotely Actuated Radio Frequency Powered Devices" primarily focusing on evident usage of radio frequency energy "approaching the theoretical maximum". As RFID technology was mostly used by the military, in the1960s _rstcompanies recognized the advantages it brings for civilian commercial usage. One of the most widespread and well known inventions of this time were RFID based electronic article surveillance (EAS), to prevent theft and loss of merchandise, which was developed by Arthur Minas later the founder of the company "Knogo" (1966). Also "Sensormatic Electronics Corporation" (1960) and "Checkpoint Systems, Inc." (1969) competed in this area of E-Systems, which mostly uses 1-bit passive tags and several readers called gates which form a detection zone. If a functional tag is detected in this area an alarm is triggered to signalize an unauthorized passing, whereas no radio signal can be received when the tag is either destroyed, deactivated or removed. In 1975 three scientists from the Los Alamos Sciatic Laboratory published their work on "Short-Range Radio-Telemetry for Electronic Identification, Using Modulated RF Backscatter "and presented an innovative method of communication for passive RFID tags.

They were developing a passive "electronic identification system for livestock", which reported the animals identification number as well as its body temperature over a distance of several meters between tag and reader During the 1970s further novel developments of RFID systems included also the ends of vehicle identification and access control systems. So far RFID technology was mostly a subject of research and development, whereas widespread commercial applications were yet to come in the following decades. Since the late 1980s several countries began to deploy electronic toll collection systems, rst of all Norway in October 1987, soon followed by the United States, Italy, and France. As there was only little competition in this market section prices for RFID systems were very high, hindering it from becoming mainstream technology, although improvements were made considering the size, weight and range of tags. This enabled applications such as animal tracking with implanted tags under the skin, and container tracking which was a development of the Association of American Railroads and the Container Handling Cooperative Program. The 1990s and 2000s are characterized by RFID technology becoming part of everyday life of consumers and the _rest establishment of industrial standards along with governmental regulations concerning the power and used frequencies of RFID systems. New applications developed in the 1990sincluded systems for electronic toll payment, ski passes, vehicle access and article tracking. The Auto-ID Center at the Massachusetts Institute of Technology was founded in 1999supported by the EAN International (today known as GS1) and Uniform Code Council Inc. (UCC, today known as GS1US) along with Procter & Gamble and Gillette in order to develop the Electronic Product Code (EPC) and standards for low-cost UHF RFID tags used in supply chain applications. As the Auto-ID Center gained supporters and became a worldwide operating research facility, the need for global RFID standards was recognized and resulted among other developments in two air interface protocols (Class 0, Class 1) and the EPC global Network, a multi corporate network for real-time tag tracking via the Internet.

Until the late 1990s most aspects of modern RFID technology were standardized. These standards applied to animal identification (ISO/IEC 11784, 11785 and 14223), contactless smartcards (based on ISO/IEC 7810: ISO/IEC 10536, 14443 and156693), container identification (ISO 10374), anti-theft systems for goods (VDI 4470) and item management (ISO/IEC18000, EPCglobal Network). All standards are subjectto continuous revisions as technology progresses. In 2003 the UCC and EAN

International formed the nonprime _t organization EPCglobal Inc. to commercialize theEPC global Network internationally. It kept developing new protocols parallel to the combined e_orts of the International Standards Organization (ISO) and International Electro technical Commission (IEC). Although EPCglobal tried to create the ISO compatible Gen2 standard it took until 2006before it was merged wth the ISO/IEC 18000 standards. In the meantime large organizations like Wal-Mart and the US Department of Defense set up mandates, which required many of their suppliers to apply RFID tags on their shipments. In 2004 the US Food and Drug Administration (FDA) eased the way for human RFID implants containing a unique ID number."

Short for Radio Frequency Identification. The term RFID is used to describe various technologies that use radio waves to automatically identify people or objects. RFID technology is similar to the bar code identification systems we see in retail stores every day; however one big difference between RFID and bar code technology is that RFID does not rely on the line-of-sight reading that bar code scanning requires to work. Basically RFID is a wireless communication system which use RF signal to establish the communication between two ends. RFID system does this communication by using modulated RF signal which is sent between the two main components in the system; the reader and the tag. [4]

2.2 RFID HISTORY

Radio Frequency Identification (RFID) is not a recent technology in fact it has been used years ago in many application. It is believed that RFID can be traced back to World War II where the Germans, Japanese and

British were using radar which has been discovered by the Scottish Physicist Robert Watson Watt. Back then those radars used radio frequency systems in order to warn of approaching planes; the problem was that those radars could only sense the approaching plane but could not identify it. It was of particular importance to be able to identify the approaching object that’s why Watson Watt developed a system known as IFF Identification Friend or Foe which can differentiate between objects. The system basic concept is placing a transponder on a certain object, when this transponder is interrogated by a radio station it will respond with a code which identifies the object. Through years researches has been done to study the communication between the reader and the tag placed on the object and how can the reader communicate with a certain object. Although that the IFF system successfully demonstrated the principles of remote detection then object interrogation but the cost of the system implementation is significantly high that is why studies were done to enable this system to be used for low cost commercial application.

In the 70’s, at Los Alamos National Laboratories researches have been done to implement a RFID system which can track the transportation of nuclear materials[2]. Since it was a very sensitive issue they developer a system which can keep tracking the vehicles used to transport these materials at various points along its route. By the same time further activities were done by Charles Walton a researcher who quitted IBM to start producing proximity devices. Walton’s patent was using radio waves to control door locks, where radio transceiver sends a small electrical current to a tag to identify it then unlocking the door. Schlage the lock making firm bought his prototype to produce an electronic lock which can be operated using a keycard. Years later the cost of RFID component reduced, one of the first applications for RFID technology is the electronic surveillance tags used in hypermarkets, where RFID technology is used as a replacement for the European Article Number (EAN) or the Universal Product Code (UPC) which are commonly known as barcode. Barcode has been used for years to identify a certain object by placing a barcode tag closely to the barcode scanner. The barcode tag represents the product's data in Terms of variation of the width and spacing of printed parallel lines. The Data imprinted on a barcode tag is a fixed data and cannot be changed, While there is a certain type of RFID tags which are rewritable. Also unlike RFID, optical scanners which are known as barcode readers must be placed closely to the tag in order to identify it properly. The 80s was the decade for full implementation of RFID technology. That's when RFID system was used for access control in different fields of life. A significant achievement in 1987 Norway was the implementation of the first successful toll collection system, this was a breakthrough product for RFID technology. That is why after few years toll systems and government toll collection agencies had spread across the United States.

In the 21st century RFID technology spread nearly everywhere and it is used in different life fields. The reason behind that is that the used tags can vary in shapes and sizes which make it easily to use RFID in different applications. Since RFID technology continues to spread all over the world therefore a quantity of applications implemented using RFID in different aspects of life and each application is implemented to fulfill a unique task. This proves how flexible RFID technology is and how interesting it is to work with it.

The reason why RFID technology is flexible is the variability in its components especially the RFID tag. Tags can be easily implemented in different shapes in order to fulfill different tasks. For access control systems, RFID tags are designed in the shape of cards. That is not the only form of tags; tags can also be designed as small chips so that they can be implanted in animals to keep track of their location and even their medical conditions and in some cases tags can be implanted into humans too. This is because there are certain types of RFID tags which could be rewritable. This is not the only variation in RFID technology, RFID can be operated at different frequencies depending on the application and the appropriate frequency band in each country. There are many more advantages of RFID technology that is why it is believed that within a short period of time, RFID technology will take over barcode technology. Like any technology there are certain problems could confront RFID like inaccuracy due to reading collision. There are two types of collision, reader collision and tag collision. After many researches and many introduced anti-collision protocols RFID technology has proven its efficiency and its accuracy identifying each different tag. Another problem which can confront RFID technology is the inaccuracy occurs due to RF signals interference and in order to solve this problem the human operator should be aware of the RFID operating frequency. This is not the only problem occurred due to RF signals, another problem is the RF signal reflection due to the presence of objects. This problem is encountered only in certain RFID applications. [5]

2.3 RFID Antenna

Any RF communication system needs a pair of antennas. Antenna is simply a device that transforms an electric wave, coming from a generator with a given impedance, into a radiated electromagnetic wave that will propagate in free space or will reciprocally transform an electromagnetic wave into an electric wave to a receiver. Because it is difficult to transmit power over the air, an antenna designer wants reasonable power efficiency in the transmission. To do this, you need to take care of two things: the electric and the electromagnetic sides of the transmission: On the electric side, you need good impedance matching between the transmitter or receiver and the antenna or, more exactly, between the transmitter and the combination of the antenna and free space. On the electromagnetic side, because the antenna transforms the electric energy into a radiated field, you need it to radiate its power in the direction that you want. That’s the radiation pattern of the antenna.

An antenna (or aerial) is an electrical device which converts electric currents into radio waves, and vice versa. It is usually used with a radio transmitter or radio receiver. In transmission, a radio transmitter applies an oscillating radio frequency electric current to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves). In reception, an antenna intercepts some of the power of an electromagnetic wave in order to produce a tiny voltage at its terminals that is applied to a receiver to be amplified. An antenna can be used for both transmitting and receiving. Antennas are essential components of all equipment that uses radio. They are used in systems such as radio broadcasting, broadcast television, two-way radio, communications receivers, radar, cell phones, and satellite communications, as well as other devices such as garage door openers, wireless microphones, Bluetooth enabled devices, wireless computer networks, baby monitors, and RFID tags on merchandise.

The helical antenna is an antenna consisting of a conducting wire wound in the form of a helix. In most cases, helical antennas are mounted over a ground plane. The feed line is connected between the bottom of the helix and the ground plane. Helical antennas can operate in one of two principal modes: normal mode or axial mode. In the normal mode or broadside helix, the dimensions of the helix (the diameter and the pitch) are small compared with the wavelength. The antenna acts similarly to an electrically short dipole or monopole, and the radiation pattern, similar to these antennas is omnidirectional, with maximum radiation at right angles to the helix axis. The radiation is In the axial mode or end-fire helix, the dimensions of the helix are comparable to a wavelength. The antenna functions as a directional antenna radiating a beam off the ends of the helix, along the antenna's axis. It radiates circularly polarized radio waves. IN order to make the beam that is radiated by the antenna to by directional we made a helical antenna to make the radiated beam as narrow as possible to be more accurate to locate the place of the Active tags. The wire used for making the antenna is 1.5mm wire diameter which is twisted to a number of turns to make a helical antenna. [6]

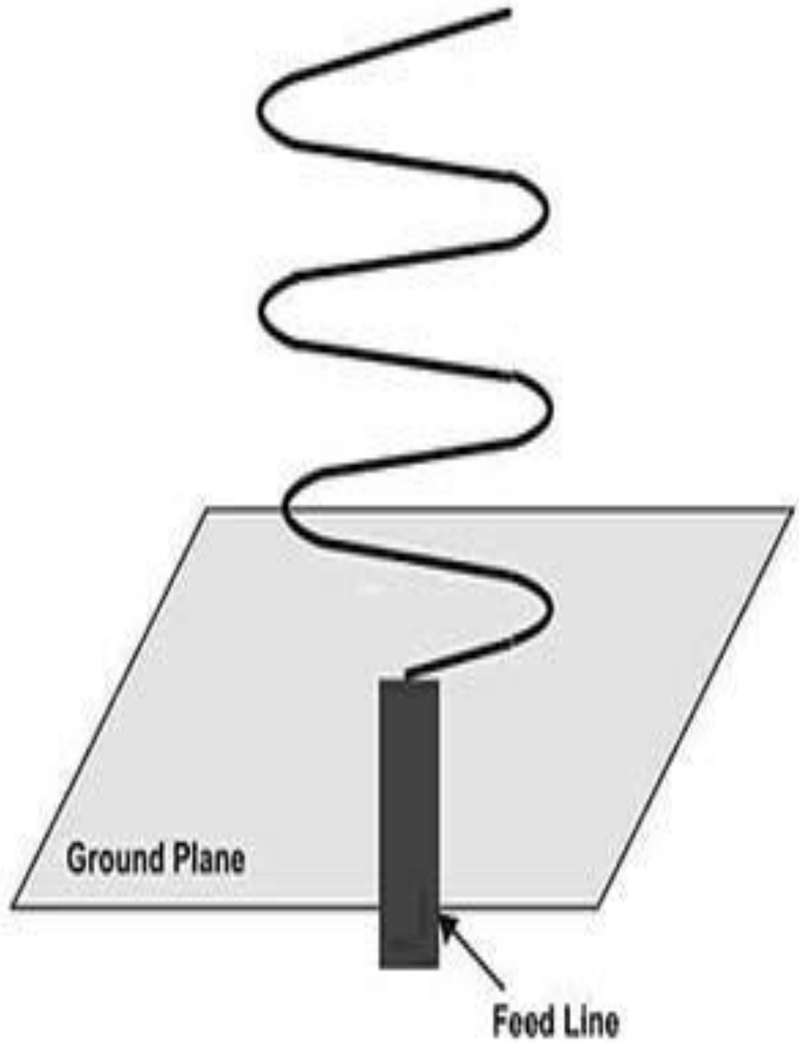


Figure 2.1 an example of a helical antenna

2.4 Received signal strength indication (RSSI)

"Estimating the location of a roaming sensor is a fundamental task for most sensor networks applications. For example, if a sensor network has been deployed to provide protection against fire (in this case, sensor nodes report a sudden increase in temperature), we want to know the location of the sensor that triggers an alert so that action can be taken accordingly. Additionally, some routing protocols for sensor networks, such as geographical routing, make routing decisions based on the knowledge of the locations of the sensor nodes. Common location estimation protocols that are widely adopted in practice assume that there are some fixed nodes (base stations) that know their location which are called *beacons*.

These nodes send a signal to the sensor nodes that want to determine their location. According to the intensity (or for example the angle) of this signal, the sensor node can have an estimate of the distance between them and the beacons. After performing a certain number of such measurements for different beacons, the sensor node has to combine all this information (for RSSI (Received Signal Strength Indicator), this information is the power of each individual signal and the coordinates of the corresponding transmitter) in order to estimate its location. Cannot we use a Geographic Positioning System (GPS) to efficiently achieve the task of localization because is that a GPS requires a strong computing platform which is not available in sensor networks. Sensor nodes are typically very low-computing power units that can efficiently perform only basic arithmetic operations; Requiring the execution of complex arithmetic operations on a sensor node would entail a quick depletion of its battery which is not desirable for most practical applications. Finally, the localization problem gets even more difficult because the available power on the sensor node is limited: therefore no accurate measurements of the signal can be made (since an accurate measurement requires more computing power) which means that the measurements are prone to errors. This is something that should also be taken into consideration and treated accordingly. Therefore, any location estimation algorithm should have the following requirements:

1. The sensor node should avoid complex and time consuming computations, which would deplete its energy supply (typically a low-cost battery) rapidly.
2. The computations should take into consideration the error in the measurements, which can be large.

The Received Signal Strength Indicator (RSSI) value is part of the data packet transmitted by all VerisAerospond sensor units. It is intended as means to obtain a relative indication of the quality of connection that exists between the sensor unit and the access point it is connected to on the wireless network. In order for this to be a useful tool in determining the quality of the connection, there are a few principals that need to be understood about what the RSSI value means. Signal strength is based on a number of factors, including the output power of the transmitter (the original strength of the signal), the sensitivity of the receiver (how well the receiving device can hear weak signals), the gain of the antennae at both ends of the path, and the path loss, or attenuation of the signal as it travels through the air from the transmitter to the receiver. Signal strength is expressed in units of decibels (dB). Due to the low power levels and the attenuation of free space, an RSSI value is expressed as a negative number. The more negative the number, the weaker the signal strength; conversely the closer the number is to zero, the stronger the signal.

The RSSI value is an indication of how well the sensor hears the signal being transmitted by the access point. It does not indicate how well the access point is hearing the Aerospond unit, as that information must be attained directly from the access point itself and is not typically available. Since Aerospond units typically transmit with lower power than most access points, it is reasonable to assume that the Aerospond unit sees a slightly stronger signal from the access point than the access point sees from the Aerospond unit. This normally does not pose any problems unless the sensor is on the very fringe of the access point's range. It should also be noted that RSSI values are a relative indication of signal strength, not an absolute measurement. It is normal to see RSSI values fluctuate several dB between readings. If a sensor is in range of multiple access points, it is also normal to see the unit occasionally switch between them, even though one access point may have a much higher RSSI value than the other. [7]

2.5 Mobile Phone Signal Detector

The existing technology currently available in the open market utilizes mostly discrete components, and a design approach using a down converter in conjunction with a band pass filter. These technologies are not adequate because they are inaccurate and expensive. The first signal detection technique, an RF detector using tuned Inductor-Capacitor (LC)utilizes discrete components which is difficult to implement.

They are very affordable to construct, but requires precision tuning. This design when analyzed was found to be inaccurate. The design incorporated tuned LC circuit which is used to detect low frequency radiation in the Amplitude Modulation (AM) and Frequency Modulation (FM) bands. It detects signals in the GHz frequency band used in mobile phones as the transmission frequency of mobile phone ranges from 0.9 to 3 GHz. A capacitor is used to form a part of the LC circuit as C while the lead (coiled wire) of the same forms the L to receive RF signals from the mobile phone. When the mobile phone is activated the RF transmission signal is detected by the detector and starts sounding a beep alarm and the LED blinks.

The second technique seems to be accurate but has its own short comings, in addition to being very expensive. The two most popular mobile phone detectors available under this technology are produced by Berkeley Varitronics Systems and mobile Security products. These companies produce the wolfhound cell phone detector and cell buster, respectively. The Berkeley Varitronics systems Wolfhound cell phone detects Personal Computers (PCs), Code Division Multiple Access (CDMA), Global System for Mobiles (GSM) and cellular bands using the RF signals. It is also capable to directionally find and locate cellular phones that are nearby.

The Wolfhound seems to be a great way to detect cellular phones but may just randomly detect mobile phone communications in the area and not necessarily the Phone or device that set it off. The Cell Buster from mobile security product which provides continuous monitoring for mobile phone and has voice alert that tells the user to shut their phone off if detected. The Cell Buster only receives and does not transmit, making it great for areas that are sensitive to cellular phone usage. It also detects phones that are in standby mode. The Cell Buster also seems like it would work wonderfully for keeping people from bringing their phones into restricted areas, however, like the Berkeley Vantronics systems it has its shortcomings as it takes up to 20 minutes to detect if it is in standby and that the phone needs to be on and its detection could be random transmission in that area.

2.5.1DESIGN PROCEDURE/ METHODOLOGY

An ordinary RF detector using tuned LC circuits is not suitable for detecting signals in the GHz frequency band used in mobile phones due to the high frequency at which it transmit and huge energy that it gives out.

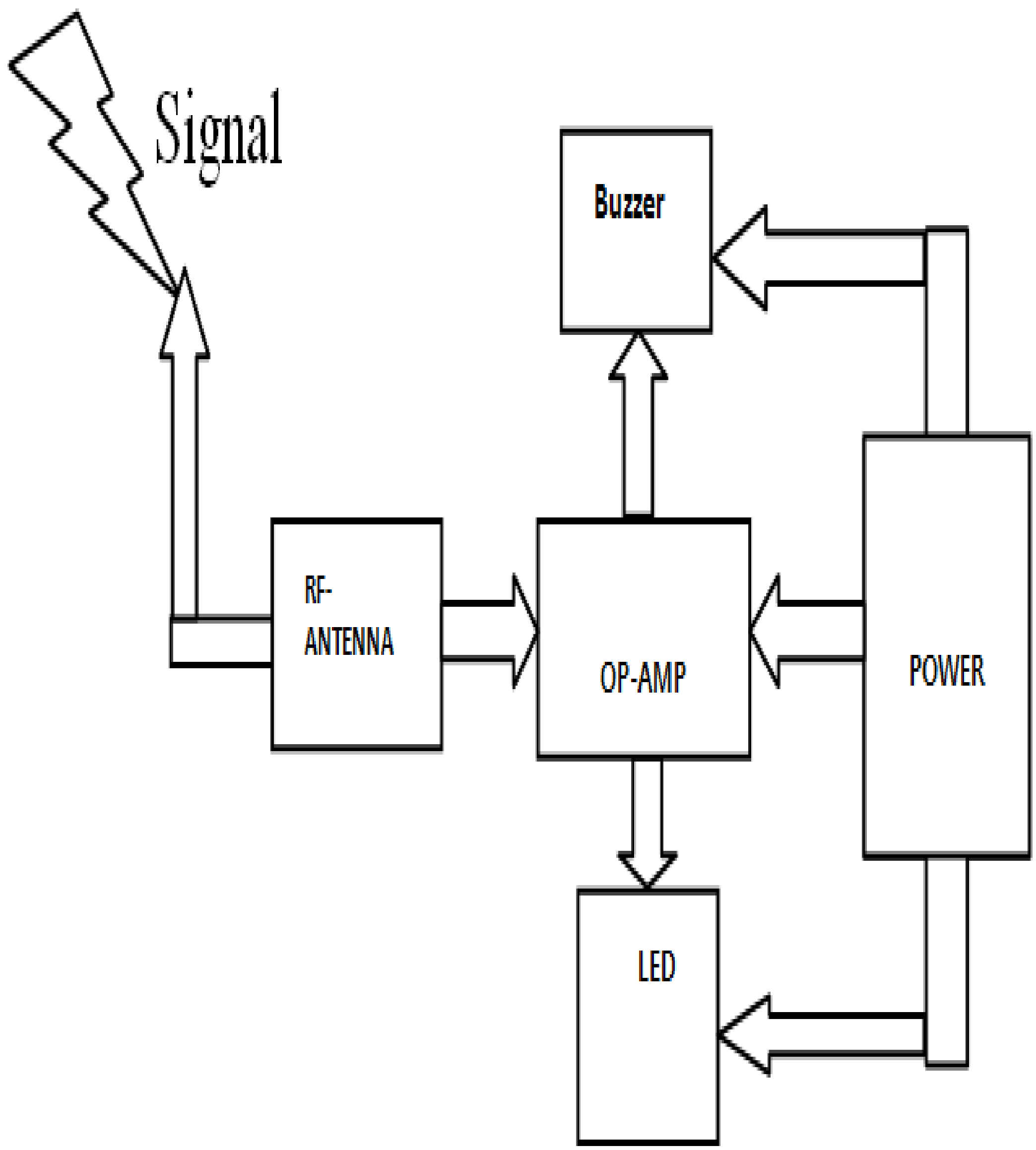


Figure 2.2 Block Diagram of Mobile Signal Detector

The construction of this pocket size mobile phone signal detector is so simple and not expensive. For the construction to be understood and appreciated a more detailed description of the design is required using the block diagram.

The design consists of four stages as shown in the block diagram.

1. The sensor stage
2. The power stage
3. Operational Amplifier (Op-Amp) stage
4. Response stage

From the above block diagram, once the RF antenna receives wireless signal after the circuit has been powered by a 9 Volts dc battery, the operational Amplifier LM358AN amplifies the received signal which is turn triggers the buzzer and makes the LED to flicker when signal is detected. [8]

2.6 Source of Radio Waves

Consider electric current as a flow of electrons along a conductor between points of differing potential. A direct current flows continuously in the same direction. This would occur if the polarity of the electromotive force causing the electron flows were constant, such as is the case with a battery. If, however, the current is induced by the relative motion between a conductor and a magnetic field, such as is the case in a rotating machine called a generator, then the resulting current changes direction in the conductor as the polarity of the electromotive force changes with the rotation of the generator's rotor. This is known as alternating current. The energy of the current flowing through the conductor is either dissipated as heat (an energy loss proportional to both the current flowing through the conductor and the conductor’s resistance) or stored in an electromagnetic field oriented symmetrically about the conductor. The orientation of this field is a function of the polarity of the source producing the current. When the current is removed from the wire, this electromagnetic field will, after a finite time, collapse back into the wire. When occur should the polarity of the current source supplying the wire be reversed at a rate which exceeds the finite amount of time required for the electromagnetic field to collapse back upon the wire In this case, another magnetic field, proportional in strength but exactly opposite in magnetic orientation to the initial field, will be formed upon the wire. The initial magnetic field, its current source gone, cannot collapse back upon the wire because of the existence of this second electromagnetic field. Instead, it propagates out into space. This is the basic principle of a radio antenna, which transmits a wave at a frequency proportional to the rate of pole reversal and at a speed equal to the speed of light. [8]

Chapter Three

Chapter Three

Block Diagram and Design

3.1 Methodology

In this project the methodology can be described as following:

-Study the previous work about RF detector

-Study the types of signals that can be track

-Draw the block diagram of the project

-Design the circuit simulation

- Choose the rssi module and suitable antenna

-Upload the code in arduino

-Connecting the directional antenna to stepper motor in serial board

-Connecting the stepper motor to arduino to control the steps based on the received signal

-Making metal cavities to antenna to concentrate radiation in one way

-Complete the component of the circuit

-Test the system

3.2 Block Diagram

This RF detector suitable for detecting the direction of signals in the MHz frequency band The design consists of ten stages as shown in the block diagram. From the below block diagram, the band pass filter to pass frequencies within a certain range and rejects the frequencies outside the range, once the RF antenna receive signal after the circuit has been powered by a 5 Volts dc battery, the operational Amplifier amplifies the received signal which is turn the stepper motor to move the antenna the arduino control the moving of stepper motors by comparing between the receive frequency and the standard frequency. The LCD show the frequency when signal direction is detected.

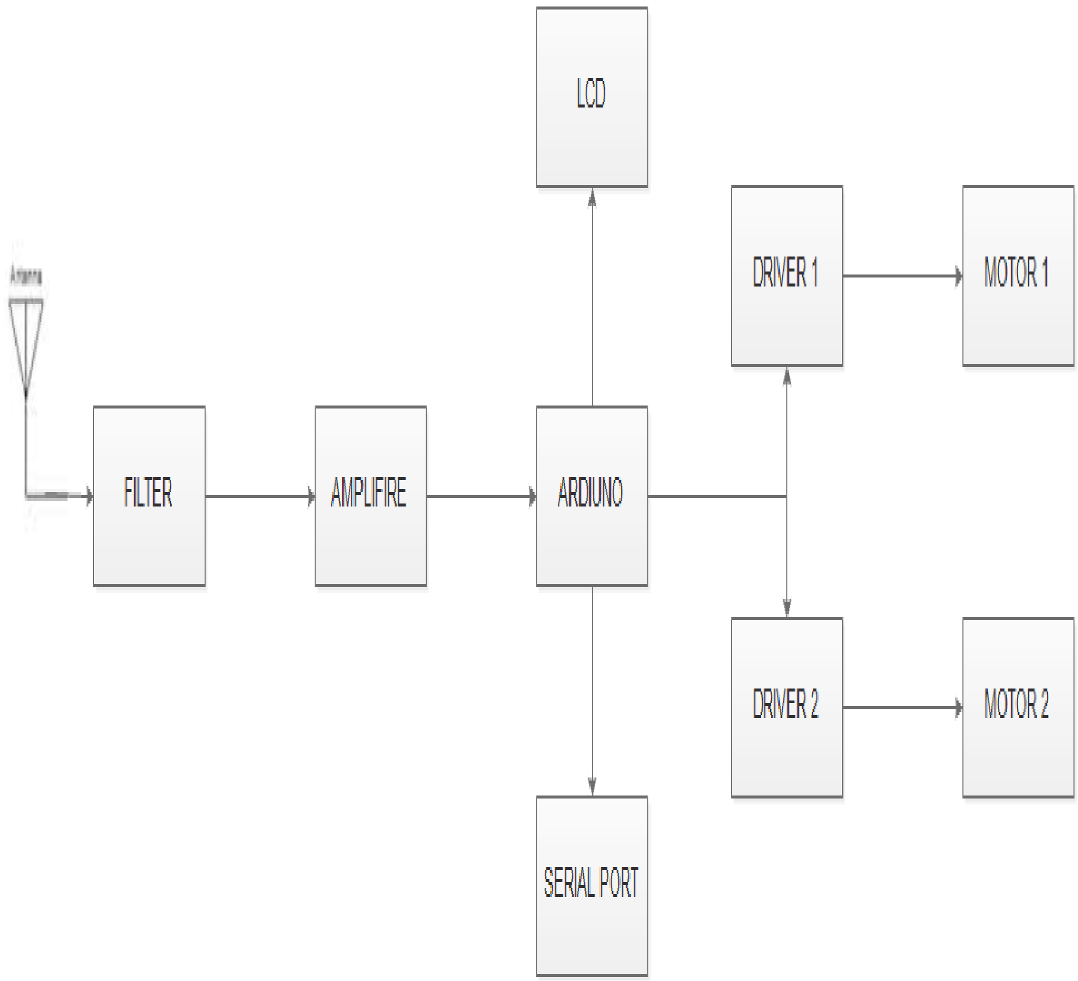


Figure 3.1 Block Diagram of RFDR

3.3 Flow chart

In this project the flow chart can be described in figure 3.2

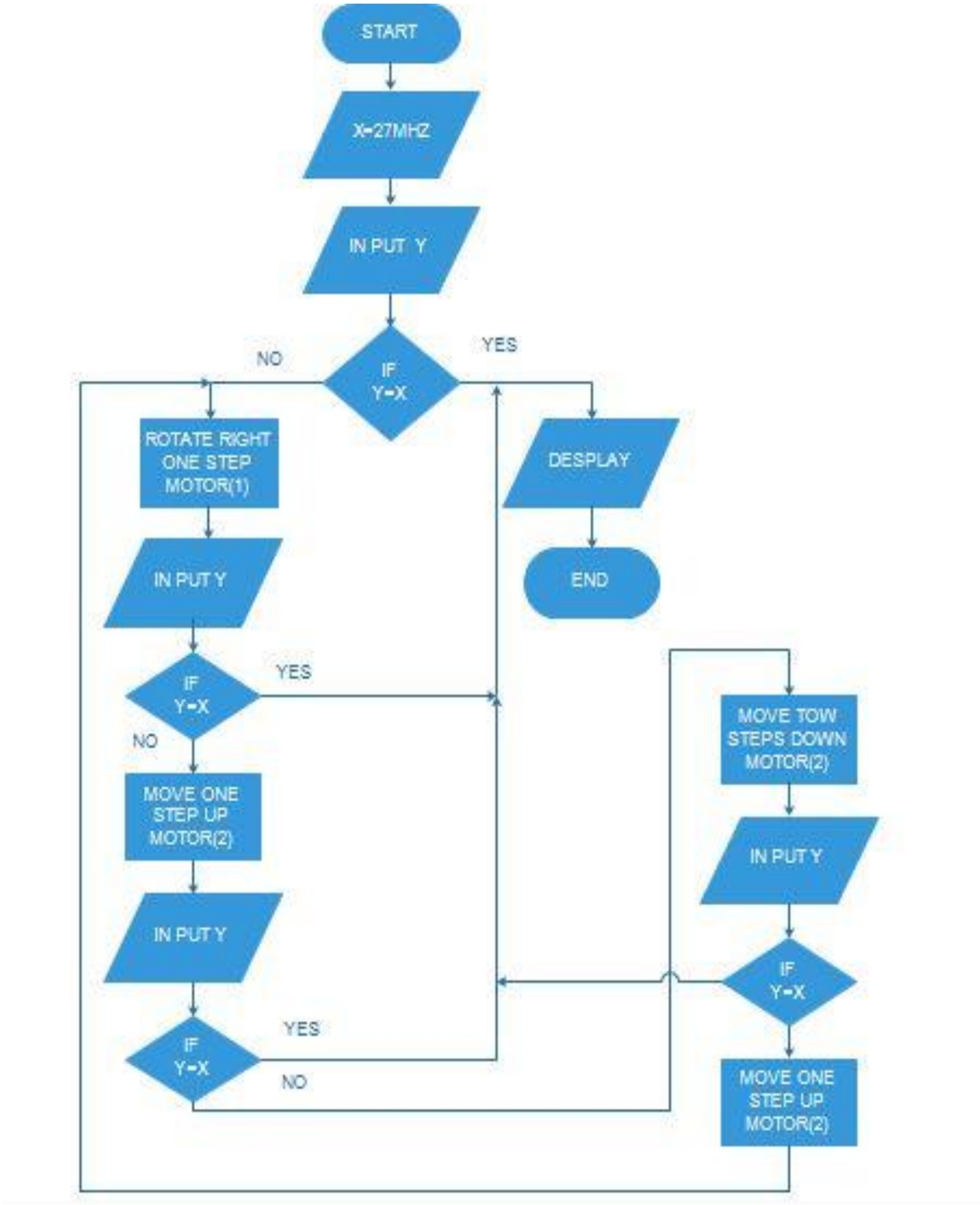


Figure3.2 Flow chart of particular circuit

3.4 Arduino mega 2650

The Arduino/Genuino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, 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 a AC-to-DC adapter or battery to get started. The Mega 2560 board is compatible with most shields designed for Arduino/Genuino Uno and the former boards Duemilanove or Diecimila.

The Arduino/Genuino Mega 2560 board has a number of facilities for communicating with a computer, another board, or other microcontrollers. The ATmega2560 provides four hardware UARTs for TTL (5V) serial communication. An ATmega16U2 (ATmega 8U2 on the revision 1 and revision 2 boards) on the board channels one of these over USB and provides a virtual com port to software on the computer (Windows machines will need a .inf file, but OSX and Linux machines will recognize the board as a COM port automatically. The Arduino Software (IDE) includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the ATmega8U2/ATmega16U2 chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

Table 3.1Arduino Mega 2560 Technical specs

Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	54 (of which 15 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz
Length	101.52 mm
Width	53.3 mm
Weight	37 g

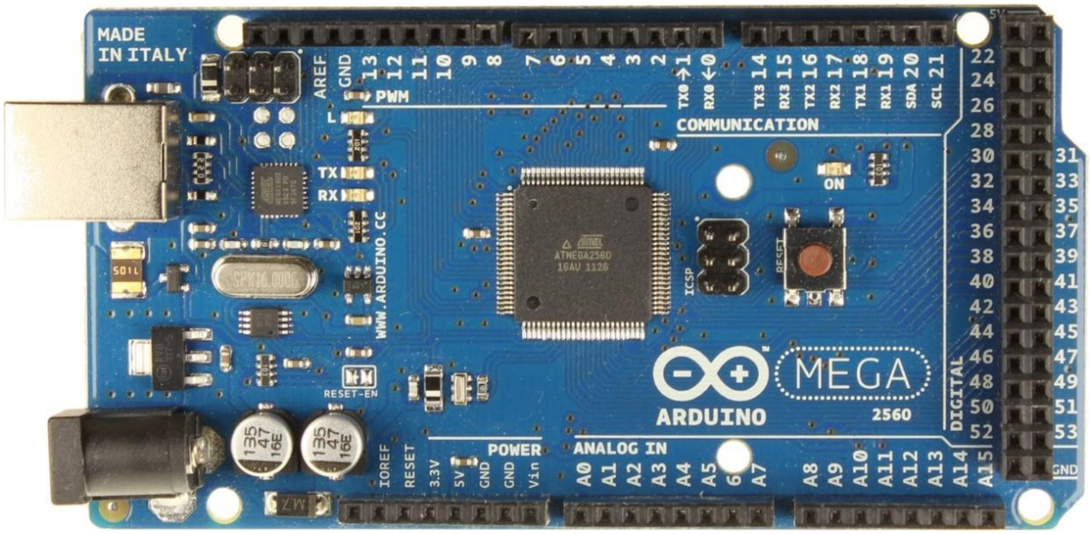
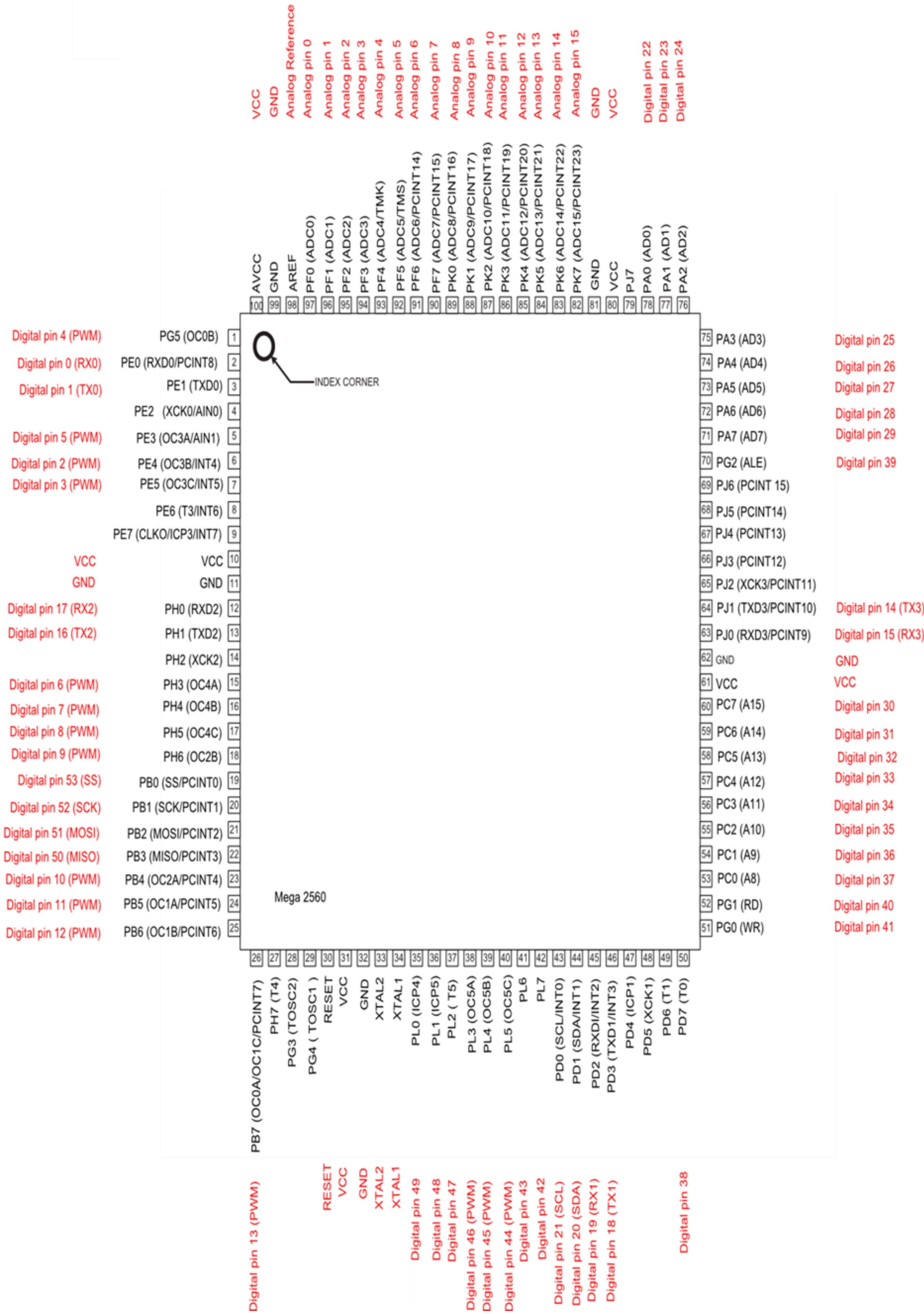


Figure 3.3 Arduino Mega 2560



Mega 2560
INDEX CORNER
VCC
GND
Analog Reference
Analog pin 0
Analog pin 1
Analog pin 2
Analog pin 3
Analog pin 4
Analog pin 5
Analog pin 6
Analog pin 7
Analog pin 8
Analog pin 9
Analog pin 10
Analog pin 11
Analog pin 12
Analog pin 13
Analog pin 14
Analog pin 15
GND
VCC
Digital pin 22
Digital pin 23
Digital pin 24
100 AVCC
99 GND
98 AREF
97 PF0 (ADC0)
96 PF1 (ADC1)
95 PF2 (ADC2)
94 PF3 (ADC3)
93 PF4 (ADC4/TMK)
92 PF5 (ADC5/TMS)
91 PF6 (ADC6/PCINT14)
90 PF7 (ADC7/PCINT15)
89 PK0 (ADC8/PCINT16)
88 PK1 (ADC9/PCINT17)
87 PK2 (ADC10/PCINT18)
86 PK3 (ADC11/PCINT19)
85 PK4 (ADC12/PCINT20)
84 PK5 (ADC13/PCINT21)
83 PK6 (ADC14/PCINT22)
82 PK7 (ADC15/PCINT23)
81 GND
80 VCC
79 PJ7
78 PA0 (AD0)
77 PA1 (AD1)
76 PA2 (AD2)
Digital pin 4 (PWM) PG5 (OC0B) 1
Digital pin 0 (RX0) PE0 (RXD0/PCINT8) 2
Digital pin 1 (TX0) PE1 (TXD0) 3
PE2 (XCK0/AIN0) 4
Digital pin 5 (PWM) PE3 (OC3A/AIN1) 5
Digital pin 2 (PWM) PE4 (OC3B/INT4) 6
Digital pin 3 (PWM) PE5 (OC3C/INT5) 7
PE6 (T3/INT6) 8
PE7 (CLKO/ICP3/INT7) 9
VCC VCC 10
GND GND 11
Digital pin 17 (RX2) PH0 (RXD2) 12
Digital pin 16 (TX2) PH1 (TXD2) 13
PH2 (XCK2) 14
Digital pin 6 (PWM) PH3 (OC4A) 15
Digital pin 7 (PWM) PH4 (OC4B) 16
Digital pin 8 (PWM) PH5 (OC4C) 17
Digital pin 9 (PWM) PH6 (OC2B) 18
Digital pin 53 (SS) PB0 (SS/PCINT0) 19
Digital pin 52 (SCK) PB1 (SCK/PCINT1) 20
Digital pin 51 (MOSI) PB2 (MOSI/PCINT2) 21
Digital pin 50 (MISO) PB3 (MISO/PCINT3) 22
Digital pin 10 (PWM) PB4 (OC2A/PCINT4) 23
Digital pin 11 (PWM) PB5 (OC1A/PCINT5) 24
Digital pin 12 (PWM) PB6 (OC1B/PCINT6) 25
75 PA3 (AD3) Digital pin 25
74 PA4 (AD4) Digital pin 26
73 PA5 (AD5) Digital pin 27
72 PA6 (AD6) Digital pin 28
71 PA7 (AD7) Digital pin 29
70 PG2 (ALE) Digital pin 39
69 PJ6 (PCINT 15)
68 PJ5 (PCINT14)
67 PJ4 (PCINT13)
66 PJ3 (PCINT12)
65 PJ2 (XCK3/PCINT11)
64 PJ1 (TXD3/PCINT10) Digital pin 14 (TX3)
63 PJ0 (RXD3/PCINT9) Digital pin 15 (RX3)
62 GND GND
61 VCC VCC
60 PC7 (A15) Digital pin 30
59 PC6 (A14) Digital pin 31
58 PC5 (A13) Digital pin 32
57 PC4 (A12) Digital pin 33
56 PC3 (A11) Digital pin 34
55 PC2 (A10) Digital pin 35
54 PC1 (A9) Digital pin 36
53 PC0 (A8) Digital pin 37
52 PG1 (RD) Digital pin 40
51 PG0 (WR) Digital pin 41
26 PB7 (OC0A/OC1C/PCINT7)
27 PH7 (T4)
28 PG3 (TOSC2)
29 PG4 (TOSC1)
30 RESET
31 VCC
32 GND
33 XTAL2
34 XTAL1
35 PL0 (ICP4)
36 PL1 (ICP5)
37 PL2 (T5)
38 PL3 (OC5A)
39 PL4 (OC5B)
40 PL5 (OC5C)
41 PL6
42 PL7
43 PD0 (SCL/INT0)
44 PD1 (SDA/INT1)
45 PD2 (RXDI/INT2)
46 PD3 (TXD1/INT3)
47 PD4 (ICP1)
48 PD5 (XCK1)
49 PD6 (T1)
50 PD7 (T0)
Digital pin 13 (PWM)
RESET
VCC
GND
XTAL2
XTAL1
Digital pin 49
Digital pin 48
Digital pin 47
Digital pin 46 (PWM)
Digital pin 45 (PWM)
Digital pin 44 (PWM)
Digital pin 43
Digital pin 42
Digital pin 21 (SCL)
Digital pin 20 (SDA)
Digital pin 19 (RX1)
Digital pin 18 (TX1)
Digital pin 38

Figure 3.4 Arduino Mega 2560 PIN diagram

3.5 Stepper motor

A stepper motor is an electromechanical device which converts electrical pulses into discrete mechanical movements. The shaft or spindle of a stepper motor rotates in discrete step increments when electrical command pulses are applied to it in the proper sequence. The motors rotation has several direct relationships to these applied input pulses. The sequence of the applied pulses is directly related to the direction of motor shafts rotation. The speed of the motor shafts rotation is directly related to the frequency of the input pulses and the length of rotation is directly related to the number of input pulses applied.

stepper motor is a “digital” version of the electric motor. The rotor moves in discrete steps as commanded, rather than rotating continuously like a conventional motor. When stopped but energized, a *stepper* (short for stepper motor) holds its load steady with a *holding torque*. Wide spread acceptance of the stepper motor within the last two decades was driven by the ascendancy of digital electronics. Modern solid state driver electronics was a key to its success. And, microprocessors readily interface to stepper motor driver circuits.

Application wise, the predecessor of the stepper motor was the servo motor. Today this is a higher cost solution to high performance motion control applications. The expense and complexity of a servomotor is due to the additional system components: position sensor and error amplifier. It is still the way to position heavy loads beyond the grasp of lower power steppers. High acceleration or unusually high accuracy still requires a servo motor. Otherwise, the default is the stepper due to low cost, simple drive electronics, good accuracy, good torque, moderate speed, and low cost.

Table 3.2 28BYJ-48 – 5V Stepper Motor

Rated voltage	5VDC
Number of Phase	4
Speed Variation Ratio	1/64
Stride Angle	5.625° /64
Frequency	100Hz
DC resistance	50Ω±7%(25℃)
Idle In-traction Frequency	> 600Hz
Idle Out-traction Frequency	> 1000Hz
In-traction Torque	>34.3mN.m(120Hz)
Self-positioning Torque	>34.3mN.m
Friction torque	600-1200 gf.cm
Pull in torque	300 gf.cm

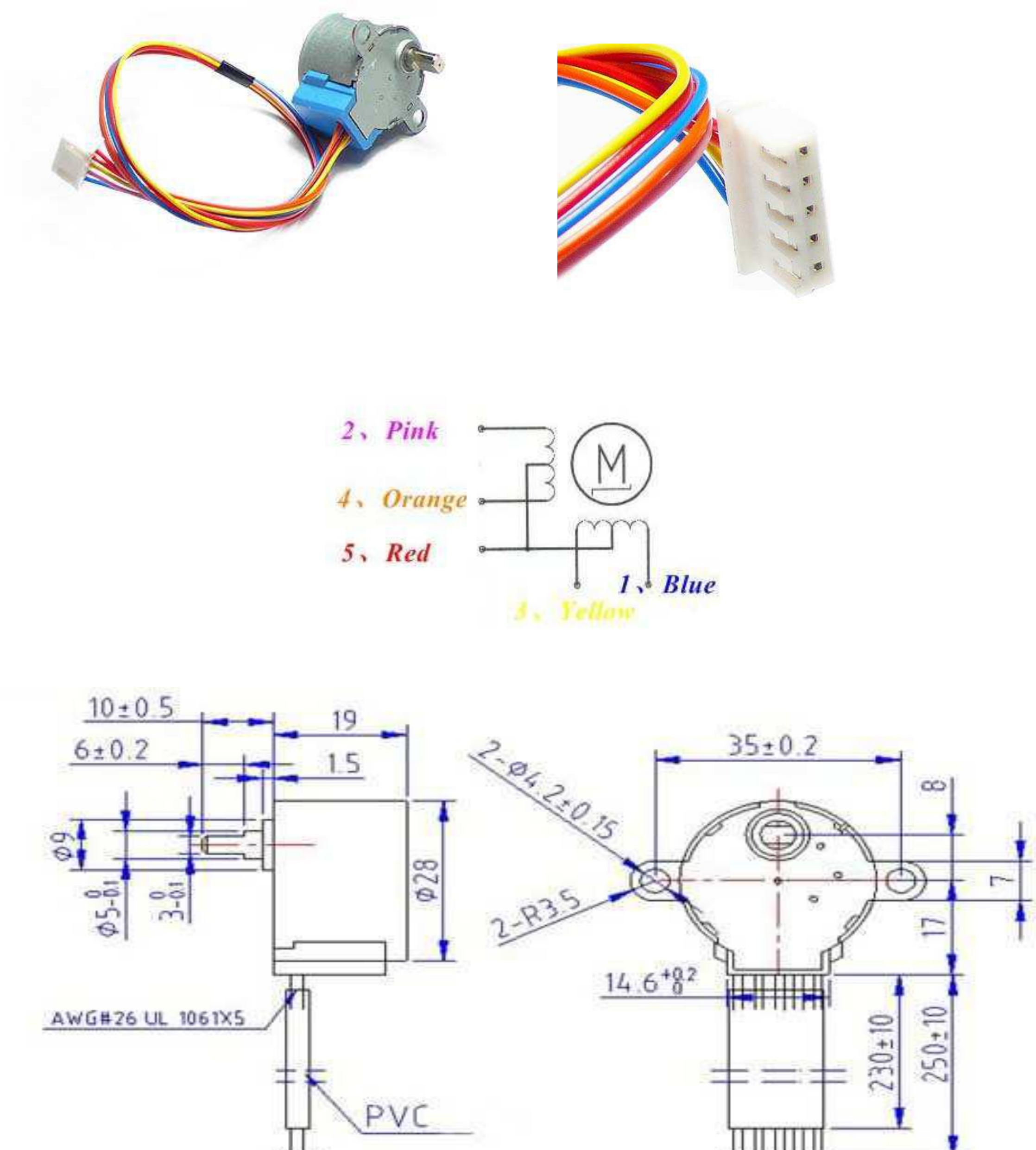


Figure 3.5 28BYJ-48 – 5V Stepper Motor data sheet

In Half mode step sequence, motor step angle reduces to half the angle in full mode. So the angular resolution is also increased i.e. it becomes double the angular resolution in full mode. Also in half mode sequence the number of steps gets doubled as that of full mode. Half mode is usually preferred over full mode. Table below shows the pattern of energizing the coils

Table 3.3 Stepper motor half step

step	A	B	A'	B'
0	1	1	0	0
1	0	1	0	0
2	0	1	1	0
3	0	0	1	0
4	0	0	1	1
5	0	0	0	1
6	1	0	0	1
7	1	0	0	0

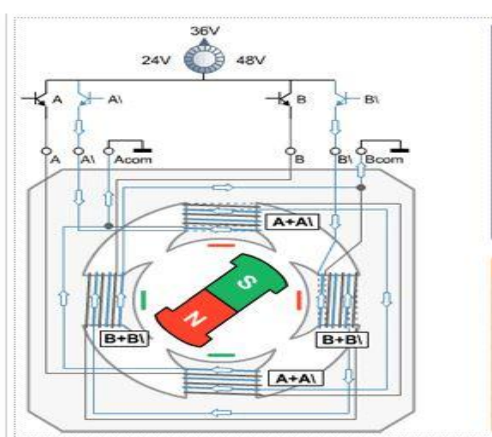


Figure3.6 Half mode Sequence

3.6 Driver ULN 2003

The ULN2003 is a monolithic IC consists of seven NPN darling ton transistor pairs with high voltage and current capability. It is commonly used for applications such as relay drivers, motor, display drivers, led lamp drivers, logic buffers, line drivers, hammer drivers and other high voltage current applications. It consists of common cathode clamp diodes for each NPN darlington pair which makes this driver IC useful for switching inductive loads.that the driver provides open collector output, so it can only sink current, cannot source. Thus when a 5V is given to 1B terminal, 1C terminal will be connected to ground via darlington pair and the maximum current that it can handle is 500A. From the above logic diagram we can see that cathode of protection diodes are shorted to 9th pin called COM. So for driving inductive loads, it must connected to the supply voltage.

ULN2003 is widely used in relay driving and stepper motor driving applications.

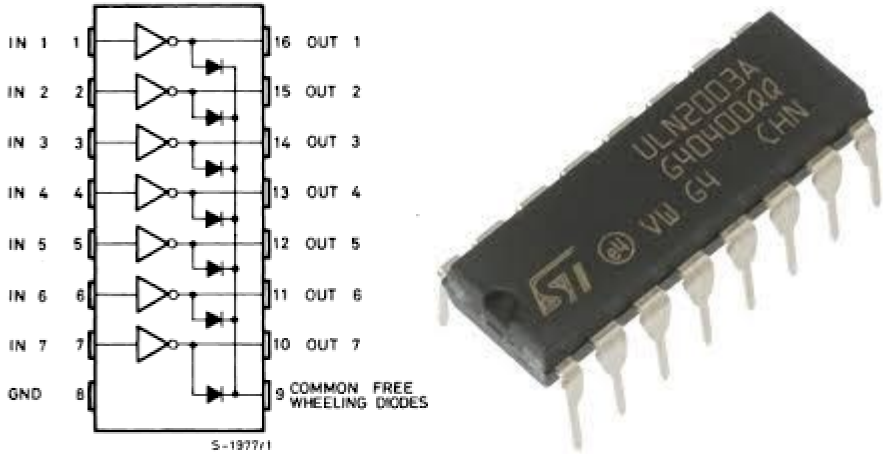


Figure3.7 Driver ULN2003 (16 pin)

3.7 UlN2003 Stepper motor driver circuit

This is an easy to build stepper motor driver that will allow you to precisely control a unipolar stepper motor through your computer's parallel port. With a stepper motor you can build a lot of interesting gadgets such as robots, elevator, PCB drilling mill, camera panning system, automatic fish feeder, etc. Stepper motors are very different from a regular DC motors. Instead of spinning like DC motors do, stepper motor steps at a specific resolution for each pulse. The motor that we are using needs 48 steps / pulses just to complete a single revolution! That should be enough to tell about its precision. Another advantage of stepper motors is the fact that their speed of rotation can be achieved almost instantly even if you change the spinning direction Stepper motor consists of a **rotor** - the permanent magnet that rotates inside, and **stator** - four coils (north, east, south, west) that are part of the case, and which **don't move**. Rotor can be moved by sequentially applying a pulsed DC voltage to one or two coils at a time. In able to move the rotor you will need a driver. Driver is a circuit that applies a voltage to any of the four stator coils. Driver can be built with IC such as ULN2003 (pictured on the circuit diagram), four Darlington transistors or four power transistors such as 2N3055.

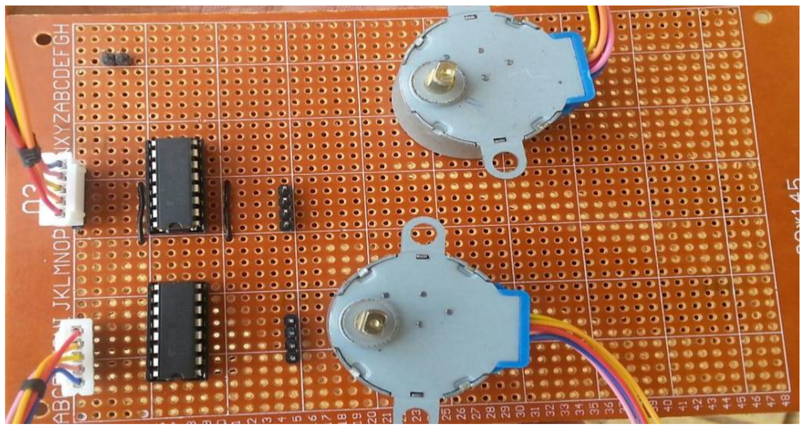


Figure3.8 The motor control circuit

3.8 Stepper Motor with an Arduino

Working with the Arduino coding platform, there is a wide range of example libraries to get you started. Connecting a stepper motor to an Arduino is a different than connecting a DC motor to the board. Because stepper motors have to pulse in a specific way for the rotor to spin, there is a special Stepper library and function built into the Arduino code platform.

Opening the Arduino software, browseto

"File>Examples>Stepper>stepper_oneRevolution"

This program drives a unipolar or bipolar stepper motor, by attaching the motor to digital pins 8 - 11 of the Arduino. After the sketch is loaded on to the Arduino board, the motor should revolve one revolution clockwise, then one revolution moving counter-clockwise.

The example code is an excellent point to start from; you can certainly make edits to the sketch to suit your needs. The delay is listed in microseconds, so if you want there to be no break between its revolutions, you can set delay to delay(10). Or if you want it to spin for a long time you can change steps Per Revolution to equal = (1000000) How you modify the sketch will depend on what you are trying to accomplish with the motor. Playing with some of the other sketches in the example sketch library will help you develop a greater understanding of how stepper motors are able to communicate with Arduino Boards.

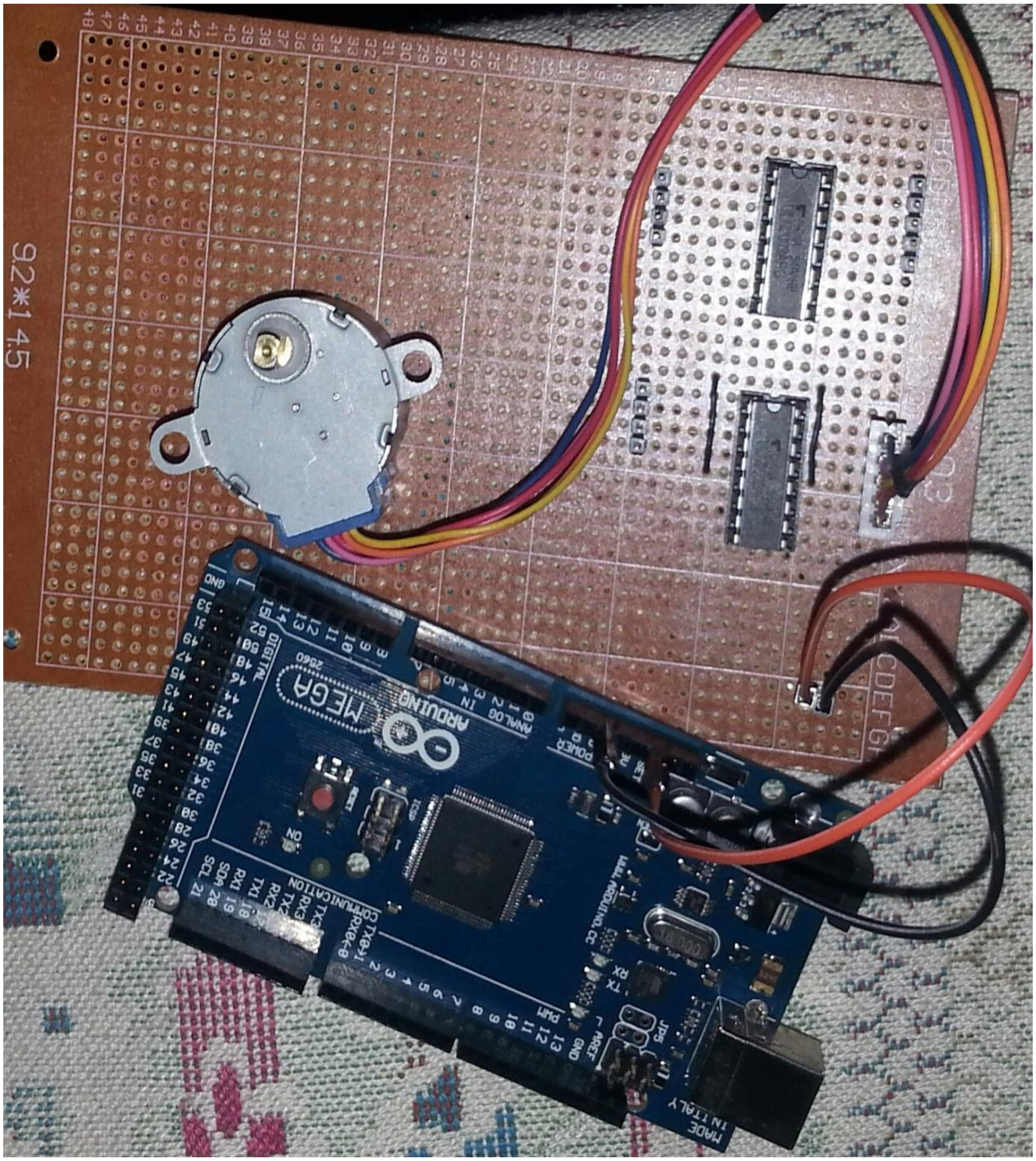


Figure3.9 Stepper Motor with an Arduino

Chapter Four
Simulation
&
Result

Chapter Four

Results and Dissection

4.1 Simulations & Result

This section discusses the achieved from the project, the software outputs are discussed first.

4.1.1 Software Outputs

The simulation has been performed to get the initial results using the pouteus 7 professional software and added arduino mega2560, two stepper motors, two driver's uln2003, signal generation,oscilloscope and terminal.

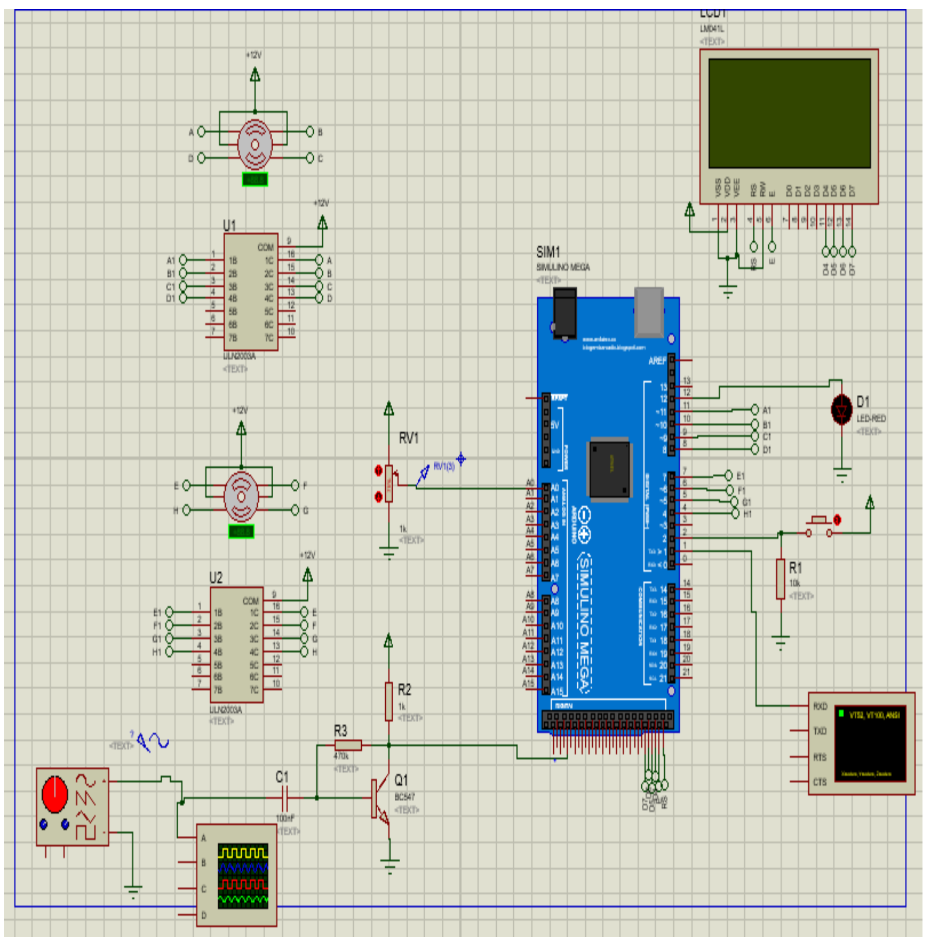


Figure 4.1 the circuit simulation by proteus.

The next section will display the system response in each case, the first figure shows the uploading of the code to the aruino.

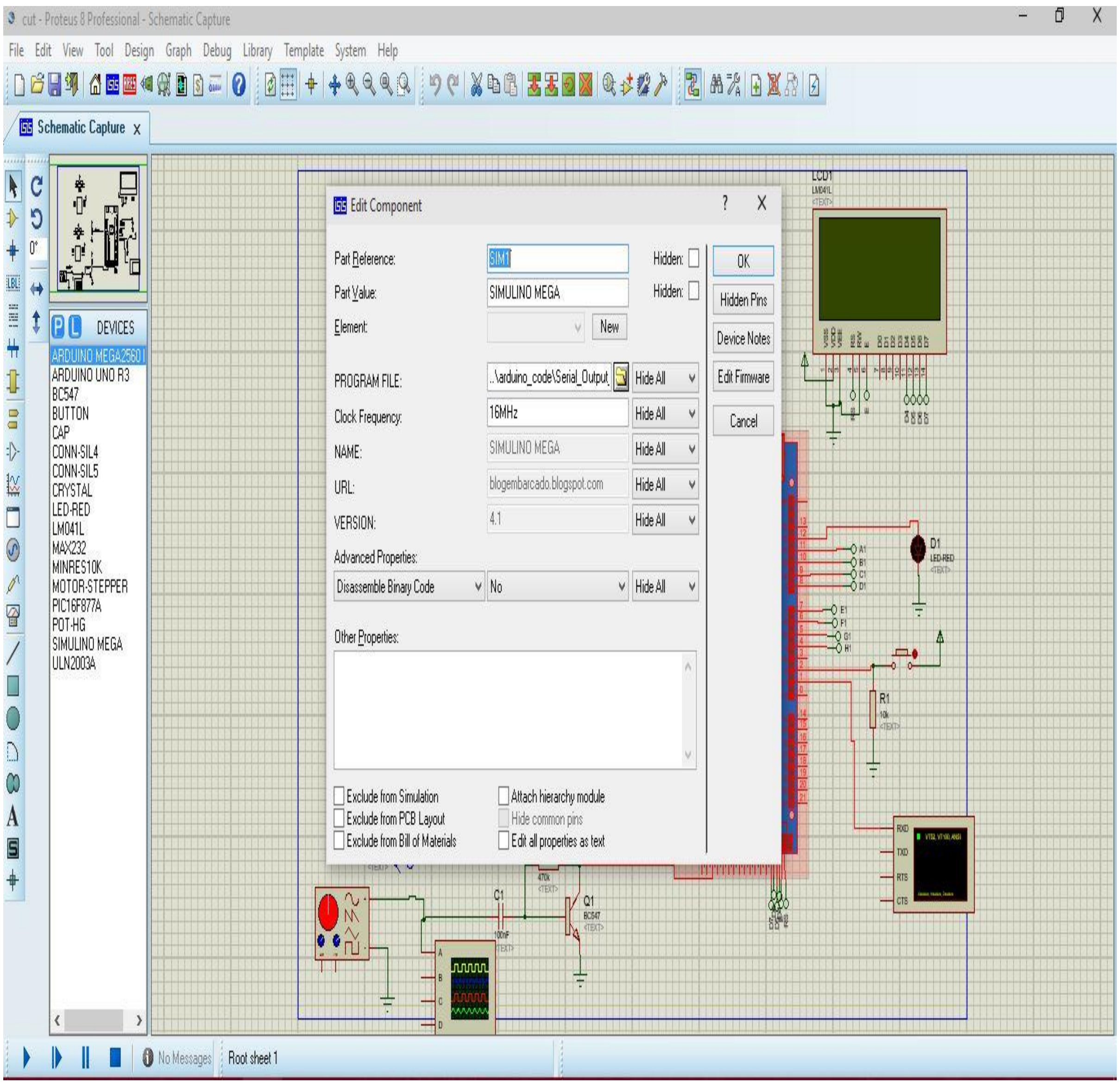


Figure 4.2 run code in aruino.

The next figure shows the response of the system for the low frequencies, you can notice the motors rotation, from the LCD the value of the frequency.

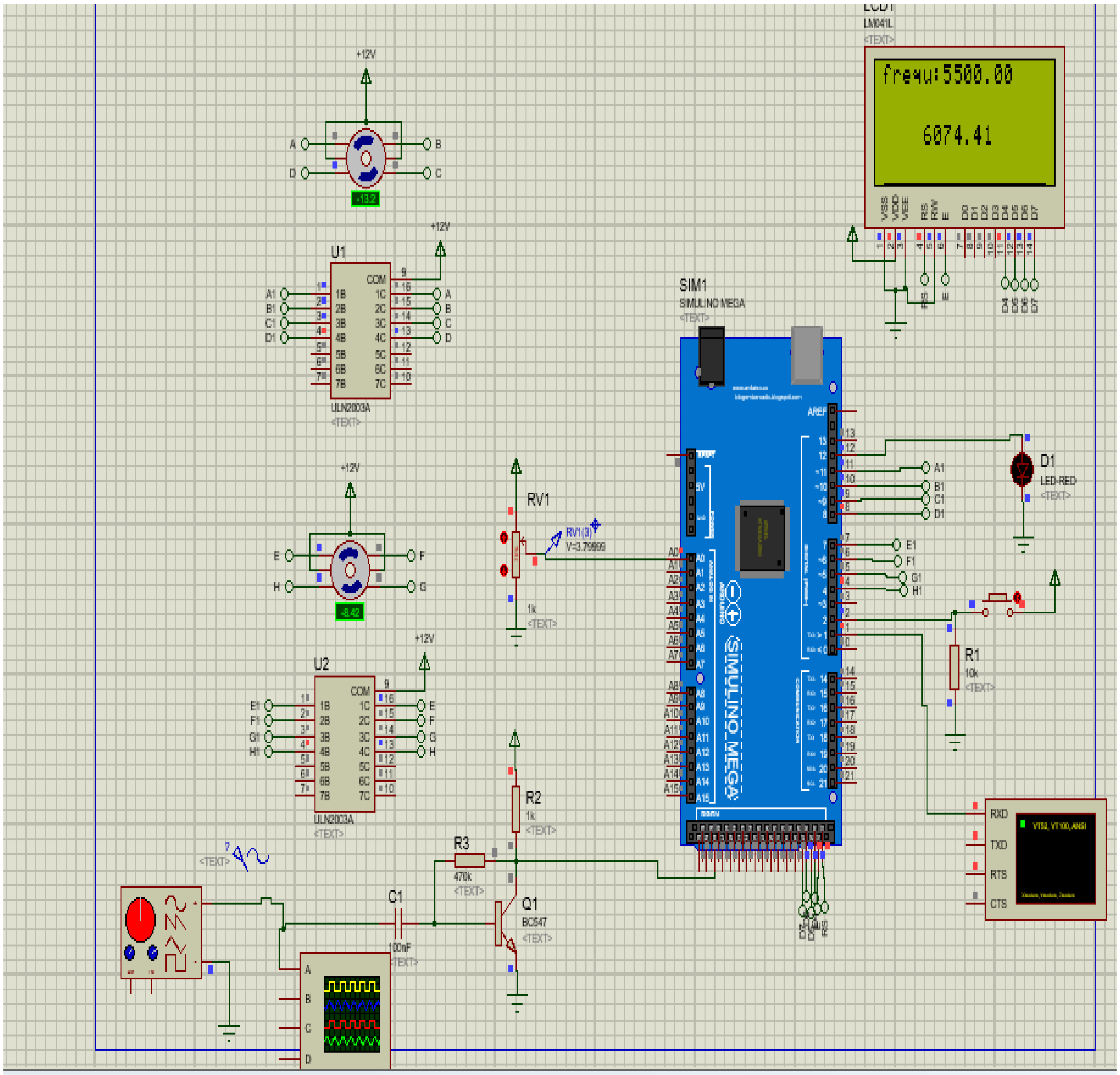


Figure 4.3 simulation window

Stepper motors stop when antenna senesce the reference value of frequency

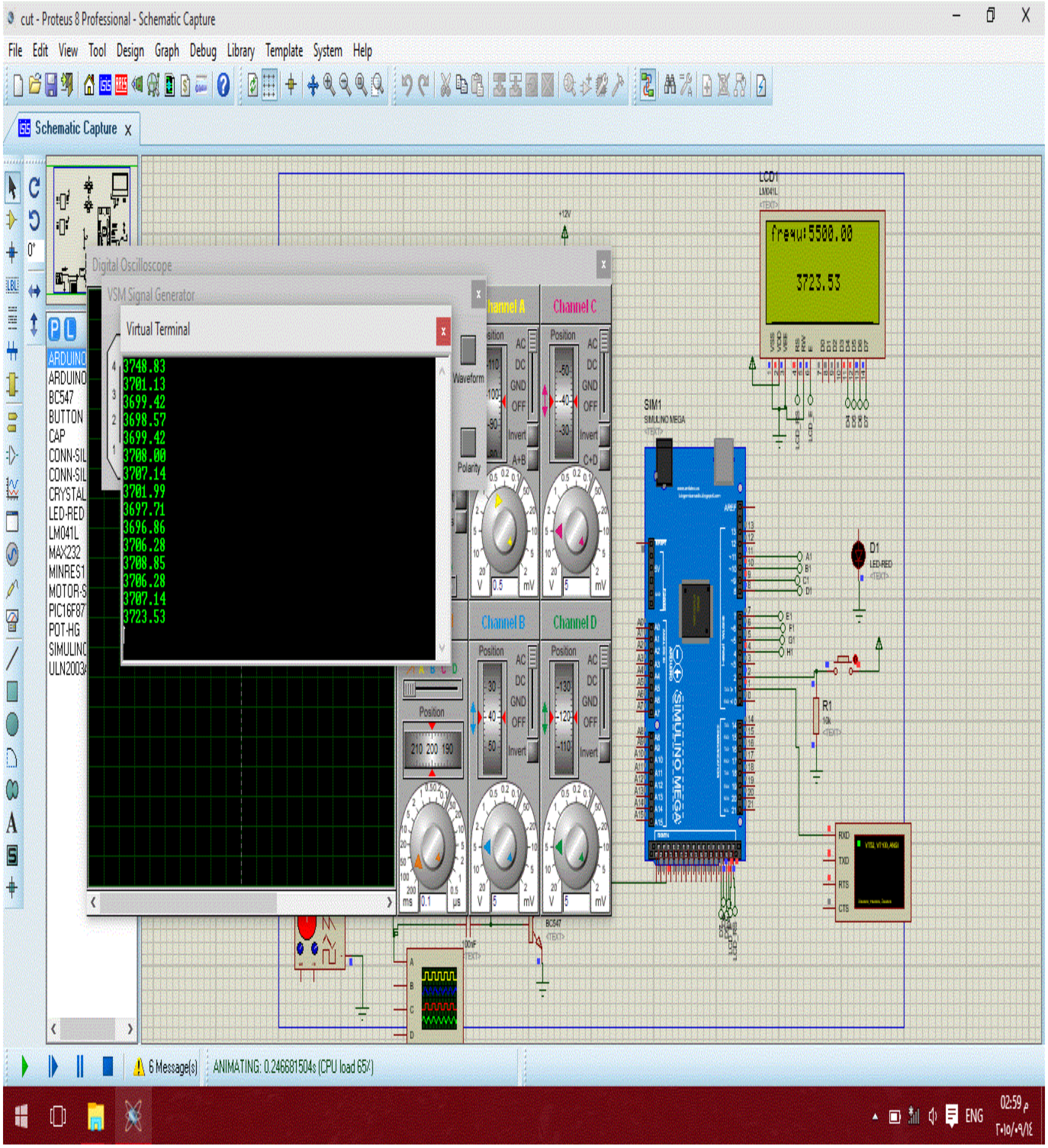


Figure 4.4 simulation result

4.1.2 Hardware steps

The first step place the components on the board by interfacing the arduino to the stepper motors using the motors driver (ULN2003).

The two motors are used move the antenna in the two axis either vertically and horizontally

The coming figure shows the connection between the motors and the motor driver:

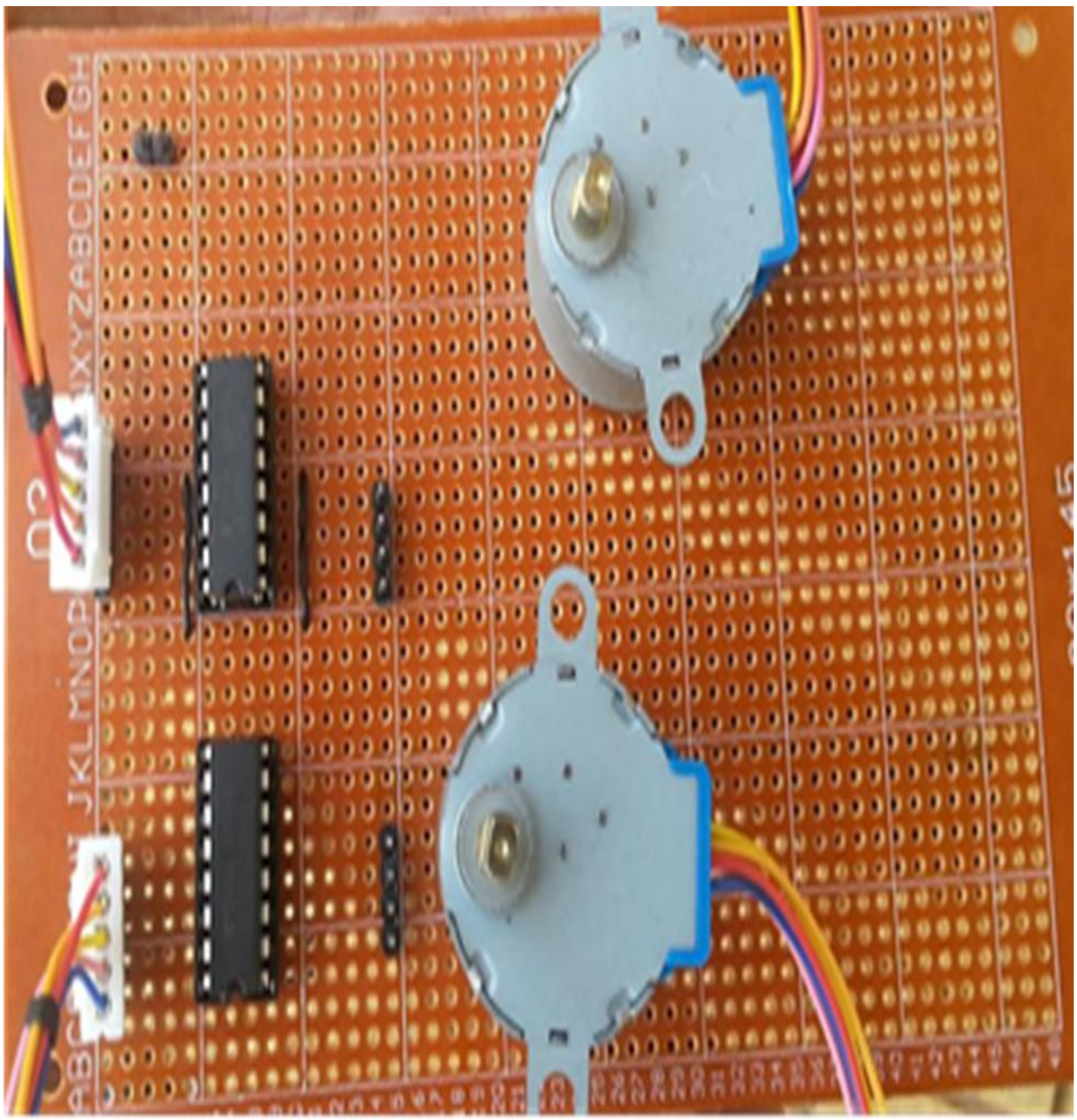


Figure 4.5 stepper motor with driver uln2003

The next step in the following figure is to interface the previous circuit to the arduino circuit, you can notice the ground pins are connected together and the motors control signal is taken from the (pin 49).

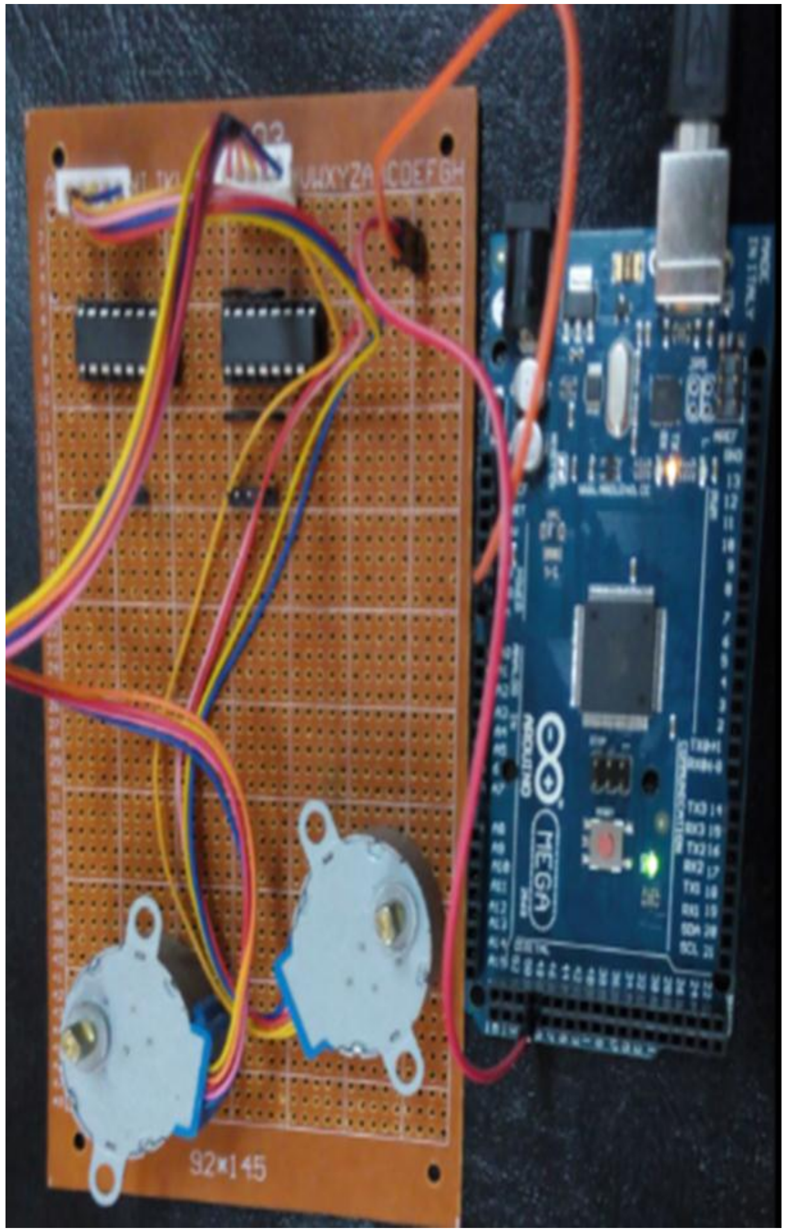


Figure 4.6 particular circuits (arduino)

Chapter Five

Conclusion

&

Recommendation

Chapter Five

Conclusion and Recommendations

5.1 Conclusion

After a year of well-organized work, we reached the objective of this project, which can be summarized as following:

- Manage to control the stepper motors to detect the direction of broad casting

- The directional antenna mange to sense the frequency

The RF detector can be used as an indicator of objects and can be used in tracking, but not in a fully exact way, and needs development of up to date technology in order to reach full accurate results.

After working on detection the direction of broad casting using the RF detector technology, with all the possible materials available for us as students, for sure the results won't be very accurate, as well as the operation itself. The results were fair, but the rate of error had well known reasons:

1- The antenna of the reader should have special properties, as it should be directional with very small beam width, and getting such an antenna for a reader working at such low operating frequency (27MHZ) with high directionality will make it have large size, which is inconvenient for the motor. So it was replaced by the cavity.

2- The stepper motor itself has a large step

5.2 Recommendations

The clearest application that can be used in detection the direction is the robot. For an automatically controlled robot, a robot can be used to carry or lift boxes and move them somewhere else. Our exact demo version of the project can be used for the robot, after treating the problems in our demo project. The motor will be placed on the robot, with the antenna connected to it. With this target detection method, the robot can detect the target automatically without any human interference.

From the previous problems, the results from our demo project for the idea weren't giving satisfying results for the industrial field. If the previous problems had a good industrial solution, the RF detector technology can be used very well in detection direction. So in order to solve the previous problems, the following steps should be carried out:

-A directional antenna with small beam width, with small size and non-effective side lobes, with high gain should be used.

-A stepper motor with a step angle equals to the beam width of the antenna should be used.

-In case of finding the required antenna, there will be no need for the cavity.

References

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[7]Kaemarungsi, K., and Krishnamurthy,"Properties of indoor received signal strength for WLAN location fingerprinting", 2004.

[8]O. Shoewu, and P.O. Nwamina,"Design and Development of a Mobile Phone Signal Detector", 2014.

Appendix

Ardiuno code:

```
/* FreqMeasure - Example with serial output

 * http://www.pjrc.com/teensy/td_libs_FreqMeasure.html

 *

 * This example code is in the public domain.

 */

#include <FreqMeasure.h>

#include <LiquidCrystal.h>

LiquidCrystallcd(22, 23, 24, 25, 26, 27);


//constintanalogInPin = A0;  // Analog input pin that the potentiometer is attached to

//constintanalogOutPin = 9; // Analog output pin that the LED is attached to

float Rssi1 = 5500;

float Rssi2;

int i;

int d;

constint led1=8;

constint led2=9;

constint led3=10;

constint led4=11;

constint led5=4;
```

```
constint led6=5;
constint led7=6;
constint led8=7;
intsensorValue = 0;        // value read from the pot
intoutputValue = 0;        // value output to the PWM (analog out)
void motor1_F(){
digitalWrite(led1, HIGH);
digitalWrite(led2, LOW);
digitalWrite(led3, LOW);
digitalWrite(led4, LOW);
delay(0.2);
digitalWrite(led1, LOW);
digitalWrite(led2, HIGH);
digitalWrite(led3, LOW);
digitalWrite(led4, LOW);
delay(0.2);
digitalWrite(led1, LOW);
digitalWrite(led2, LOW);
digitalWrite(led3, HIGH);
digitalWrite(led4, LOW);
delay(0.2);
digitalWrite(led1, LOW);
digitalWrite(led2, LOW);
```

```
digitalWrite(led3, LOW);
digitalWrite(led4, HIGH);
delay(0.2);
  }
void motor1_R(){
digitalWrite(led1, LOW);
digitalWrite(led2, LOW);
digitalWrite(led3, LOW);
digitalWrite(led4, HIGH );
delay(0.2);
digitalWrite(led1, LOW);
digitalWrite(led2, LOW);
digitalWrite(led3, HIGH);
digitalWrite(led4, LOW);
delay(0.2);
digitalWrite(led1, LOW);
digitalWrite(led2, HIGH);
digitalWrite(led3, LOW);
digitalWrite(led4, LOW);
delay(0.2);
digitalWrite(led1, HIGH);
digitalWrite(led2, LOW);
digitalWrite(led3, LOW);
```

```
digitalWrite(led4, LOW);
delay(0.2);
  }
void motor2_F(){
digitalWrite(led5, HIGH);
digitalWrite(led6, LOW);
digitalWrite(led7, LOW);
digitalWrite(led8, LOW);
delay(0.2);
digitalWrite(led5, LOW);
digitalWrite(led6, HIGH);
digitalWrite(led7, LOW);
digitalWrite(led8, LOW);
delay(0.2);
digitalWrite(led5, LOW);
digitalWrite(led6, LOW);
digitalWrite(led7, HIGH);
digitalWrite(led8, LOW);
delay(0.2);
digitalWrite(led5, LOW);
digitalWrite(led6, LOW);
digitalWrite(led7, LOW);
digitalWrite(led8, HIGH);
```

```
delay(0.2);
  }
void motor2_R(){
digitalWrite(led5, LOW);
digitalWrite(led6, LOW);
digitalWrite(led7, LOW);
digitalWrite(led8, HIGH );
delay(0.6);
digitalWrite(led5, LOW);
digitalWrite(led6, LOW);
digitalWrite(led7, HIGH);
digitalWrite(led8, LOW);
delay(0.6);
digitalWrite(led5, LOW);
digitalWrite(led6, HIGH);
digitalWrite(led7, LOW);
digitalWrite(led8, LOW);
delay(0.6);
digitalWrite(led5, HIGH);
digitalWrite(led6, LOW);
digitalWrite(led7, LOW);
digitalWrite(led8, LOW);
delay(0.6);
```

```
  }
void motor2_S(){
digitalWrite(led5, LOW);
digitalWrite(led6, LOW);
digitalWrite(led7, LOW);
digitalWrite(led8, LOW );}
void motor1_S(){
digitalWrite(led5, LOW);
digitalWrite(led6, LOW);
digitalWrite(led7, LOW);
digitalWrite(led8, LOW );}
void setup() {
Serial.begin(57600);
FreqMeasure.begin();
pinMode(led1,OUTPUT);
pinMode(led2,OUTPUT);
pinMode(led3,OUTPUT);
pinMode(led4,OUTPUT);
lcd.begin(20, 4);
lcd.print("frequ:");
  //lcd.setCursor(0, 6);
lcd.print(Rssi1);
}
```

```
double sum = 0;

int count = 0;

void loop() {

if (FreqMeasure.available()) {
   // average several reading together
sum = sum + FreqMeasure.read();
count = count + 1;
   //myStepper1.step(1);
if (count > 30) {
float frequency = FreqMeasure.countToFrequency(sum / count);
Serial.println(frequency);
lcd.setCursor(0, 2);
lcd.print(frequency);
sum = 0;
count = 0;
     Rssi2 = frequency;

   }
  }
```

```
if((Rssi1>Rssi2)||(Rssi1<Rssi2)){
i++;
if((i<30)&&(i>1)){
motor1_R();
d++;
if(d<5){
motor2_R();}
if((d>5)&&(d>8)){
motor2_F();d=0;i=0;}
}
if((i<31)&&(i>40)){
motor1_F(); }
d++;
if(d<5){
motor2_R();}
if((d>5)&&(d>8)){
motor2_F();d=0;i=0;}
if(i==40){
motor2_R();
motor2_S();
}
}
if(Rssi1==Rssi2){
```

```
motor2_S();
motor1_S();
}
  //delay(50);
}
```