Sudan University of Science &Technology

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Design of A Transmission Direction Location Using Computer

تصميم نظام محدد الإتجاه لمصادر الإرسال بإستخدام الحاسوب

A Thesis Submitted in A Partial Fulfillment of the

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Telecommunication Engineering

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قال الله تعالى في محكم تنزيله:

﴿ وَقُلِ اعْمَلُوا فَسَيَرَى اللَّهُ عَمَلَكُمْ وَرَسُولُهُ وَالْمُؤْمِنُونَ ۖ﴾

صدق الله العظيم

سورة التوبة (الاية 105)

Dedication

I would like to dedicate this work to my great teacher Dr. AbdElrasoul Gabar Alzubaidi , without his support it would not have been possible.

Acknowledgements

I would like to thank all people who have helped me to complete this project.

I especially want to thanks my supervisor Dr. Abd Elrasoul Gabar for supporting and guiding. I would like also to acknowledge the support and assistance given me by Dr. Mahmoud Alastal

Finally, I would like to thanks family, especially my wife for she’s continued support & motivation, also to my colleagues for their support in to complete this Research.

Abstract

Direction finding (DF) refers to determine the direction of unknown transmitter in space which received signal from it; there are several ways to achieve this.

The aim of this research is, how to detect the friendly and non-friendly frequencies and explain how to control antenna to find the target. In addition the purpose of this research is to study the direction finding technique and building a receiver with aboard that can be utilized with c ++ software to receive signals from an antenna.

The outcome of this research concentrates in how the countries protect themselves against enemy.

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مصطلح (تحديد الاتجاه) يشير إلى تحديد اتجاه مصدر إرسال في الفضاء الذي الطقتت منه إشارة ، وتوجد عدة طرق لتحقيق ذللك.

والغرض من هذا البحث هو كيفية اكتشاف ترددات الاشارات الصديقة وغير الصديقة وشرح كيفية التحكم بالهوائي للعثور علي الهدف . وايضا الهدف من هذا البحث هو دراسة تقنية تحديد الاتجاه عن طريق بناء جهاز استقبال والتحكم به عن طريق برنامج حاسوب يعمل بلغة البرمجة سي, لاستقبال اشارة من هوائي ومن ثم تحديد اتجاهها.

تتركز اهمية هذا البحث في كيفية عمل الدول علي حماية نفسها ضد الاعداء في سبيل توفير الامن لمواطنيها .

Table of Contents

List of Figures

List of tables

Glossary

DF	Direction finding
RDF	Radio Direction finding
AM	Amplitude Modulation
AMPS	American Mobile Phone System
ELINT	Electronic Intelligence
ESM	Electronic Support Measures
ADF	Automatic Direction finding
LW	Low Band
RMI	Remote Method Invocation
SIGINT	Signals Intelligence
VHF	Very High Frequency
UHF	Ultra-High Frequency
GPS	Global Positioning System
MHZ	Megahertz
AMPS	Advanced Mobile Phone Service
MUL	Mobile-User-Link
GWL	Gateway-Link
ISL	Inter-Satellite-Link
ITU	International Telecommunication Union
GEO	Geostationary or geosynchronous earth orbit

LEO	Low Earth Orbit
MEO	Medium Earth Orbit
TV	Television
IC	Integrated Circuit
TTL	Transistor-Transistor Logic
CMOS	Complementary Metal–Oxide–Semiconductor
PMOS	P-Type Metal–Oxide–Semiconductor
NMOS	N-Type Metal–Oxide–Semiconductor
MS-DOS	Microsoft Disk Operating System
IDE	Integrated Development Environment

CHAPTER ONE

Introduction

CHAPTER ONE

6.1 Overview

With the wide use of different radiofrequency equipment, the limited spectrum resources are under heavy pressure and the mutual interference between the equipment is increasing. At present, predominates the spectrum allocation method of fixed waveform parameters such as fixed central frequency, fixed modulation system, fixed frequency-hopping interval and fixed transmitter power, but this static spectrum management method cannot solve the low efficiency of spectrum resource application in the complex electromagnetic environment and today's spectrum management method fails in the current electromagnetic environment.

The Direction finding (DF) technology will fundamentally change the current radio communication system and spectrum management model. Technical standard are associated with certain allocations and assignments, the spectrum manager can detect the existing of unauthorized transmitters which affect other users by causing interference and by reducing the value of licensed spectrum. Resolving interference problems is often a difficult task of spectrum managers since the resources of interference is not necessarily known nor easily identified. Coordination with complainant is often needed, if only to know the frequency of the receiver operation. Direction finding equipment is often used to determine the source of interference.

6.2 Problem Statement

There are many services provided to governments of security. This project focuses and executes the one way of direction finding interfaces and proposes solutions to the security area for detecting the transmission location.

6.3 Research Objective

This Research aims to produce simulation procedure to determine the direction location of friendly and non-friendly transmitter's sources.

6.4 Methodology

As practical side follows the determination of bearings of friendly and non-friendly transmitters by using direction finding technique and explains the links between direction finder components.

The approach to implement the DF of transmission is based on installing an antenna in the rotor of the stepper motor. Once the antenna intersects the electronic beam, the computer issues a command to stop the stepper motor as an indication to the direction of transmission.

6.5 Research outlines

This research includes six chapters. Chapter one presents the introduction, while chapter two gives the main concept of direction finding systems, focus on antennas types, also gives the main concept of satellites, frequencies and orbit. And in the end of this chapter gives some details about stepper motors.

Chapter three deals with hardware design and their interface layout. Chapter four is the main of the research which it concentrates on the software design starting from the flow chart and end with the software text. Chapter five explains the result, discussions and the last chapter presented conclusion and recommendations.

CHAPTER TWO

Literature review

CHAPTER TWO

6.1 Direction finding

Direction finding (DF), or radio direction finding (RDF), is the measurement of the direction from which a received signal was transmitted. This can refer to radio or other forms of wireless communication, including radar signals detection and monitoring (ELINT/ESM). By combining the direction information from two or more suitably spaced receivers (or a single mobile receiver), the source of a transmission may be located via triangulation. Radio direction finding is used in the navigation of ships and aircraft, to locate emergency transmitters for search and rescue, for tracking wildlife, and to locate illegal or interfering transmitters.

RDF systems can be used with any radio source, although very long wavelengths (low frequencies) require very large antennas, and are generally used only on ground-based systems. These wavelengths are nevertheless used for marine radio navigation as they can travel very long distances "over the horizon", which is valuable for ships when the line-of-sight may be only a few tens of kilometers. For aerial use, where the horizon may extend to hundreds of kilometers, higher frequencies can be used, allowing the use of much smaller antennas. An automatic direction finder, which could be tuned to radio beacons called non-directional beacons or commercial AM radio broadcasters, was until recently, a feature of most aircraft, but is now being phased out.

For the military, RDF is a key tool of signals intelligence. The ability to locate the position of an enemy transmitter has been invaluable since World War I, and played a key role in World War II's Battle of the Atlantic. It is estimated that the UK's advanced "huff-duff" systems were directly or indirectly responsible for 24% of all U-Boats sunk during the war. Modern systems often used phased array antennas to allow rapid beam forming for highly accurate results, and are part of a larger electronic warfare suite.

Radio direction finders have evolved, following the development of new electronics. Early systems used mechanically rotated antennas that compared signal strengths, and several electronic versions of the same concept followed. Modern systems use the comparison of phase or Doppler techniques which are generally simpler to automate. Early British radar sets were referred to as RDF, which is often stated was a deception. In fact, the Chain Home systems used large RDF receivers to determine directions. Later radar systems generally used a single antenna for broadcast and reception, and determined direction from the direction the antenna was facing.

6.2 Automatic direction finder (ADF)

An automatic direction finder (ADF) is a marine or aircraft radio-navigation instrument that automatically and continuously displays the relative bearing from the ship or aircraft to a suitable radio station.[10][11] ADF receivers are normally tuned to aviation or marine NDBs operating in the LW band between 190 – 535 kHz. Like RDF units, most ADF receivers can also receive medium wave (AM) broadcast stations, though as mentioned, these are less reliable for navigational purposes.

The operator tunes the ADF receiver to the correct frequency and verifies the identity of the beacon by listening to the Morse code signal transmitted by the NDB. On marine ADF receivers, the motorized ferrite-bar antenna atop the unit (or remotely mounted on the masthead) would rotate and lock when reaching the null of the desired station. A centerline on the antenna unit moving atop a compass rose indicated in degrees the bearing of the station. On aviation ADFs, the unit automatically moves a compass-like pointer (RMI) to show the direction of the beacon. The pilot may use this pointer to home directly towards the beacon, or may also use the magnetic compass and calculate the direction from the beacon (the radial) at which their aircraft is located.

Unlike the RDF, the ADF operates without direct intervention, and continuously displays the direction of the tuned beacon. Initially, all ADF receivers, both marine and aircraft versions, contained a rotating loop or ferrite loop stick aerial driven by a motor which was controlled by the receiver. Like the RDF, a sense antenna verified the correct direction from its 180-degree opposite.

More modern aviation ADFs contain a small array of fixed aerials and use electronic sensors to deduce the direction using the strength and phase of the signals from each aerial. The electronic sensors listen for the trough that occurs when the antenna is at right angles to the signal, and provide the heading to the station using a direction indicator. In flight, the ADF's RMI or direction indicator will always point to the broadcast station regardless of aircraft heading, however a banked attitude can have a slight effect on the reading, the needle will still generally indicate towards the beacon, however it suffers from DIP error where the needle dips down in the direction of the turn.

This is the result of the loop itself banking with the aircraft and therefore being at a different angle to the beacon. For ease of visualization, it can be useful to consider a 90° banked turn, with the wings vertical. The bearing of the beacon as seen from the ADF aerial will now be unrelated to the direction of the aircraft to the beacon. Dip error causes the needle to point more towards the wing in a turn.

It is sometimes wrongly confused with quadrant error, which is the result of radio waves being bounced and reradiated by the airframe. Quadrant error does not affect signals from straight ahead or behind, nor on the wingtips. The further from these cardinal points and the closer to the quadrant points (i.e. 45°, 135°, 225° and 315° from the nose) the greater the effect, but quadrant error is normally much less than dip error, which is always present when the aircraft is banked.

ADF receivers can be used to determine current position, track inbound and outbound flight path, and intercept a desired bearing. These procedures are also used to execute holding patterns and non-precision instrument approaches.

6.3 Direction Finding Antennas

Direction finding requires an antenna that is directional (more sensitive in certain directions than in others). Many antenna designs exhibit this property. For example, a Yagi antenna has quite pronounced directionality, so the source of a transmission can be determined simply by pointing it in the direction where the maximum signal level is obtained. However, to establish direction to great accuracy requires more sophisticated technique.

Fig 2.1—the crossed-loops DF antenna atop the mast of a tug boat

A simple form of directional antenna is the loop aerial. This consists of an open loop of wire on an insulating former, or a metal ring that forms the antenna elements itself, where the diameter of the loop is a tenth of a wavelength or smaller at the target frequency. Such an antenna will be least sensitive to signals that are normal to its face and most responsive to those meeting edge-on. This is caused by the phase output of the transmitting beacon. The phase changing phase causes a difference between the voltages induced on either side of the loop at any instant. Turning the loop face on will not induce any current flow. Simply turning the antenna to obtain minimum signal will establish two possible directions from which the signal could be emanating. The NULL is used, as small angular deflections of the loop aerial near its null positions produce larger changes in current than similar angular changes near the loops max positions. For this reason, a null position of the loop aerial is used.

To resolve the two direction possibilities, a sense antenna is used; the sense aerial has no directional properties but has the same sensitivity as the loop aerial. By adding the steady signal from the sense aerial to the alternating signal from the loop signal as it rotates, there is now only one position as the loop rotates 360° at which there is zero current. These acts as a phase ref point, allowing the correct null point to be identified, thus removing the 180° ambiguity. A dipole antenna exhibits similar properties, and is the basis for the Yagi antenna, which is familiar as the common VHF or UHF television aerial. For much higher frequencies still, parabolic antennas can be used, which are highly directional, focusing received signals from a very narrow angle to a receiving element at the center.

More sophisticated techniques such as phased arrays are generally used for highly accurate direction finding systems called goniometers such as are used in signals intelligence (SIGINT). A helicopter based DF system was designed by ESL Incorporated for the U.S. Government as early as 1972.ess to the telephone system, mobile telephone service allows interconnection to the telephone network.

2.3.1 Loop Antennas

Simple antenna for RDF work is a small loop tuned to resonance with a capacitor. Several factors must be considered in the design of an RDF loop. The loop must be small compared with the wavelength.

In a single-turn loop, the conductor should be less than 0.08 wavelengths long. For 28 MHz, this represents a length of less than 34 inches (diameter of approximately 10 inches). Maximum response from the loop antenna is in the plane of the loop, with nulls exhibited at right angles to that plane.

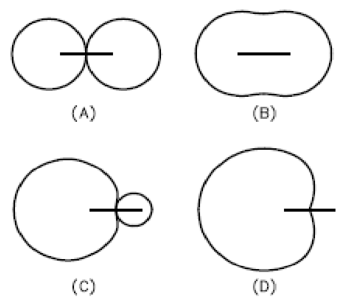
To obtain the most accurate bearings, the loop must be balanced electrostatically with respect to ground. Otherwise, the loop will exhibit two modes of operation. One is the mode of a true loop, while the other is that of an essentially no directional vertical antenna of small dimensions. This second mode is called the “antenna effect.” The voltages introduced by the two modes are seldom in phase and may add or subtract, depending upon the direction from which the wave is coming.

The theoretical true loop pattern is illustrated in Fig 2.2 A. When properly balanced, the loop exhibits two nulls that are 180° apart. Thus, a single null reading with a small loop antenna will not indicate the exact direction toward the transmitter—only the line along which the transmitter lies. Ways to overcome this ambiguity are discussed later.

When the antenna effect is appreciable and the loop is tuned to resonance, the loop may exhibit little directivity, as shown in Fig 2.2 B. However, by detuning the loop so as to shift the phasing, a pattern similar to Fig 2.2 C may be obtained. Although this pattern is not symmetrical, it does exhibit a null. Even so, the null may not be as sharp as that obtained with a loop that is well balanced, and it may not be at exact right angles to the plane of the loop.

By suitable detuning, the unidirectional cardioid pattern of Fig 2.2 D may be approached. This adjustment is sometimes used in RDF work to obtain a unidirectional bearing, although there is no complete null in the pattern. A cardioid pattern can also be obtained with a small loop antenna by adding a sensing element. An electrostatic balance can be obtained by shielding the loop, as shown in Fig 2.3. The shield is represented by the broken lines in the drawing, and eliminates the antenna effect. The response of a well-constructed shielded loop is quite close to the ideal pattern of Fig 2.2 A.

For the low-frequency amateur bands, single-turn loops of convenient physical size for portability are generally found to be unsatisfactory for RDF work. Therefore, multi turn loops are generally used instead. Such a loop is shown in Fig 2.4. This loop may also be shielded, and if the total conductor length remains below 0.08 wavelengths, the directional pattern is that of Fig 2.2 A. A sensing element may also be used with a multi turn loop.



. Fig 2.2—Small-loop field patterns

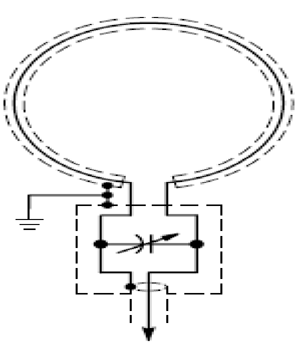


Fig 2.3—Shielded loop for direction finding

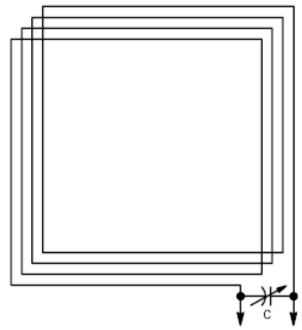


Fig 2.4—Small loop consisting of several turns of wire

2.3.2 Loop Circuits and Criteria

No single word describes a direction-finding loop of high performance better than "symmetry." To obtain an undistorted response pattern from this type of antenna, it must be built in the most symmetrical manner possible. The next key word is "balance "The better the electrical balance, the deeper the loop null and the sharper the maxima.

The physical size of the loop for 7 MHz and below is not of major consequence. A 4-foot loop will exhibit the same electrical characteristics as one which is only an inch or two in diameter. The smaller loop, however, the lower its efficiency. This is because its aperture samples a smaller section of the wave front. Thus, if loops that are very small in terms of a wavelength are used, preamplifiers are needed to compensate for the reduced efficiency.

An important point to keep in mind about a small loop antenna oriented in a vertical plane is that it is vertically polarized. It should be fed at the bottom for the best null response. Feeding it at one side, rather than at the bottom, will not alter the polarization and will only degrade performance. To obtain horizontal polarization from a small loop, it must be oriented in a horizontal plane, parallel to the earth.

In this position the loop response is essentially omnidirectional.

The earliest loop antennas were of the “frame antenna” variety. These were unshielded antennas which were built on a wooden frame in a rectangular format. The loop conductor could be a single turn of wire (on the larger units) or several turns if the frame was small. Later, shielded versions of the frame antenna became popular, providing electrostatic shielding—an aid to noise reduction from such sources as precipitation static.

2.3.3 Ferrite Rod Antennas

With advances in technology, magnetic-core loop antennas later came into use. Their advantage was reduced size, and this appealed to the designers of aircraft and portable radios. Most of these antennas contain ferrite bars or cylinders, which provide high inductance and Q with a small number of coil turns.

Magnetic-core antennas consist essentially of many turns of wire around a ferrite rod. They are also known as loop-stick antennas. Probably the best-known example of this type of antenna is that used in small portable AM broadcast receivers. Because of their reduced-size advantage, ferrite-rod antennas are used almost exclusively for portable work at frequencies below 150 MHz as implied in the earlier discussion of shielded loops in this chapter, the true loop antenna responds to the magnetic field of the radio wave, and not to the electrical field. The voltage delivered by the loop is proportional to the amount of magnetic flux passing through the coil, and to the number of turns in the coil. The action is much the same as in the secondary winding of a transformer. For a given size of loop, the output voltage can be increased by increasing the flux density, and this is done with a ferrite core of high permeability. A 1/2-inch diameter, 7-inch rod of Q2 ferrite (mi = 125) is suitable for a loop core from the broadcast band through 10 MHz For increased output, the turns may be wound on two rods that are taped together, as shown in Fig 2.5. Loop stick antennas for construction are described later in this chapter.

Maximum response of the loop stick antenna is broadside to the axis of the rod as shown in Fig 2.6, whereas maximum response of the ordinary loop is in a direction at right angles to the plane of the loop. Otherwise the performances of the ferrite-rod antenna and of the ordinary loop are similar. The loop stick may also be shielded to eliminate the antenna effect, such as with a U-shaped or C-shaped channel of aluminum or other form of “trough.” The length of the shield should equal or slightly exceed the length of the rod.

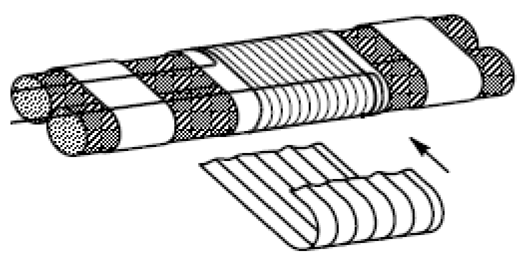


Fig 2.5—A ferrite-rod or loop stick antenna

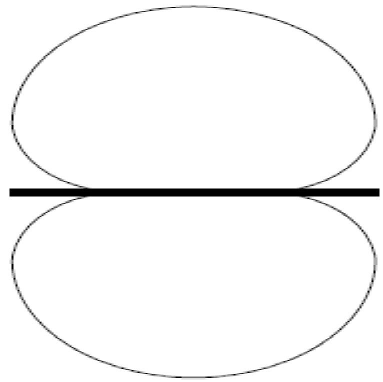


Fig 2.6—Field pattern for ferrite road antenna

2.3.4 Sensing Antennas

Because there are two nulls that are 180° apart in the directional pattern of a loop or a loop stick, an ambiguity exists as to which one indicates the true direction of the station being tracked. For example, assume you take a bearing measurement and the result indicates the transmitter is somewhere on a line running approximately east and west from your position. With this single reading, you have no way of knowing for sure if the transmitter is east of you or west of you.

If there is more than one receiving station taking bearings on a single transmitter, or if a single receiving station takes bearings from more than one position on the transmitter, the ambiguity may be worked out by triangulation, as described earlier. However, it is sometimes desirable to have a pattern with only one null, so there is no question about whether the transmitter in the above example would be east or west from your position. A loop or loop stick antenna may be made to have a single null if a second antenna element is added. The element is called a sensing antenna, because it gives an added sense of direction to the loop pattern. The second element must be omnidirectional, such as a short vertical. When the signals from the loop and the vertical element are combined with a 90° phase shift between the two a cardioid pattern results. The development of the pattern is shown in Fig 2.7A.

Fig 2.7B shows a circuit for adding a sensing antenna to a loop or loop stick. R1 is an internal adjustment and is used to set the level of the signal from the sensing antenna. For the best null in the composite pattern, the signals from the loop and the sensing antenna must be of equal amplitude, so R1 is adjusted experimentally during setup. In practice, the null of the cardioid is not as sharp as that of the loop, so the usual measurement procedure is to first use the loop alone to obtain a precise bearing reading, and then to add the sensing antenna and take another reading to resolve the ambiguity. (The null of the cardioid is 90° away from the nulls of the loop.) For this reason, provisions are usually made for witching the sensing element in and out of operation.

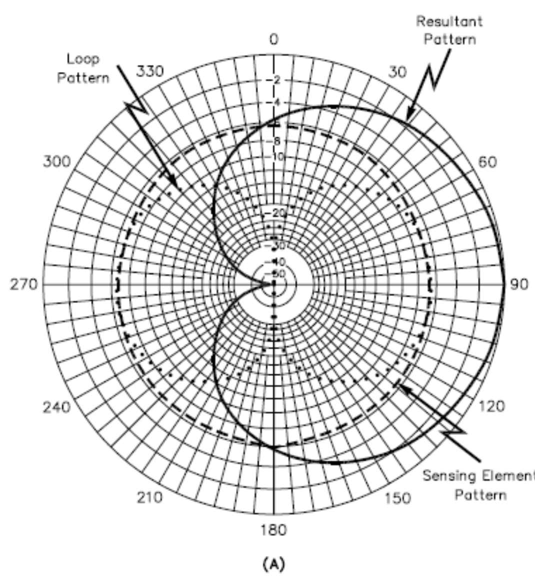


Fig 2.7—A, the directivity pattern of a loop the antenna with sensing element

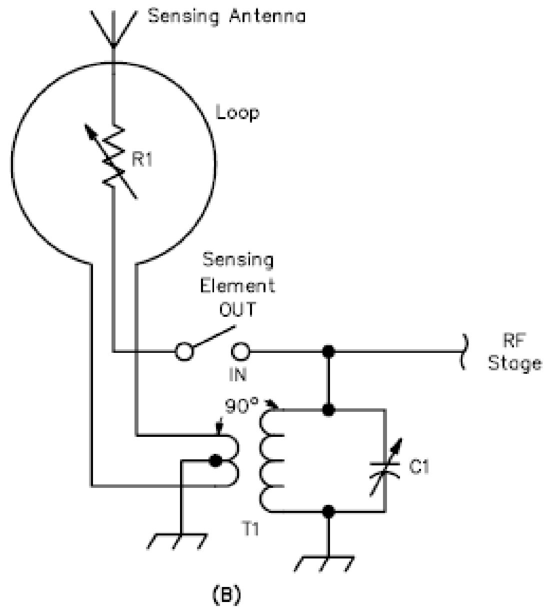


Fig 2.7—B, A circuit for combining signals from the two elements

2.3.5 Phased Arrays

Phased arrays are also used in amateur RDF work. Two general classifications of phased arrays are end-fire and broadside configurations. Depending on the spacing and phasing of the elements, end-fire patterns may exhibit a null in one direction along the axis of the elements. At the same time, the response is maximum off the other end of the axis, in the opposite direction from the null. A familiar arrangement is two elements spaced 1/4 wavelength apart and fed 90° out of phase. The resultant pattern is a cardioid, with the null in the direction of the leading element. Other arrangements of spacing and phasing for an end-fire array are also suitable for RDF work. One of the best known is the Adcock array, discussed in the next section.

Broadside arrays are inherently bidirectional, which means there are always at least two nulls in the pattern. Ambiguity therefore exists in the true direction of the transmitter, but depending on the application, this may be no handicap. Broadside arrays are seldom used for amateur RDF applications.

2.3.6 The Adcock Antenna

Loops are adequate in RDF applications where only the ground wave is present. The performance of an RDF system for sky-wave reception can be improved by the use of an Adcock antenna, one of the most popular types of end-fire phased arrays. A basic version is shown in Fig 2.8.

This system was invented by F. Adcock and patented in 1919. The array consists of two vertical elements fed 180° apart, and mounted so the system may be rotated. Element spacing is not critical, and may be in the range from 1/10 to 3/4 wavelength. The two elements must be of identical lengths, but need not be self-resonant. Elements that are shorter than resonant are commonly used. Because neither the element spacing nor the length is critical in terms of wavelengths, an Adcock array may be operated over more than one amateur band. The response of the Adcock array to vertically polarized waves is similar to a conventional loop, and the directive pattern is essentially the same. Response of the array to a horizontally polarized wave is considerably different from that of a loop, however. The currents induced in the horizontal members tend to balance out regardless of the orientation of the antenna. This effect has been verified in practice when good nulls were obtained with an experimental Adcock under sky-wave conditions. The same circumstances produced poor nulls with small loops (both conventional and ferrite-loop models). Generally speaking, the Adcock antenna has attractive properties for amateur RDF applications. Unfortunately, its portability leaves something to be desired, making it more suitable to fixed or semi-portable applications. While a metal support for the mast and boom could be used, wood, PVC or fiberglass is preferable because they are nonconductors and would therefore cause less pattern distortion.

Since the array is balanced, a coupler is required to match the unbalanced input of a typical receiver. Fig 2.9 shows a suitable link-coupled network. C2 and C3 are null-clearing capacitors. A low power signal source is placed some distance from the Adcock antenna and broadside to it. C2 and C3 are then adjusted until the deepest null is obtained. The coupler can be placed below the wiring harness junction on the boom. Connection can be made by means of a short length of 300-W twin-lead.

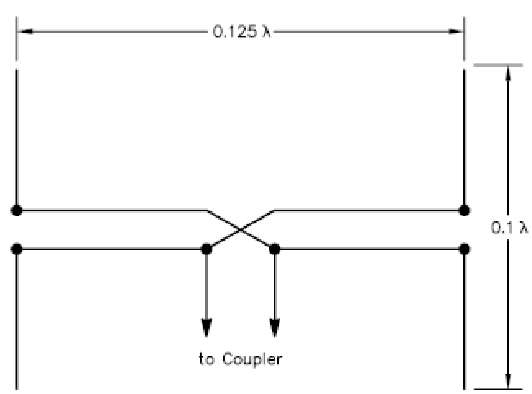


Fig 2.8— A simple Adcock antenna

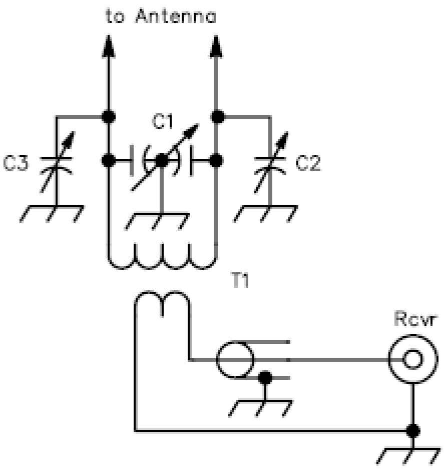


Fig 2.9— A suitable coupler for use with the Adcock antenna

6.4 Satellite Communications

Satellites are specifically made for telecommunication purpose. They are used for mobile applications such as communication to ships, vehicles, planes, hand-held terminals and for TV and radio broadcasting.

They are responsible for providing these services to an assigned region (area) on the earth. The power and bandwidth of these satellites depend upon the preferred size of the footprint, complexity of the traffic control protocol schemes and the cost of ground stations.

A satellite works most efficiently when the transmissions are focused with a desired area. When the area is focused, then the emissions don't go outside that designated area and thus minimizing the interference to the other systems. This leads more efficient spectrum usage.

Satellite's antenna patterns play an important role and must be designed to best cover the designated geographical area (which is generally irregular in shape). Satellites should be designed by keeping in mind its usability for short and long term effects throughout its life time.

The earth station should be in a position to control the satellite if it drifts from its orbit it is subjected to any kind of drag from the external forces.

2.4.1 Basics

Satellites orbit around the earth. Depending on the application, these orbits can be circular or elliptical. Satellites in circular orbits always keep the same distance to the earth's surface following a simple law:

$Fg = m\ g\ (R/r)^2$ ………………………………….……2.1

$Fc = m\ r\ \omega^2$ ……………………………………………2.2

The variables have the following meaning:

Fg the attractive force of the earth due to gravity

Fc the centrifugal force trying to pull the satellite away

m is the mass of the satellite;

R is the radius of earth with R = 6,370 km;

ri s the distance of the satellite to the center of the earth;

g is the acceleration of gravity with $g = 9.81\ m/s^2$;

ω is the angular velocity with $\omega = 2\pi f$,

f is the frequency of the rotation.

To keep the satellite in a stable circular orbit, the following equation must hold:

Fg = Fc, i.e., both forces must be equal. Looking at this equation the first thing to notice is that the mass m of a satellite is irrelevant (it appears on both sides of the equation). Solving the equation for the distance r of the satellite to the Centre of the earth results in the following equation:

The distance $r = (g R^2 / (2\pi f)^2)^{1/3}$ ………………………2.3

From the above equation it can be concluded that the distance of a satellite to the earth's surface depends on its rotation frequency.

Important parameters in satellite communication are the inclination and elevation angles. The inclination angle δ (figure 2.10) is defined between the equatorial plane and the plane described by the satellite orbit. An inclination angle of 0 degrees means that the satellite is exactly above the equator. If the satellite does not have a circular orbit, the closest point to the earth is called the perigee.

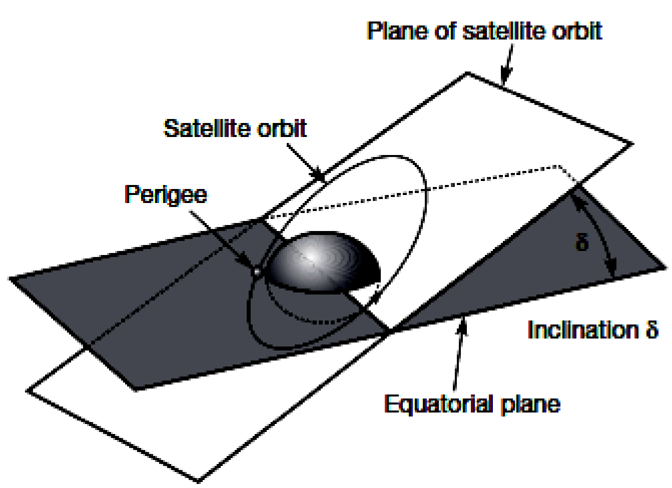


Fig 2.10— Angle of Inclination

The elevation angle ε (figure 2.11) is defined between the center of the satellite beam and the plane tangential to the earth's surface. A so called footprint can be defined as the area on earth where the signals of the satellite can be received.

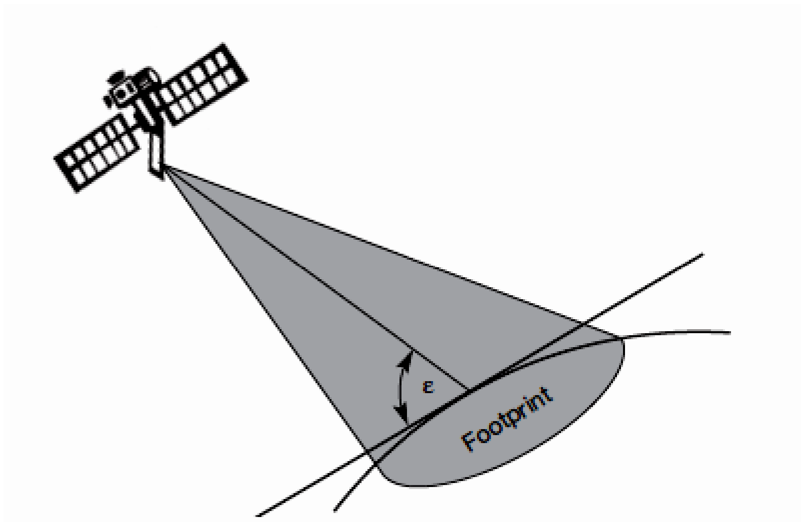


Fig 2.11— Angle of Elevation

2.4.2 Applications of Satellite

There are many applications for satellites in today's world. Ever since the first satellite, Sputnik 1, was launched in 1957, large numbers of satellites have been launched into space to meet a variety of needs. As satellite technology has developed over the years, so as the number of applications to which they can be put. Whatever the type of satellite it is necessary to be able to communicate with them, and in view of the large distances, the only feasible technology is radio. As such radio communication is an integral part of any satellite system, whatever its application.

4.4.2.1 Weather Forecasting

Certain satellites are specifically designed to monitor the climatic conditions of earth. They continuously monitor the assigned areas of earth and predict the weather conditions of that region. This is done by taking images of earth from the satellite. These images are transferred using assigned radio frequency to the earth station. (Earth Station: it’s a radio station located on the earth and used for relaying signals from satellites.) These satellites are exceptionally useful in predicting disasters like hurricanes, and monitor the changes in the Earth's vegetation, sea state, ocean color, and ice fields.

4.4.2.2 Radio and TV Broadcast

These dedicated satellites are responsible for making 100s of channels across the globe available for everyone. They are also responsible for broadcasting live matches, news, world-wide radio services. These satellites require a 30-40 cm sized dish to make these channels available globally.

4.4.2.3 Military Satellites

These satellites are often used for gathering intelligence, as a communications satellite used for military purposes, or as a military weapon. A satellite by itself is neither military nor civil. It is the kind of payload it carries that enables one to arrive at a decision regarding its military or civilian character.

4.4.2.4 Navigation Satellites

The system allows for precise localization world-wide, and with some additional techniques, the precision is in the range of some meters. Ships and aircraft rely on GPS as an addition to traditional navigation systems. Many vehicles come with installed GPS receivers. This system is also used, e.g., for fleet management of trucks or for vehicle localization in case of theft.

4.4.2.5 Global Telephone

One of the first applications of satellites for communication was the establishment of international telephone backbones. Instead of using cables it was sometimes faster to launch a new satellite. But, fiber optic cables are still replacing satellite communication across long distance as in fiber optic cable, light is used instead of radio frequency, hence making the communication much faster (and of course, reducing the delay caused due to the amount of distance a signal needs to travel before reaching the destination.)

Using satellites, to typically reach a distance approximately 10,000 kms away, the signal needs to travel almost 72,000 kms, that is, sending data from ground to satellite and (mostly) from satellite to another location on earth. This cause’s substantial amount of delay and this delay becomes more prominent for users during voice calls.

4.4.2.6 Connecting Remote Areas

Due to their geographical location many places all over the world do not have direct wired connection to the telephone network or the internet (e.g., researchers on Antarctica) or because of the current state of the infrastructure of a country. Here the satellite provides a complete coverage and (generally) there is one satellite always present across a horizon.

4.4.2.7 Global Mobile Communication

The basic purpose of satellites for mobile communication is to extend the area of coverage. Cellular phone systems, such as AMPS and GSM (and their successors) do not cover all parts of a country. Areas that are not covered usually have low population where it is too expensive to install a base station. With the integration of satellite communication, however, the mobile phone can switch to satellites offering world-wide connectivity to a customer. Satellites cover a certain area on the earth. This area is termed as a „footprint" of that satellite. Within the footprint, communication with that satellite is possible for mobile users. These users communicate using a Mobile-User-Link (MUL). The base-stations communicate with satellites using a Gateway-Link (GWL). Sometimes it becomes necessary for satellite to create a communication link between users belonging to two different footprints. Here the satellites send signals to each other and this is done using Inter-Satellite-Link (ISL).

2.4.3 Frequency Allocation for Satellite

Allocation of frequencies to satellite services a complicated process which requires international coordination and planning. This is done as per the International Telecommunication Union (ITU). To implement this frequency planning, the world is divided into three regions:

Region1: Europe, Africa and Mongolia

Region 2: North and South America and Greenland

Region 3: Asia (excluding region 1 areas), Australia and south-west Pacific.

Within these regions, he frequency bands are allocated to various satellite services. Below are the frequencies allocated to these satellites:

Table 2-1 Frequency Band for Satellite

Band	**Uplink**	**Downlink**
L/S	1.610 to 1.625 GHZ	2.483 to 2.50 GHZ
C	3.70 to 4.20 GHZ	5.924to 6.425 GHZ
Ku	11.70 to 12.20 GHZ	14.00 to 14.50 GHZ
Ka	17.70 to 21.70 GHZ	27.50 to 30.50 GHZ

2.4.4 Types of Satellites (Based on Orbits)

Satellite orbits are "grouped" into general categories because a major characteristic of a particular orbit in the "group" produces a highly desired ground track or an aspect of the orbit which is needed to accomplish the main purpose of the satellite.

In general, a satellite orbit gives rise to particular desirable ground track. For example, a communications satellite needs to stay where it can always be seen from the ground; a weather satellite needs to view the earth with the sun in the same relative position every time the satellite passes over a country. Thus, a satellite is placed in an orbit which capitalizes on an aspect of the orbit which helps the satellite meet its mission, be that scientific, military, or commercial.

4.4.4.1 Geostationary or geosynchronous earth orbit (GEO)

There are three conditions which lead to geostationary satellites. Lifetime expectancy of these satellites is 15 years.

1) The satellite should be placed 37,786 kms (approximated to 36,000 kms) above the surface of the earth.

2) These satellites must travel in the rotational speed of earth, and in the direction of motion of earth, that is eastward.

3) The inclination of satellite with respect to earth must be 00. Geostationary satellite in practical is termed as geosynchronous as there are multiple factors which make these satellites shift from the ideal geostationary condition.

1) Gravitational pull of sun and moon makes these satellites deviate from their orbit. Over the period of time, they go through a drag. (Earth's gravitational force has no effect on these satellites due to their distance from the surface of the Earth.)

2) These satellites experience the centrifugal force due to the rotation of Earth, making them deviate from their orbit.

3) The non-circular shape of the earth leads to continuous adjustment of speed of satellite from the earth station.

These satellites are used for TV and radio broadcast, weather forecast and also, these satellites are operating as backbones for the telephone networks.

Disadvantages of GEO: Northern or southern regions of the Earth (poles) have more problems receiving these satellites due to the low elevation above a latitude of 60°, i.e., larger antennas are needed in this case. Shading of the signals is seen in cities due to high buildings and the low elevation further away from the equator limit transmission quality. The transmit power needed is relatively high which causes problems for battery powered devices. These satellites cannot be used for small mobile phones. The biggest problem for voice and also data communication is the high latency as without having any handovers, the signal has to at least travel 72,000 kms. Due to the large footprint, either frequencies cannot be reused or the GEO satellite needs special antennas focusing on a smaller footprint. Transferring a GEO into orbit is very expensive.

4.4.4.2 Low Earth Orbit (LEO) satellites

These satellites are placed 500-1500 kms above the surface of the earth. As LEOs circulate on a lower orbit, hence they exhibit a much shorter period that is 95 to 120 minutes. LEO systems try to ensure a high elevation for every spot on earth to provide a high quality communication link. Each LEO satellite will only be visible from the earth for around ten minutes. Using advanced compression schemes, transmission rates of about 2,400 bit/s can be enough for voice communication. LEOs even provide this bandwidth for mobile terminals with Omni-directional antennas using low transmit power in the range of 1W. The delay for packets delivered via a LEO is relatively low (approx. 10 ms). The delay is comparable to long-distance wired connections (about 5–10 ms). Smaller footprints of LEOs allow for better frequency reuse, similar to the concepts used for cellular networks. LEOs can provide a much higher elevation in Polar Regions and so better global coverage. These satellites are mainly used in remote sensing a providing mobile communication services (due to lower latency).

Disadvantages: The biggest problem of the LEO concept is the need for many satellites if global coverage is to be reached. Several concepts involve 50–200 or even more satellites in orbit. The short time of visibility with a high elevation requires additional mechanisms for connection handover between different satellites. The high number of satellites combined with the fast movements resulting in a high complexity of the whole satellite system. One general problem of LEOs is the short lifetime of about five to eight years due to atmospheric drag and radiation from the inner Van Allen belt1. Assuming 48 satellites and a lifetime of eight years, a new satellite would be needed every two months. The low latency via a single LEO is only half of the story. Other factors are the need for routing of data packets from satellite to if a user wants to communicate around the world. Due to the large footprint, a GEO typically does not need this type of routing, as senders and receivers are most likely in the same footprint.

4.4.4.3 Medium Earth Orbit (MEO) satellites

MEOs can be positioned somewhere between LEOs and GEOs, both in terms of their orbit and due to their advantages and disadvantages. Using orbits around 10,000 km, the system only requires a dozen satellites which is more than a GEO system, but much less than a LEO system. These satellites move more slowly relative to the earth's rotation allowing a simpler system design (satellite periods are about six hours). Depending on the inclination, a MEO can cover larger populations, so requiring fewer handovers.

Disadvantages: Again, due to the larger distance to the earth, delay increases to about 70–80 ms. the satellites need higher transmit power and special antennas for smaller footprints.

6.5 Radio Frequency:

Radio frequency (RF) is any of the electromagnetic wave frequencies that lie in the range extending from around 3 kHz to 300 GHz, which include those frequencies used for communications or radar signals. RF usually refers to electrical rather than mechanical oscillations. However, mechanical RF systems do exist.

To receive radio signals an antenna must be used. However, since the antenna will pick up thousands of radio signals at a time, a radio tuner is necessary to tune into a particular frequency (or frequency range). This is typically done via a resonator – in its simplest form, a circuit with a capacitor and an inductor form a tuned circuit. The resonator amplifies oscillations within a particular frequency band, while reducing oscillations at other frequencies outside the band. Another method to isolate a particular radio frequency is by oversampling (which gets a wide range of frequencies) and picking out the frequencies of interest, as done in software defined radio.

The distance over which radio communications is useful depends significantly on things other than wavelength, such as transmitter power, receiver quality, type, size, and height of antenna, mode of transmission, noise, and interfering signals. Ground waves, tropospheric scatter and sky waves can all achieve greater ranges than line-of-sight propagation. The study of radio propagation allows estimates of useful range to be made.

6.6 Frequency Bands:

Frequency	Wavelength	Designation	Abbreviation[6]
3–30 Hz	10^5–10^4 km	Extremely low frequency	ELF
30–300 Hz	10^4–10^3 km	Super low frequency	SLF
300–3000 Hz	10^3–100 km	Ultra low frequency	ULF
3–30 kHz	100–10 km	Very low frequency	VLF
30–300 kHz	10–1 km	Low frequency	LF
300 kHz – 3 MHz	1 km – 100 m	Medium frequency	MF
3–30 MHz	100–10 m	High frequency	HF

30–300 MHz	10–1 m	Very high frequency	VHF
300 MHz – 3 GHz	1 m – 10 cm	Ultra high frequency	UHF
3–30 GHz	10–1 cm	Super high frequency	SHF
30–300 GHz	1 cm – 1 mm	Extremely high frequency	EHF
300 GHz – 3000 GHz	1 mm – 0.1 mm	Tremendously high frequency	THF

6.7 **GPS:**

Global Positioning Systems (GPS) are a relatively new technology when it comes to applications in agriculture. GPS was developed by the U.S. Department of Defense in the 1980’s under the name NAVSTAR (Navigation System for Timing and Ranging). Initially the U.S. government made available to the public GPS signals of intentionally degraded quality. The induced error, known as “selective availability,” was removed in May 2000. Since then we have seen an explosion of applications, including tractor guidance, variable rate dispensing of chemical inputs, in-field monitoring of crop yield, and many others. Agricultural GPS technologies have been developing at a fast rate and they are made available all across the United States through the networks of farm equipment dealers. This commercial channel has provided a robust mechanism for the dissemination of GPS technology. As these technologies keep evolving, the private sector will intensify its product development and provide growers with solutions that have increased accuracy and affordability. This publication is focused on the basic concepts of GPS as they apply to agricultural production. The companion article "From GPS to GNSS – Enhanced functionality of GPS-integrated systems in agricultural machines" provides a detailed review and analysis of the newest developments in this area with a focus on functionality and efficiency.

6.8 How Does GPS Work?

GPS receivers are electronic devices that provide positioning information using a global network of orbiting satellites and ground stations. Positioning is based on the mathematical principle of trilateration, requiring the precise timing of radio signals transmitted from orbiting satellites to GPS receivers on the ground. To solve for position, a GPS receiver must link communication with at least four satellites and calculate its distance from them. These distances (or ranges) are obtained by measuring precisely the time-of-flight of each signal and multiplying it by the speed of light. These distances are actually known as pseudo-ranges to reflect the error in these computations. Due to the iterative nature of trilateration algorithms, the accuracy of the position information will depend primarily on the number of satellites communicating with the GPS receiver.

The basic framework of satellite-receiver communication was improved significantly when the concept of "differential correction" was introduced. This concept relies on the addition of a correction station installed at a point of known position. Differential correction compares the true position of the correction station and the calculated position according to the direct satellite-receiver links. This differential correction information is constantly broadcast to receivers in the area which will use it to improve the accuracy of their positioning computations. Receivers capable of collecting correction data are classified as DGPS receivers where the letter D denotes differential-correction. With very few exceptions, most agricultural applications of GPS rely on differential correction of some kind.

Now that we have set up this basic framework of GPS operation, let's analyze the larger scope by separating the three parts of a GPS system. The space segment refers to the constellation of U.S. GPS satellites orbiting the earth. Many satellites have been launched but 32 remain operational (PRN-132) and only 24 are required at a given time to secure full operation. The control segment is composed of 11 ground stations around the world that track and update the precise position of every satellite in the U.S. constellation. A central control unit is located at Schriever Air Force Base in Colorado. The third part is the user segment which refers to the actual GPS receivers used by the civilian and military communities. Figure 1 presents a diagram with a view of the GPS space, control, and user segments that provide the functional platform of satellite-based communications in agricultural applications. In the next sections we will analyze the contribution of additional ground stations such as the US Coast Guard Beacons that broadcast correction data to enhance the operational and functional characteristics of GPS receivers used in agriculture.

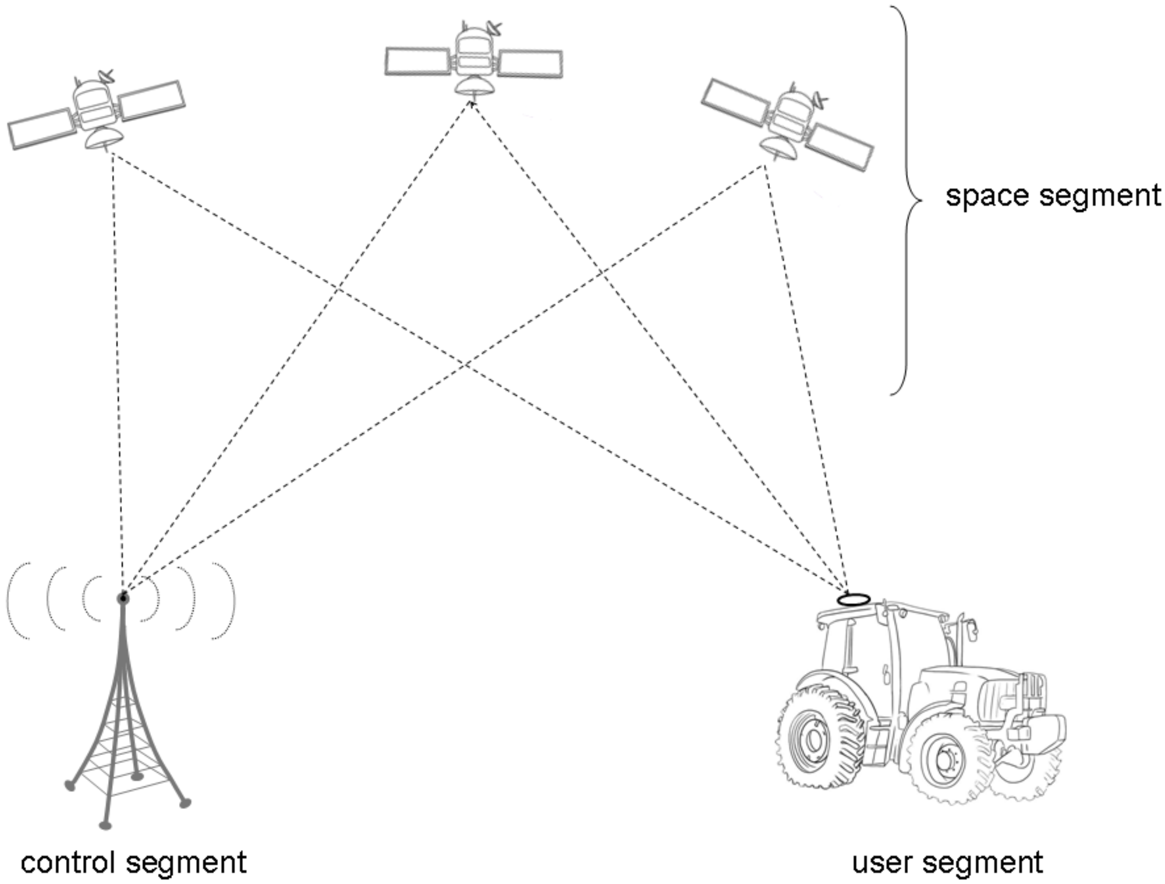


Fig 2.12— Diagram of GPS space, control, and user segments in agricultural applications

6.9 Stepper Motors:

Motion control in electronic terms means to accurately control the movement of an object based on speed, distance, load, inertia or a combination of all these factors. There are numerous types of motion control systems including: Stepper Motor, Liner Step Motor, Dc Brush, Brushless, Servo, Brushless Servo and more.

Stepper motors are a special type of motor. Instead of rotating smoothly, they move incrementally - in steps. Each step is a fixed angular displacement of the motor's shaft.

2.9.1 Fundamentals of operation:

A stepper motor is a brushless, synchronous electric motor that converts digital pulses into mechanical shaft rotation, every revolution of the stepper motor is divided into a discrete number of steps, in many cases 200 steps, and the motor must be sent by a separate pulse for each step, the stepper motor can only take one step at a time and each step is the same size. Since each pulse causes the motor to rotate a precise angle, typically 1.8°, the motor's position can be controlled without any feedback mechanism.

As the digital pulses increase in frequency, the step movement changes into continuous rotation, with the speed of rotation directly proportional to the frequency of the pulses. Step motors are used every day in both industrial and commercial applications because of their low cost, high reliability, high torque at low speeds and a simple, rugged construction that operates in almost any environment.

2.9.2 Types of stepper motor:

There are basically three types of stepping motors: variable reluctance, permanent magnet and hybrid. They differ in terms of construction based on the use of permanent magnets and/or iron rotors with laminated steel stators.

4.9.2.1 Variable Reluctance:

The variable reluctance motor has four "stator pole sets" (A, B, C,), set 15 degrees apart. Current applied to pole A through the motor winding causes a magnetic attraction that aligns the rotor (tooth) to pole A. Energizing stator pole B causes the rotor to rotate 15 degrees in alignment with pole B. This process will continue with pole C and back to A in a clockwise direction. Reversing the procedure (C to A) would result in a counterclockwise rotation.

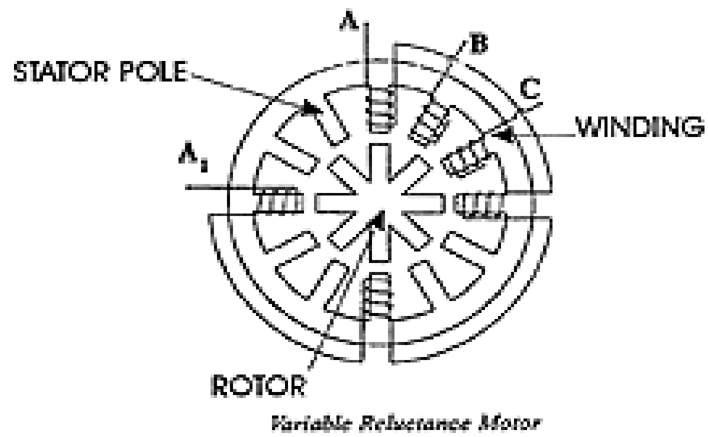


Fig 2.13— Variable Reluctance Motor

4.9.2.2 Permanent Magnet:

The permanent magnet motor, also referred to as a "can stack motor", has as the name implies a permanent rotor. It is a relatively low speed, low torque device with large step angles of either 45 or 90 degrees. It's simple construction and low cost make it an ideal choice for non-industrial illustrates permanent magnet motor.

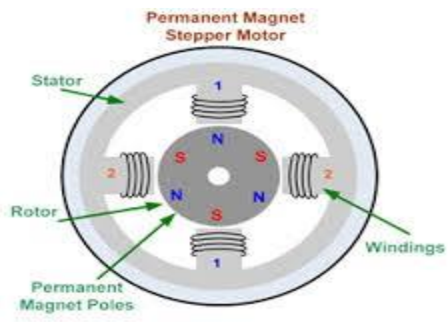


Fig 2.14— Permanent magnet Motor

4.9.2.3 Hybrid:

They are constructed with multi-toothed stator poles and a permanent magnet rotor. Standard hybrid motors have 200 rotor teeth and rotate at 1.8 step angles. Other hybrid motors are available in 0.9 and 3.6 step angle configurations. Because they exhibit high static and dynamic torque and run at very high step rates, hybrid motors are used in a wide variety of industrial applications.

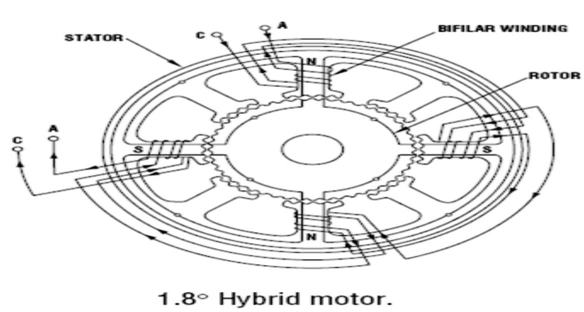


Fig 2.15— Hybrid Motor

2.9.3 Stepper motor and interfacing with Microcontroller:

Stepper motors can be used in various areas of microcontroller projects such as making robots, robotic arm, automatic door lock system etc. Here will discuss different controlling types (Half step and Full step), Interfacing Techniques (using L293D or ULN2003) to control stepper motor.

Stepper motors can be driven in two different patterns or sequences. Namely

4.9.3.1 Full Step Sequence:

In the full step sequence, two coils are energized at the same time and motor shaft rotates. The order in which coils has to be energized is given in the table below.

Table 2-2 Full Step Sequence

step	**A**	**B**	**C**	**D**
1	1	0	1	1
2	1	1	0	0
3	0	1	0	0
4	0	0	1	1

4.9.3.2 Half Step Sequence:

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 pre offered over full mode. Table below shows the pattern of energizing the coils.

Table 2-3 Half Step Sequence

Step	A	B	C	D
1	1	0	0	1
2	1	0	0	0
3	1	1	0	0
4	0	1	0	0
5	0	1	1	0
6	0	0	1	0
7	0	0	1	1
8	0	0	0	1

4.9.3.3 Step Angle:

Step angle of the stepper motor is defined as the angle traversed by the motor in one step. To calculate step angle, simply divide 360 by number of steps a motor takes to complete one revolution. As we have seen that in half mode, the number of steps taken by the motor to complete one revolution gets doubled, so step angle reduces to half.

As in above examples, Stepper Motor rotating in full mode takes 4 steps to complete a revolution, So step angle can be calculated as…

Step Angle ø = 360° / 4 = 90°

And in case of half mode step angle gets half so 45°.

So this way we can calculate step angle for any stepper motor. Usually step angle is given in the spec sheet of the stepper motor you are using. Knowing stepper motor's step angle helps you calibrate the rotation of motor also to helps you move the motor to correct angular position.

2.9.4 Darlington Transistor Operation:

For high input impedance we may use two transistors to form a Darlington pair. This pair in CC configuration provides input impedance as high as 2Mohms. The input signal varies the base current of the first transistor this produces variation in the collector current in the first transistor. The emitter load of the first stage is the input resistance of the second stage. The emitter current of the first transistor is the base current of the second transistor.

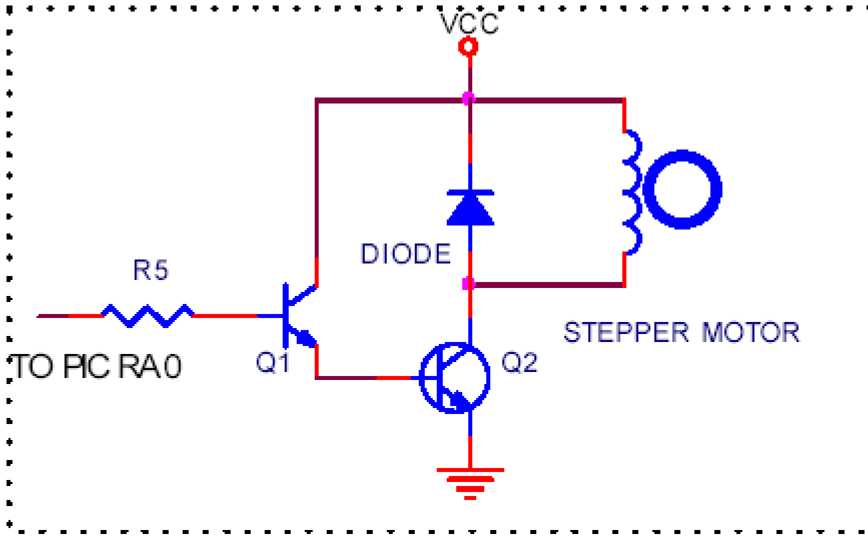


Fig 2.16— Darlington Circuit

2.9.5 Advantages of Stepper Motor:

- The rotation angle of the motor is proportional to the input pulse.
- The motor has full torque at standstill
- Precise positioning and repeatability of movement since good stepper motors have an accuracy of 3 to 5% of a step and this error is non-cumulative from one step to the next.
- Excellent response starting/stopping/reversing.

CHAPTER THREE

Hardware Design

CHAPTER THREE

6.1 Overview

Motion control in electronic terms, means to accurately control the movement an object based on speed, distance, load, inertia or a combination of all these factors. There are numerous types of motion control systems, including motor, DC Brush, Brushless, Servo, Brushless Servo and more.

6.2 Hardware Components

-Stepper Motor

-Register HD74LS373 IC

-Transistor ULN 2803A

-Board Panel

-Operation Circuit Design

-Radar Antenna Module

-Computer System

6.3 Stepper Motor

A stepper motor is a brushless, synchronous electric motor that converts digital pulses into mechanical shaft rotations. Each rotation of a stepper motor is divided into a set number of steps, sometimes as many as 200 steps. The stepper motor must be sent a separate pulse for each step.

Fig 3.1— Stepper Motor

6.4 Register HD74LS373 IC (Refer appendix A)

The HD74LS373, 8-bit register features totem-pole three-state outputs designed specifically for driving highly capacitive or relatively low-impedance loads. The high-impedance third state and increased high-logic-level drive provide this register with the capacity of being connected directly to and driving the bus lines in a bus-organized system without need for interface or pull-up components. They are particularly attractive for implementing buffer registers, I/O ports, bidirectional bus drivers, and working registers

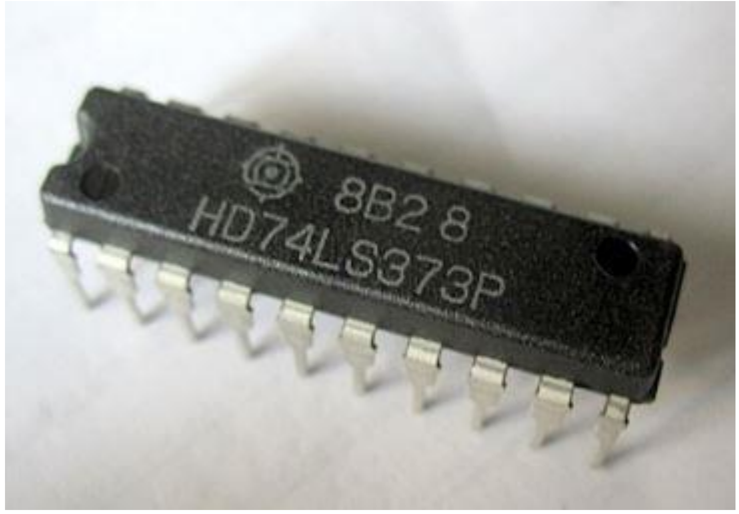


Fig 3.2— HD74LS373

6.5 Transistor ULN 2803A (Refer appendix B)

The eight NPN Darlington connected transistors in this family of arrays are ideally suited for interfacing between low logic level digital circuitry (such as TTL, CMOS or PMOS/NMOS) and the higher current/voltage requirements of lamps, relays, printer hammers or other similar loads for a broad range of computer, industrial, and consumer applications. All devices feature open–collector outputs and freewheeling clamp diodes for transient suppression.

The ULN2803 is designed to be compatible with standard TTL families while the ULN2804 is optimized for 6 to 15 volt high level CMOS or PMOS.

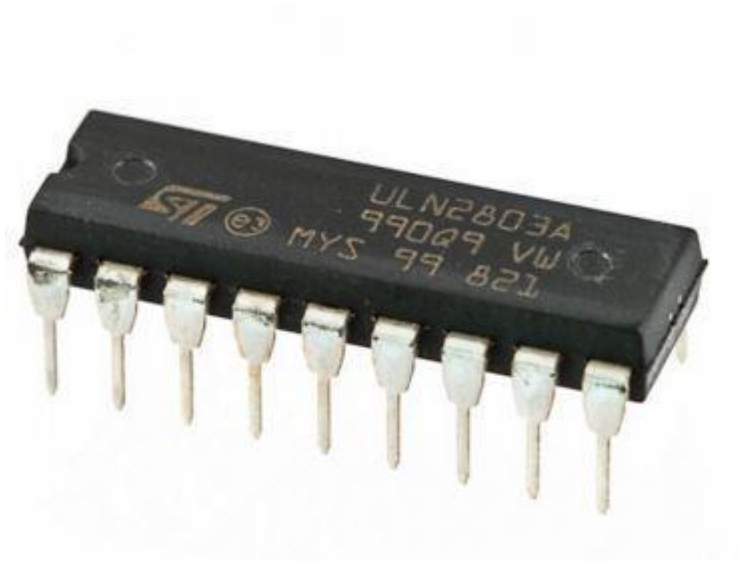


Fig 3.3— ULN2803

6.6 Board Panel

This board is ideally for basic design and experiment of analog or digital circuit. It can offer end-user to perform circuit development in interface or communication field with special universal connector or basic plate.

6.7 Operation Circuit Design

The design illustrated in figure 3.1 which enables the simplified radar antenna by controlling for the module (X axis), the circuit design operators by (+5 v) voltages to enable four ICs (2* HD74LS373, 2* ULN 2803A) on the board which connected to a stepper motor which have been installed in the radar antenna module.

6.8 Design Steps

1- Step No (1)

Table 3-1: D-25 to IC HD74LS373 interconnection

D-25 Connector	IC No. (1) HDL74LS373
PIN 1	PIN II (LED)
PIN 2	PIN 2
PIN 3	PIN 3
PIN 4	PIN 4
PIN 5	PIN 5
PIN 6	PIN 6
PIN 7	PIN 7
PIN 8	PIN 8
PIN 9	PIN 9

1- Step No (2)

Table 3-2: IC HD74LS373 to IC ULN2803 interconnection

IC No. (1) HDL74LS373	IC No. (1) ULN2803
PIN 18	PIN 1
PIN 17	PIN 2
PIN 14	PIN 3
PIN 13	PIN 4

1- Step No (3)

Table 3-3: IC ULN2803 to Stepper Motor interconnection

IC No. (1) ULN2803	**Stepper Motor No. (1)**
PIN 16	Coil 1 Red
PIN 15	Coil 2 Brown
PIN 14	Coil 3 Green
PIN 13	Coil 4 White
COMMON 9	Black

6.9 The calculations

The total response time for the block diagram of hardware design of the radar antenna control Fig 3.1 below which used by the computer system, is the sum of the times which passing from D-25 during each IC and stepper motor on the hardware design

The total response time = T1 + T2 + T3 …………….3.1

Where:

T1: Time which pass from D-25 to HD74LS373

T2: Time which pass from HD74LS373 to ULN2803

T3: Time which pass from ULN2803to Stepper Motor

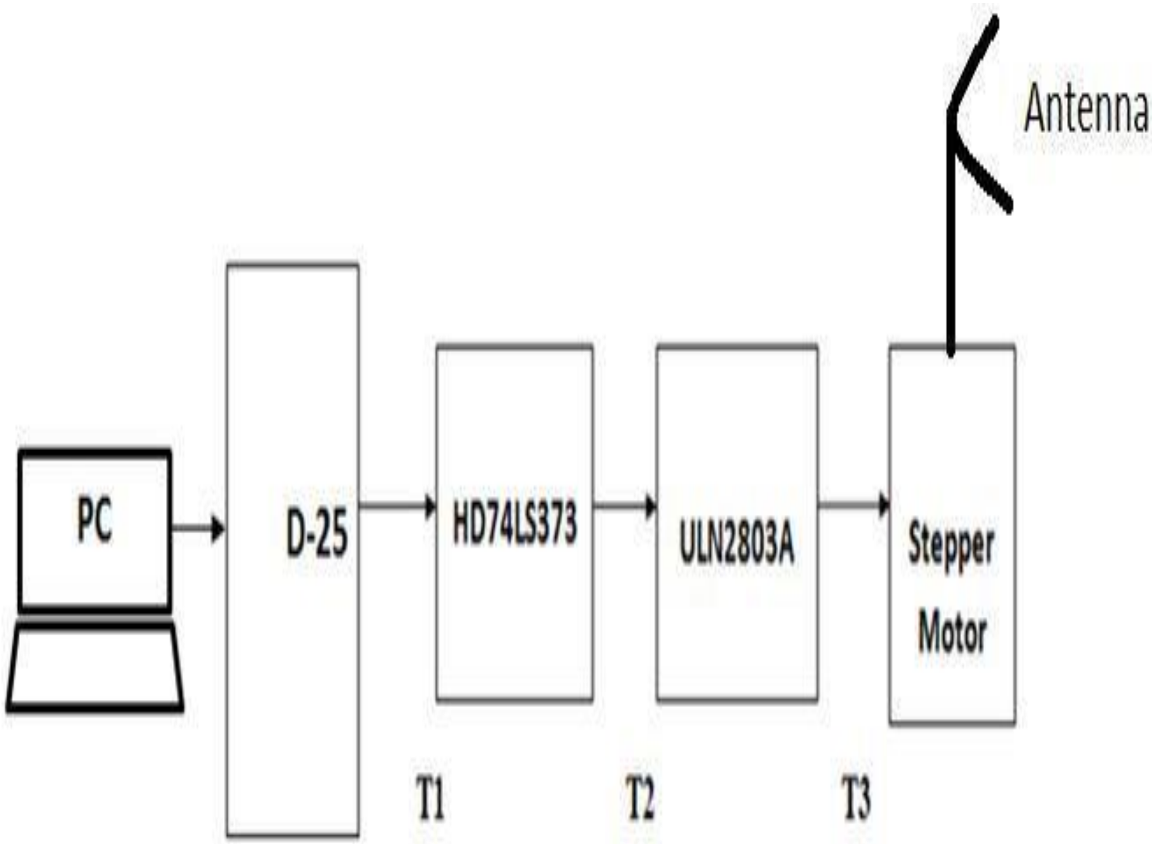


Fig 3.4— the block diagram of the Circuit calculations

CHAPTER FOUR

Software Design

CHAPTER FOUR

6.1 Turbo C ++ Language

C is one of the oldest and most powerful programming languages that were first developed in the 1970s by Dennis Ritchie. However, if C programming is mastered, learning other programming languages will be easy.

Turbo C++ is a discontinued C++ compiler and integrated development environment and computer language originally from Borland. Most recently it was distributed by Embarcadero Technologies, which acquired all of Borland's compiler tools with the purchase of its Code Gear division in 2008. The original Turbo C++ product line was put on hold after 1994 and was revived in 2006 as an introductory-level IDE, essentially a stripped-down version of their flagship C++Builder. Turbo C++ 2006 was released on September 5, 2006 and was available in 'Explorer' and 'Professional' editions. The Explorer edition was free to download and distribute while the Professional edition was a commercial product. In October 2009 Embarcadero Technologies discontinued support of its 2006 C++ editions. As such, the Explorer edition is no longer available for download and the Professional edition is no longer available for purchase from Embarcadero Technologies. Turbo C++ is succeeded by C++Builder.

The first release of Turbo C++ was made available during the MS-DOS era on personal computers. Version 1.0, running on MS-DOS, was released in May 1990. An OS/2 version was produced as well. Version 1.01 was released on February 28, 1991,[1] running on MS-DOS. The latter was able to generate both COM and EXE programs and was shipped with Borland's Turbo Assembler compiler for Intel x86 processors. The initial version of the Turbo C++ compiler was based on a front end developed by TauMetric (TauMetric was later acquired by Sun Microsystems and their front end was incorporated in Sun C++ 4.0, which shipped in 1994).This compiler supported the AT&T 2.0 release of C++.

6.2 The flow chart for the System Operation

The design shows all the steps of operation to get the direction of the source of transmission.

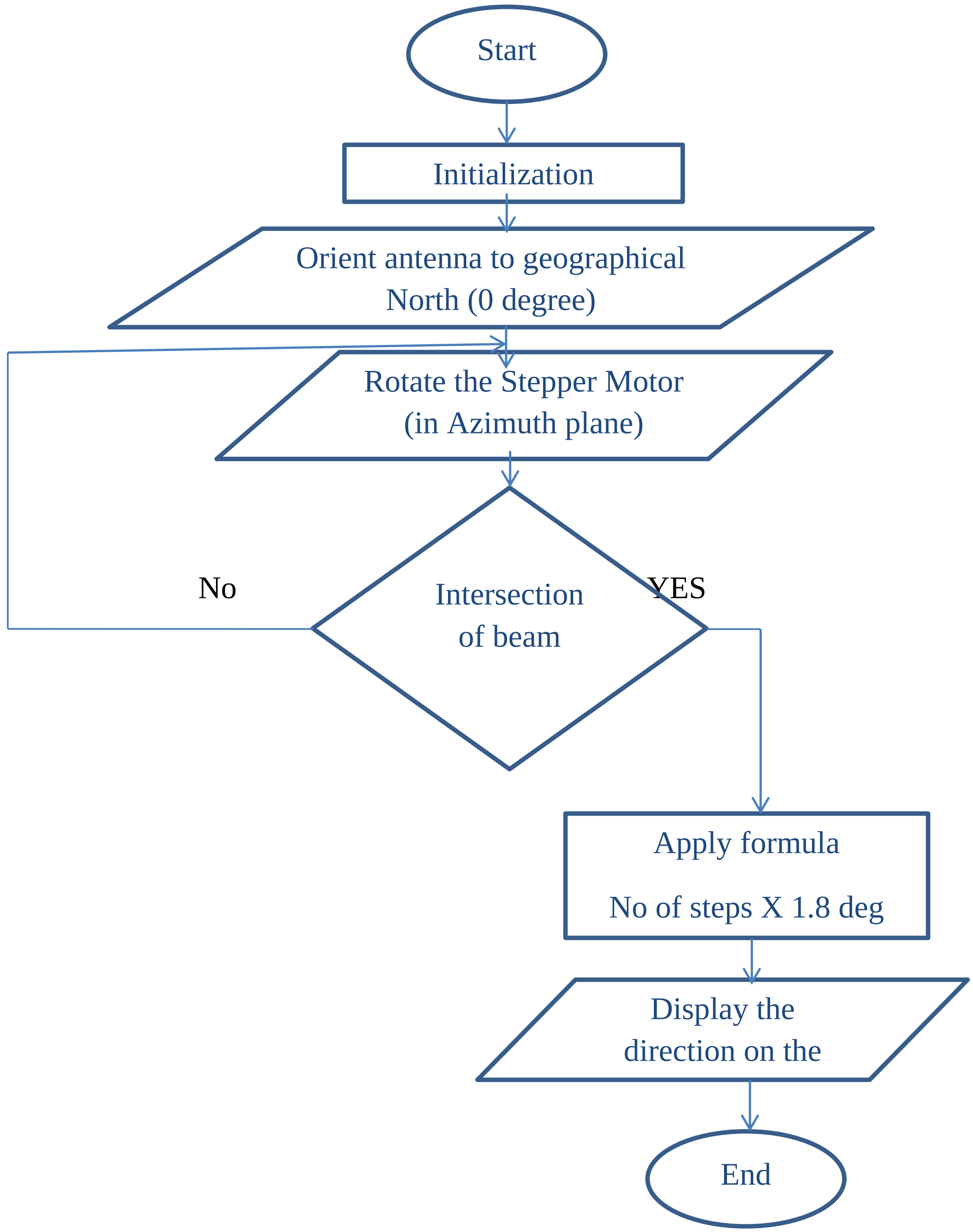


Fig 4.1—the flow chart for the System Operation

6.3 Program Text

```
#include<stdio.h>
#include<conio.h>
#include<dos.h>

/* This program is written byb Eng. Faisal Hamad
Mohammed Alameen  */
main()
{
screen1:
/* title for the thesis */
textmode(1);
gotoxy(5,2);
textcolor(WHITE);
textbackground(RED);
cprintf("\n Faisal Hamad Mohammed Alameen ");

gotoxy(5,5);
cprintf("\n SUDAN  UNIVERSITY (CETS)");

gotoxy(3,8);
cprintf("\n Design of transmission      ");

gotoxy(3,11);
cprintf("\n  Direction Finding   ");


textcolor(WHITE+BLINK);
textbackground(BLUE);
gotoxy(5,14);
cprintf("\n        start operation        ");

struct date d;
getdate(&d);
```

```
printf("\n\n %d / %d / %d", d.da_day,
d.da_mon,d.da_year);
delay(1000);

screen2:
clrscr();
textcolor(WHITE);
textbackground(BLUE);
gotoxy(5,18);
cprintf("\n        ENTER THE COMMAND             ");
delay(1000);

screen3:
clrscr();
textcolor(WHITE);
textbackground(BLUE);
gotoxy(5,18);
/*Rotate stepper motor*/
cprintf("\n Rotate stepper motor  ");
delay(1000);
int steps=0;
int angel;

rotate:
if (kbhit()) goto angelcount;
outportb(0x378,0x01);
delay(2000);
steps = steps + 1;

outportb(0x378,0x02);
delay(2000);
steps = steps + 1;

outportb(0x378,0x04);
delay(2000);
steps = steps + 1;
```

```
outportb(0x378,0x08);
delay(2000);
steps = steps + 1;
goto rotate;

angelcount:
angel = steps * 1.8;

cprintf("\n %d angel" , angel);
delay(5000);


finish:
getch();
return(0);
}
```

CHAPTER FIVE

Results and Discussions

CHAPTER FIVE

6.1 Results

As a result the hardware is done by installing the circuit design, connected by leads on board panel and D-25 female type connector works as analog-to-digital converter. This circuit connected to antenna module which it motivated by the stepper motor.

The overall design controlled by computer connected through uplink male type connector.

First interface monitor shows the project execution, university name, project name, date applied by software after running.

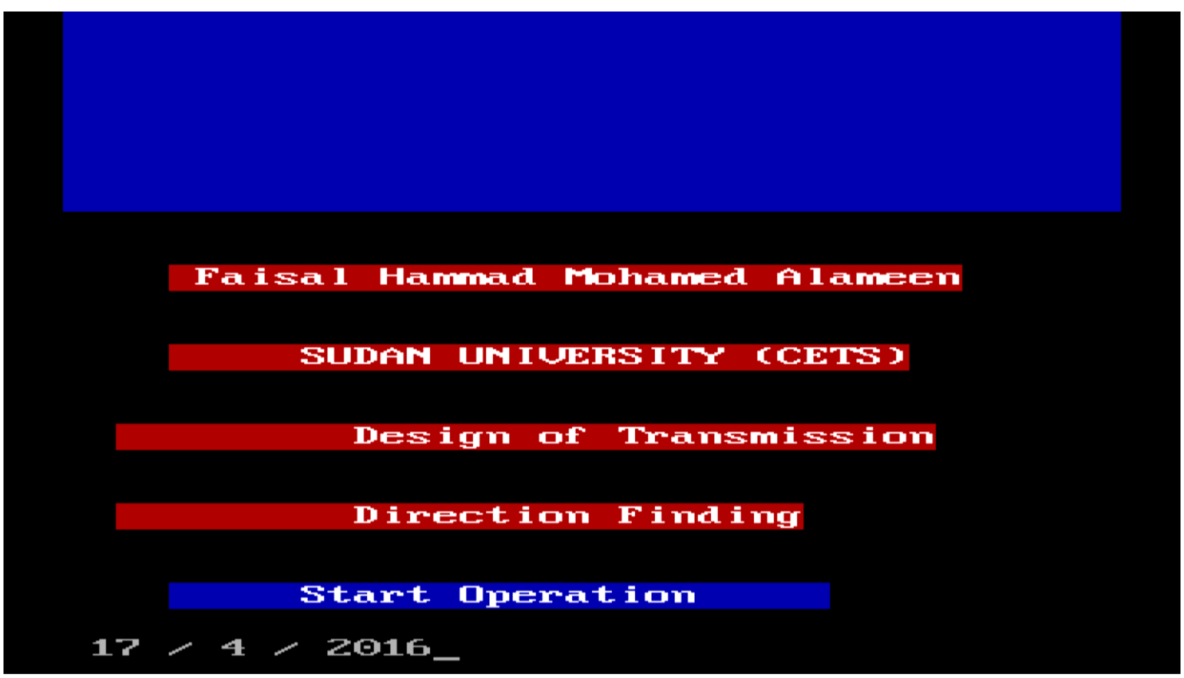


Fig 5.1—First Monitor

Second monitor shows how to fill the number of steps specify the rotation of the antenna.

Fig 5.2—Second Monitor

Third monitor shows that, the stepper motor started the rotation so as to detect the direction of the transmitter.

Fig 5.3—Third Monitor

Fourth monitor shows the direction location of target (after 20 steps mean that 36°).

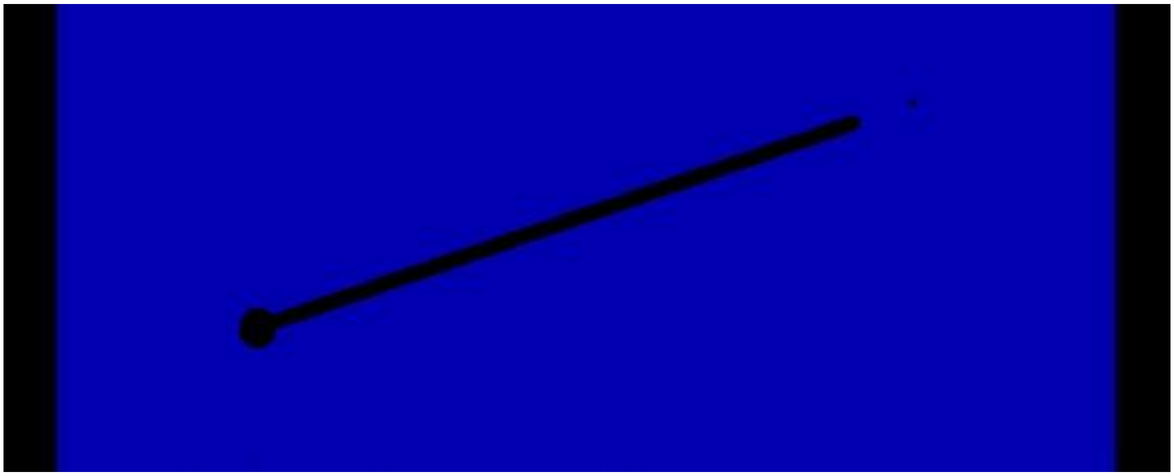


Fig 5.4—Fourth Monitor

6.2 Discussion

The circuit design has been executed, connected to the PC and operated with power supply. The output of the software was guide to the antenna to capture the signals.

CHAPTER SIX

Conclusions and Recommendations

CHAPTER SIX

6.1 Conclusions

1. Firstly concluded that, the design locate the direction and not find the location
2. Secondly if had been needed to locate accurate direction, we need to use many antennas.
3. Lastly recommended use this technique because it so easy to apply it and a low-cost system developed entirely from commercially available components.

6.2 Recommendations

This system design can be expanded in such a way as to detect wide range of frequencies.

The commercialization of this research would be to bring the product to market so that public service groups can easily take advantage of the system. Once the actual receiver accuracy is improved, the simple addition of a rugged enclosure would provide a promising product to use or an RDF.

REFERENCES

[1] Boffa P. D., Sistemi per la radionavigazione, ed. Siderea, 1985

[2] V. Piazzi, Sistemi radioelettrici di navigazione, vol V, A.A.

[3] M. Richharia, Mobile Satellite Communication: Principles and Trends, Pearson Education.

[4] Rappaort, Wireless Communications Principals and Practices.

[5] Satellite Communications Dennis Roddy 3rd edition, Mc-Graw Hill publication.

[6] http://www.tech-faq.com/vsat.html.

[7] www.wikipedia.com

[8] Elaman company Germany security solution Communication Monitoring Catalogue www.elaman.de October 2007 from

[9] Mobility Management prof .S.-I. Sou EE, NCKU Fall,2008.

[10] Satellite Data Communications using VSAT Systems-Extending IT.

[11] Networks to the Global Context from Bruce Elbert.

[12] Networking Strategies for information Technology-Bruce Elbert.

[13] IMS_USER_MANUALTOC.fm ERICSSON COMPANY 2008.

[14] http://www.arabfedeng.org.

[15] A sampling of radio direction finding systems.(includes list of radio. Magazine article from: Journal of Electronic Defense Radio direction finding systems.

[16] Transmitter Hunting: Radio Direction Finding Simplified (paperback).

APPENDICES