DESIGN AND IMPLEMENTATION OF AN ANDROID BASED AUTOMATIC SECTOR ANTENNA POSITIONING USING ATMEGA328P.

(Case study: Namuyenje Site in Mokono)

Final year project report submitted to Kampala international university in partial fulfillment of the requirement for the award

Of

Bachelor of Science in Telecommunications Engineering

BY

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DECLARATION

I hereby declare that the material submitted in has been compiled by me and produced to the best of my own understanding as a prerequisite to pertain a Bachelor of Science in Telecommunication Engineering. This report has never been submitted elsewhere for any professional award in any institution of higher learning.

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APPROVAL

This is to certify that MPUUGA ABDU NASSER is presenting a final year project entitled the “design and implementation of an android based automatic sector antenna positioning using atmega328p” under the Supervision of:

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ACKNOWLEDGMENT

I thank the Almighty God for giving me all the necessary strengths, knowledge, wisdom, financial and moral ability to complete this project report.

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LIST OF ABBREVIATION

GSM	Global System of Mobile Communication
LED	Light Emitting Diode
LCD	LIQUID CRYSTAL DISPLAY
AVR	ALF EGIL BOGEN & VERGAND WOLLAN RISC
SMS	Short Message Service
PCB	Printed Circuit Board
BTS	Base transceiver station
EM	Electromagnetics
MSC	Mobile switching center
DC	Direct current
RX	Receiver
TX	transmitter
AC	Alternating current
EM	Electromagnetic waves
LCC	Leadless chip carrier

ABSTRACT.

To achieve most accurate coverage area results during installations of sector antennas, the technical team must create a coverage map for each of the sectors basing on the provided coverage values. The technical team uses these values to make manual position adjustments of sector antennas. Manual antenna adjustments are sometimes risky in a way that unexpected accidents usually occur that even result into death. To overcome such scenarios, an android based sector Antenna positioning system is implemented in a way that is controlled by an android application to adjust sector antenna positions using stepper motors to achieve proper cell coverage. This system can be used in different antenna positioning but this time round it is focused on sector antenna positioning to achieve the set azimuth.

CHAPTER ONE

1.0 INTRODUCTION.

To increase or widen the coverage area, and thus the number of served clients, several sector antennas are installed on the same supporting structure. Once the antenna unit is attached to the supporting structure, it has to be positioned. Positioning means setting a correct direction or the right azimuth to restrict emitted energy to sub-circular arc which offers high-gain and 120-degree wireless beam performance for broad coverage. These Sector Antennas can be combined with other Sector antennas to create 360-degree area coverage for any variety of point to-multipoint scenarios.

To achieve most accurate coverage area results during installations of sector antennas, the technical team must create a coverage map for each of the sectors basing on the provided values. The technical team uses these values to make manual position adjustments of sector antennas. Manual antenna adjustments are sometimes risky in a way that unexpected accidents usually occur that even result into death.

This is why it is important to come up with an Android Based automatic Antenna Positioning System that can help to position the antenna with the help of android application. This helps the antenna to point straight towards the sending signal device so as to capture the signal. For this the system uses AVR family microcontroller and LCD screen. The LCD screen is used to display the status of the angle of the antenna. The system makes use of stepper motor to demonstrate as the antenna motor which is used to move the antenna in proper direction. Antenna can be moved by the user commands received through the android application. User commands can then be received by the Bluetooth receiver modem. As the system receives user commands, it moves the antenna on the basis of input parameters provided. The input parameters includes number of steps i.e. the angle in which the antenna is to be moved. The whole system will be powered by the 12V transformer.

1.1 BACKGROUND OF THE STUDY.

Antennas have been widely used since the turn of the last century. Ever since, this field has undergone extensive research, resulting in a wide body of experimental and theoretical knowledge alongside numerous designs and applications.

The earliest antenna was introduced in the late 19^{th} century by the German physicist Heinrich Hertz. Hertz's work was followed by a great theoretical investigation of the subject during the early to mid-20^{th} century. This investigation proceeded with the development of computer aided design (CAD) tools during the 1970s-2000s, made possible by the development of powerful yet affordable computer technology**.**

Antenna applications are vast and diverse. These include: television and radio broadcasting, RADAR, wireless computer communication, Bluetooth enabled devices, military personal communication, satellite communication, cell phones, RFID tags and much more.

This project intends to cover the sector antenna positioning mechanism behind antennas' operation and performance and physical mechanisms governing antenna's operation, and the various parameters comprising antenna specifications.

The rigorous treatment of this subject requires an extensive mathematical background.

First, an important figure of merit describing antennas radiation properties, and from which other antenna parameters are derived - the Radiation Intensity.

The EM wave radiated by the antenna carries EM power. The radiated power varies in magnitude, depending on both the direction of observation and the distance from the antenna. The EM power's general pattern is maintained in the far-field, regardless of the distance from the antenna. Therefore, a normalized EM power density that will be independent of the distance from the antenna in the far-field is introduced. This is known as the radiation intensity.

The radiation intensity is a mathematical description of the angular radiated power distribution in the far field (for a given polarization). Or in simpler terms - how much power is radiated by the antenna in a certain direction in the far field (using proper normalization with respect to the distance from the antenna).

In order to mathematically describe the radiation intensity**,** a way for representing directions is defined. Two angles with each direction that uniquely define it - an azimuth angle denoted by φ, and an elevation angle denoted by θ are associated. The elevation angle is used to describe the antenna tilt relative to the horizon while the azimuth angle is used to describe the antenna traverse in a zero tilt state.

The azimuth angular separation of sector antennas is 120 degrees from each of the three sector antennas because they are directional antennas meaning that they transmit and receive signals in front of them and not behind or aside. All the three sector antennas are always installed on one mast for the purpose of collecting much more lower signals in return of the less coverage behind and on the sides.

1.2 PROBLEM STATEMENT.

Sector antennas have several advantages for mobile communication system. Higher gain antenna improves the performance in the power consumption, coverage and sensitivity. However, for proper maximum coverage of a BTS in a cell, the azimuth angular separation of sector antennas has to be 120 degrees from each of the three sectors because they are directional antennas meaning that they transmit and receive signals in front of them and not behind or aside. All the three sector antennas are always installed on one mast for the purpose of collecting much more lower signals in return of the less coverage behind and on the sides.

To achieve maximum coverage during BTS installation, manual adjustments of these antennas are always made. Here one of the working team members has to stay down the tower with a compass direction to direct the one up while making adjustment in antenna positions so that they suit set angles or achieve the right azimuth. However, several problems have always been reported in the past years of BTS installation in Uganda and these include: Severe accidents that occur due to the falling of technicians from heights trying to make angular adjustments of antennas to suit calculated positions in the link budget. Inaccurate positioning of antennas that normally result into losses. Loss of money to the service providers caused by improper mounting of antennas that leads to network loss in some areas.

In order to overcome these challenges, the android based automatic sector antenna positioning system is able to automatically adjust sector antenna positions by use of rotational stepper motors interfaced to the microcontroller. Adjustments by the controller are based on the Control commands which are sent by mobile phone through Bluetooth to the receiver interfaced on the microcontroller.

1.3 OBJECTIVES OF THE STUDY.

1.3.1 Main objective.

To design and implement an android based automatic Antenna positioning system using Atmega328p microcontroller.

1.3.2 Specific Objectives

I. To detect initial angular parameters of the sector antenna using a magnetometer sensor.
II. To develop an android application that uses Bluetooth technology for sending direction, speed and angular parameters to the microcontroller.
III. To make adjustments in direction, speed and angular parameters by the use of a stepper motor.
IV. To sound an alarm when the set angle is achieved.
V. To display status of made adjustments on an LCD.

1.4 RESEARCH QUESTIONS.

I. How to detect initial angular parameters of the sector antenna using a magnetometer sensor.
II. How to develop an android application that uses Bluetooth technology for sending direction, speed and angular parameters to the microcontroller.
III. How to make adjustments in direction, speed and angular parameters by the use of a stepper motor.
IV. How to sound an alarm when the set angle is achieved.
V. How to display status of made adjustments on an LCD.

1.5 SIGNIFICANCE OF THE PROJECT

I. The Project is cost effective, efficient, pollution free and environment friendly since its operations do not involve release of any waste product.

II. In the long run the maintenance cost is very less when compared to the present systems.

1.6 SCOPE THE STUDY.

Geographical scope.

The system is designed for sector antenna proper positioning during BTS installations in Uganda for different service providers for example AIRTEL and MTN.

Content scope

In this project, the aim is designing and implementing an android based sector Antenna positioning system that is controlled by an android application to adjust sector antenna positions using stepper motors to achieve proper cell coverage. This system can be used in different antenna positioning but this time round it is focused on sector antenna positioning to achieve the set azimuth.

Time scope.

The whole process of design and implementation of an android based automatic sector antenna positioning using atmega328p is expected to take a maximum of four months.

CHAPTER TWO.

LITERATURE REVIEW

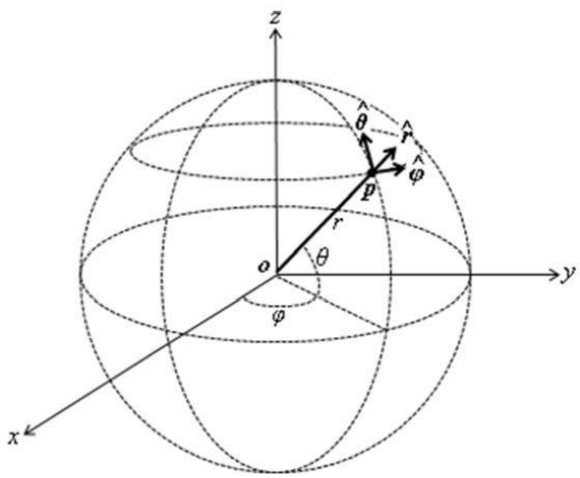
2.0 INTRODUCTION.

It is well known that wireless communication systems work on antennas for reception and radiation of signals. It is necessary to properly position the antennas in the direction of transmitter for effective wireless communication. This chapter summarizes all the related literatures about existing antenna positioning systems, concept of their operation, their limitation gaps and techniques used.

2.1 CONCEPTS, DEFINITIONS AND DESCRIPTIONS.

Antennas.

An antenna is the component of a radio system that transmits and/or receives radio signals via electromagnetic wave. All antenna parameters are expressed in the spherical coordinate system. The graphic presentation of the spherical coordinate system is shown in the figure below. The origin of the coordinate system is **o**. The coordinates of point **p,** are (r, Ɵ, Ø), where r is the radius distance, Ɵ is the elevation angle, and Ø is the azimuth angle.

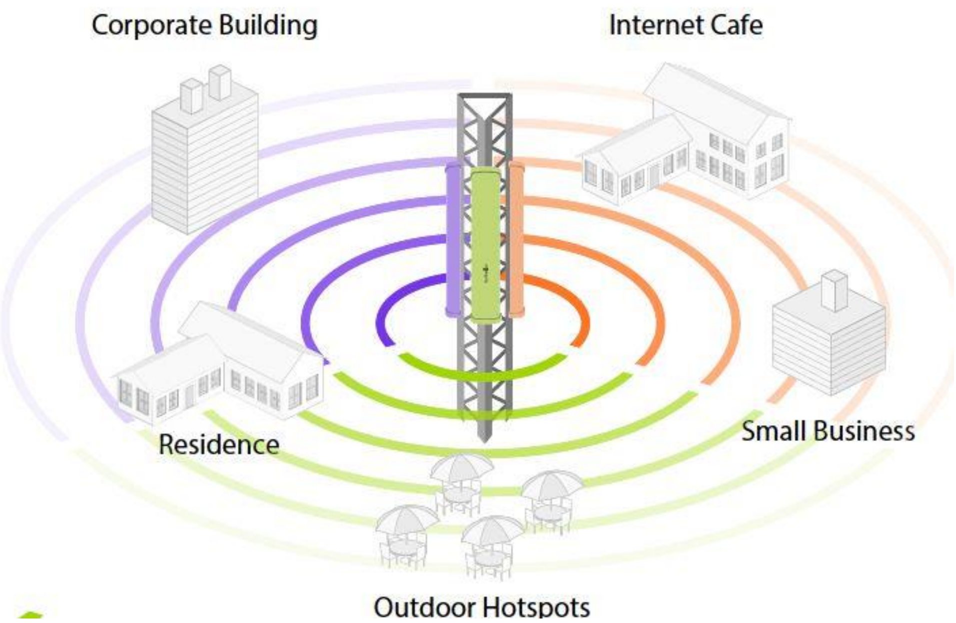


The azimuth angle.

The azimuth is the angle between a celestial body and the North, measured clockwise around the observer's horizon. It determines the direction of the celestial body. For example, a celestial body due North has an azimuth of 0º, one due East 90º, one due South 180º and one due West 270º.

Sector antenna.

A sector antenna is a type of directional microwave antenna with a sector-shaped radiation pattern. The word "sector" is used in the geometric sense; some portion of the circumference of a circle measured in degrees of arc. 60°, 90° and 120° designs are typical, often with a few degrees 'extra' to ensure overlap and mounted in multiples when wider or full-circle coverage is required. The largest use of these antennas is as antennas for cell phone base-station sites.



They are also used for other types of mobile communications, for example in Wi-Fi networks. They are used for limited-range distances of around 4 to 5 km.

Horizontal and vertical radiation patterns. The antenna radiates a horizontal fan-shaped beam, sharp in the vertical axis so it doesn't spill over into neighboring sectors.

At the bottom, there are RF connectors for coaxial cable and adjustment mechanisms. For its outdoor placement, the main reflector screen is produced from aluminum, and all internal parts are housed into a fiberglass Radom enclosure to keep its operation stable regardless of weather conditions.

Grounding is very important for an outdoor antenna so all metal parts are DC-grounded.

The antenna's long narrow form gives it a fan-shaped radiation pattern, wide in the horizontal direction and relatively narrow in the vertical direction. According to the radiation patterns depicted, typical antennas used in a three-sector base station have 66° of horizontal beam-width. This means that the signal strength at the ±33° directions is half (3 dB down) from its peak value at the center. At the ±60° directions, it is suggested to be a border of a sector and antenna gain is negligible there.

Vertical beam-width is not wider than 15°, meaning 7.5° in each direction. Unlike antennas for commercial broadcasting - AM, FM and television for example - which must achieve line-of-sight over many miles or kilometers, there is usually a downward beam tilt or down-tilt so that the base station can more effectively cover its immediate area and not cause RF interference to distant cells.

The coverage area, which is determined by the projection of the radiation pattern on the ground, can be adjusted by changing the down-tilt of the pattern. In some models this is done mechanically by manually adjusting the tilt of the antenna with an adjustable mounting bracket. In more recent sector antennas the pattern can be electronically tilted, by adjustable phase shifters in the feed of the individual dipole elements. These are adjusted by a remote control circuit from the ground, eliminating the need for a technician to climb the antenna tower.

2.2 RELATED LITERATURE.

Locally manual adjustments of the antenna positions is always done but several scientists from the past years have tried to come up with projects to simplify antenna positioning and these are as follows:

In March. 22 1994, Charles E. Rodeffer, Burlington,Iowa; John D. Byers, Arvada, Colo. Michael E. Rodeffer, Burlington and Iowa came up with a method for automatically

Positioning a satellite dish Antenna to satellites in a geosynchronous belt where a receiver connected to the satellite dish antenna receives signals from an electronic compass for generating a magnetic direction signal. The approximate latitude and longitude values of the parked vehicle are displayed and the user of the system manually selects the latitude and longitude coordinates corresponding to the parked vehicle location. The receiver determines an initial search position for the satellite dish antenna based upon the magnetic reading and the entered latitude and longitude values. The satellite dish antenna is moved from an unsowed.

In Sept. 13, 1994, Daniel Babitch, San Jose, Calif implemented an Automatic antenna pointing System based on global Positioning system (gps). Attitude Information. The system was for automatically pointing a directional antenna. The system comprised of two GPS antennas mounted at horizontally opposed extremities of the directional antenna, the placement was such that the GPS antennas lie on a line having a normal vector approximately parallel to a foresight of the directional antenna.

In Dec. 17, 1996, Charles E. Rodeffer, Burlington, Iowa proposed a method for automatically positioning a satellite dish Antenna to satellites in a geosynchronous belt. The system would automatically determines its location and bearing relative to two geosynchronous satellites and then uses this information to accurately calculate the azimuths and elevations of any other geosynchronous satellites. A magnetic compass generates a magnetic bearing signal for the system. An estimated latitude and longitude for the vehicle are provide by the user based on the approximate geographic location of the vehicle.

In Jan. 4, 2000, Benson Chuong, San Jose; Charles Barry, Campbell, both of Calif came up with a Satellite Dish Positioning System. The Signal generator would send a low frequency coded Signal to a display visible to a person who is adjusting the Antenna. The display provides a quantitative indication of the Signal Strength to the installer of the antenna, allowing precise adjustments to be made in accordance with the displayed value. The Signal generator provides the coded signal to the display via the same cable used to carry the received Signals from the antenna to a receiver, Such as a Set-top box.

In Feb. 20, 2001, Ruben Flores Dizchavez, Tucson, AZ (Us) implemented a Two-Antenna Positioning System for Surface-Mine Equipment where two GPS units were mounted at two separate points on the body of a work machine to periodically measure their three-dimensional coordinates with respect to a chosen reference system. As soon as two sets of measurements are recorded, a plane is through the four points so collected and it is used to determine the current orientation of the machine. As each additional set of position data is collected at predetermined intervals for the two points on the machine’ a new plane equation is Calculated to update the orientation of the machine based on a predetermined number of Prior measurements' standard deviate on analysis is used to check the validity of each plane calculation and the process is restarted When the deviation is found to be greater than an acceptable parameter. Based on the current coordinates of the two GPS antennae, the current orientation plane so calculated, and the known geometry of the Work machine, the current position of its critical components can be determined as Well irrespective of the specific motion pattern of the machine.

In Mar. 21, 2006, David J. Kuether, Brea, CA (US), Kesse Ho, and Westminster came up with an antenna positioning system and Method for simultaneous Reception of signals from a

Plurality of satellites. The system and method for positioning a dish antenna having a plurality of low noise block converters for the simultaneous reception of Signals from a plurality of Satellites in a direct broadcast Satellite System. An integrated receiver/ decoder alternately powers at least two low noise block converters to Sample signals for comparison to a threshold value to detect a peak signal for each of the low noise block converters. When the peak signals are detected, they are compared to a master threshold to indicate a master lock for the System.

In 2006, Amit Dvir, Yehuda Ben-Shimol, Yoav Ben-Yehezkel, and Michael Segal implemented an Automated Antenna Positioning for Wireless Networks. This article addressed a real-life problem which is obtaining communication links between multiple base stations sites. This is done by positioning a minimal set of fixed-access relay antenna sites on a given terrain. To minimize the number of relay antenna sites is considered difficult due to substantial installation and maintenance costs. Despite the potential significant cost saving by eliminating even a single antenna site, a hardly optimal manual approach is employed due to the computation complexity of the problem.
In September. 2009, Ian Sharp, Kegen Yu, Member, IEEE, and Y. Jay Guo, Senior Member, IEEE came up with GDOP Analysis for Positioning System Design. In this paper, GDOP analysis was performed to obtain concise analytical expressions for a number of scenarios, which are generally applicable to geometries where the mobile device is surrounded by base stations. Comparison of the analytical results with simulations using the typical geometries of indoor positioning systems shows good agreement, except when the mobile position is close to a base station. This effect is a consequence of the ranging errors being a significant proportion of the range in short-range tracking systems and discontinuities in

GDOP at the base station. The results provide useful information for the design and testing of tracking systems, as well as for the determination of the geometric deployment of base stations for good GDOP in the coverage area.

In Mar. 24, 2009, Larry A Nelson, Seattle, WA (US) implemented a Satellite Antenna Positioning System. The system and method for automatically positioning an antenna aperture on a mobile platform in a manner to avoid blockages created by other components/subsystems on the mobile platform between the line of sight of the antenna aperture and a satellite and to avoid interference with other systems that share the mobile platform. In one embodiment, one or more linear Support elements are moved by one or more corresponding motors to allow the antenna aperture to be re-positioned between a pluralities of different positions.

In august 2014, Surya Deo Choudhary, Pankaj Rai, Arvind Kumar, Irshad Alam Implemented a "microcontroller based wireless automatic antenna positioning system**"** that was primarily functioning to identify the source of signal. The signal may be of any type and any kind, it could automatically identify the presence of a particular signal and the antenna could remain stationary as long as the signal link is established. Whenever the signal could link break between the antenna and the satellite or source the antenna revolves continuously in search of the signal. This system also had advance connectivity with the monitor/LCD screen to indicate the antenna position.

In 2015, "Microcontroller Based Wireless 3D Position Control" by Amritha Mary A. S.1, Divyasree M V2, Jesna Prem2, Kavyasree S M2, and Keerthana Vasu was discussed on main application of using a dish is to receive signal from satellite or other broad casting sources. In order to position the dish to the exact angle to receive the maximum signal of a particular frequency it needs to be adjusted manually. To overcome the difficulty of adjusting manually, they proposed a system that could help in adjusting the position of the dish through an android application device.

In March. 2017, Prof. S. A Maske1 and Mr. Shelake Aniket Vishwasrao implemented a dish positioning by using IR remote. In this paper, microcontroller was designed to develop a dish positioning system which can be operated by using a remote control. The main point of using a dish is to receive signal from satellites and other broadcasting sources. In order to get the exact angle of position of the dish, it needs to be adjusted manually. In order to overcome the difficulty of adjusting manually, this paper helps in adjusting the position of the dish through a remote control. Remote control acts as a transmitter whose data is received by an IR receiver which is interfaced to a microcontroller. The remote control sends coded data to the receiver whose output is then sent to the microcontroller.

In December 2017, Robert A. Sowah, Godfrey A. Mills, Joseph Y. Nortey, Stephen K. Armoo and Seth Y. Fiawoo implemented an Automatic Satellite Dish Positioning for Line of Sight. The system would align the satellite receiver by mechanical means while allowing the user to interact with the system remotely to achieve a line of sight communication with the satellite source of interest. This paper proposes the design and development of a system which receives user specifications from an Android application via Bluetooth by either specifying the direction of orientation of the dish or selecting a satellite of interest.

On 21st - 22nd February, 2018, Jadhav Seema, Shejwalkar Rakshanda, and Andhale Jyoti implemented an automatic dish antenna positioning system that would rotate the dish using remote operation and automatically. The main aim of this project was to control a dish position automatically, which is capable of receiving the standard broadcast signals from the satellite. According to maximum signal strength dish will rotate automatically. It would rotate horizontal as well as vertical direction.

On May 1, 2018, Mark L. Psiaki, Brooktondale, NY Steven P. Powell, Ithaca, and Brady W. O'Hanlon, Ithaca proposed a methods and apparatus for detecting spoofing of global navigation satellite system signals using carrier phase measurements and known antenna motions. The system would detect GNSS spoofing attacks and that do not require explicit or implicit knowledge of exact position or attitude and that provide hypothesis test statistics, threshold values, and probabilities of false alarm and missed detection.

In 2018, Godse sharayu devidas, Khatale priyanka prakash, Nimgaonkar komal Kailas and prof. l.p.bhamare came up with an “android antenna positioning system” that could help in adjusting the position of the dish through a remote Control. Remote control acted as a transmitter whose data was received by the Bluetooth receiver which is interfaced to a Microcontroller of PIC 16F877A.

In March 2018, Rahane Suraj Dildar, Mhaske Shital Arun2, and Shingate Sujata Rajendra came up with the Design of Advanced Antenna Positioning System. The idea was to develop a system which would control the movement of the antenna in all direction. In order to overcome the difficulty of adjusting manually, this proposed system helps in adjusting the position of the antenna. Remote operation is achieved by any smart-phone with android OS. The different directions of the dish are attained by using two servomotors, one move in vertical and other in horizontal direction. The servo motor actions are controlled by the microcontroller.

In April 2018, Pooja Revane, Shradha Salaskar, Komal Shelke, Priyanka Tawar, and Akshata Raut implemented an IOT based Antenna Positioning System. The system would allow remote positioning of antennas based over IOT. Here in this system sensors will be mounted on the antenna to detect its direction and its direction will be changed by motors using IOT. When the direction of a transmitting station changes over time, the antenna direction must also be changed accordingly. This system will help in monitoring antenna direction and transmitting new coordinates to position the antenna. This system appropriately positions the antenna accordingly. So basically using this system we can wirelessly position antennas in the desired directions using IOT.

2.3 OBSERVATIONS IN THE MOST RECENT PROJECT.

I have learnt that Antenna positioning has been done in the above elaborated ways and the most recent project of implementing an IOT based antenna positioning system which would remotely position antennas based over IOT. Here the system accelerometer sensors were mounted on the antenna to detect its direction and its direction was changed by motors using IOT. When the direction of a transmitting station changes over time, the antenna direction would also be changed accordingly.

The system is an antenna monitoring GUI system which is remotely monitored and controlled. This system could help in monitoring antenna direction and transmitting new coordinates to position the antenna.

2.4 WEAKNESS OF RECENT PROJECTS.

The major challenge normally faced by technicians in remote areas where new BTS installation for respective service providers take place is unreliable network. And according to the most recent project, communication was done through a Wi-Fi routers that use the mobile network to receive commands from the computers of the management team which requires a stable network to control the project. It is well known that wireless communication can also be affected by weather changes for example heavy rains. So in such situations, the previous project may be affected by unnecessary delays caused by network unreliability.

As it is observed that the system is an antenna monitoring GUI system which is remotely monitored and controlled. This implies that it again requires someone to observe antenna position changes and send resend the required set angles. In the due course the system automation becomes weak since more labour cost is required for it to operate.

Dc motors rotate in specific angular directions where by making them turn in small angles become a challenge. Since they are the ones used in the most recent project, accuracy at its most is hard to achieve and the system can only be used for micro wave dishes and simple yagi-uda antennas.

2.5 ADVANCEMENT OF THE RECENT PROJECT.

The improved system can be operated in two different modes that is to say; manual mode that is mostly used during installations of antennas. This is facilitated by the android application where a user sends commands to turn antenna to required positions however, in this mode it will again requires a technician to set positions through the mobile application in case the set antenna position is forced to change by say heavy winds. On the other hand, when the system is set to auto mode which is always done after installation, it can be in position to restore its initial set position in case its forced to change position by un controlled weather conditions.

It is well known that stepper motors don't move, they step so this fact provides assurance to accuracy which is far better than that of the regular dc motor. In this case therefore, the improved system uses a stepper motor to turn the antenna in required positions.

CHAPTER THREE

METHODOLOGY

3.0 INTRODUCTION.

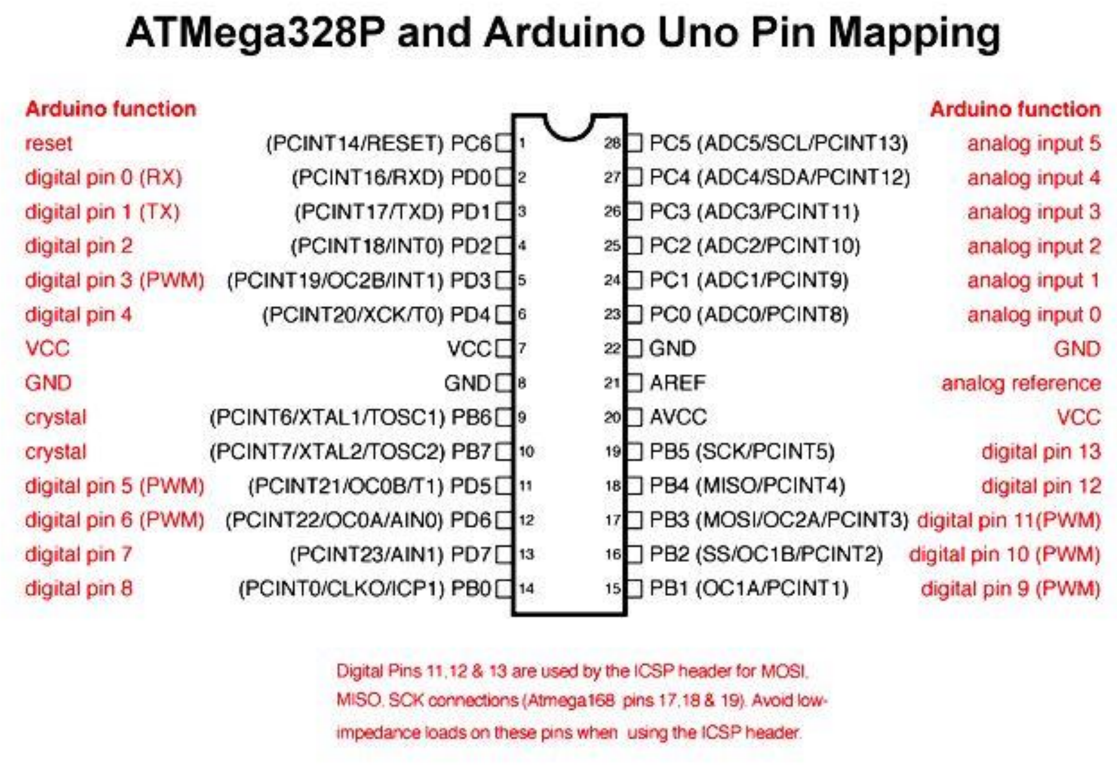
The high risks of unexpected dangerous accidents faced during the manual antenna positioning process call for immediate solutions of automatic systems that can do the same task without harm. A Low cost android based automatic antenna positioning system that can help in adjusting the positions of the sector antennas by rotational stepper motors interfaced with the microcontroller.

3.1 INSTRUMENTATION/ MAJOR COMPONENTS USED.

A microcontroller.

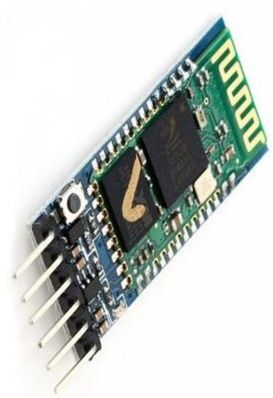
A microcontroller is a computer-on-a-chip used to control electronic devices. It is a type of microprocessor emphasizing self-sufficiency and cost-effectiveness, in contrast to a general-purpose microprocessor. A typical microcontroller contains all the memory and interfaces needed for a simple application. A microcontroller is a single integrated circuit with the following key features: Central processing unit - ranging from small and simple 8-bit processors to sophisticated 32- or 64-bit processors, input/output interfaces such as serial ports, peripherals such as timers, RAM for data storage, ROM, EEPROM or Flash memory for program storage, clock generator often an oscillator for a quartz timing crystal and resonator or RC circuit. This integration drastically reduces the number of chips and the amount of wiring and Printed Circuit Board (PCB) space that would be needed to produce equivalent systems using separate chips.

ATMEGA328P is high performance, low power controller from Microchip. ATMEGA328P is an 8-bit microcontroller based on AVR RISC architecture. It is the most popular of all AVR controllers as it is used in ARDUINO boards.



Bluetooth module (hc-05).

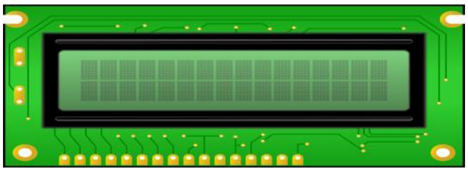
Bluetooth is one of the popular wireless communication technologies because of its low power consumption, low cost and a light stack but compensates on range. Having a connection between the Bluetooth module and the android application requires a smartphone with a Bluetooth and this can be checked by navigating the wireless networks under settings, the HC-05 Bluetooth transceiver. To use HC-05 module connections will be made i.e. VCC to 5V output of the circuit, GND to ground, RX to TX of the microcontroller and vice versa. Since RX pin is designed for 3.3v signals, a voltage divider will be used to ensure no damages are made to the Bluetooth module.



Liquid Crystal Display

An Lcd Jhd162a is a flat panel, an electronic visual display that uses the light modulating properties of liquid crystals. Liquid crystal does not emit light directly. The working of LCD depends on two sheets of polarizing material with a liquid crystal solution in between them. When an electric current is passed through the liquid, it causes the crystals to align so that it blocks out light and does not allow it to pass. Each crystal behaves like a shutter; it either allows light to pass through or blocks the light.

It can function properly in the temperature range of -10°C to 60°C and has an operating lifetime of longer than 50000 hours (at room temperature without direct irradiation of sunlight).



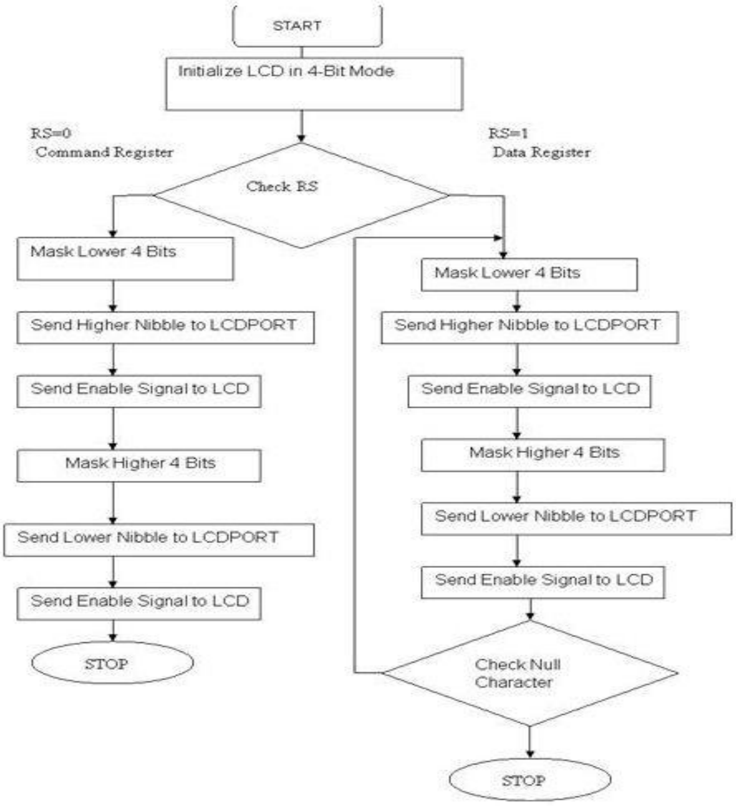
Mode operation of the liquid crystal display.

LCD in 4-Bit means 4 Lines of data bus are used instead of using 8 Line data bus. In this Method, Data is splinted in Nibbles. If a Microcontroller is successfully interfaced with LCD with 4 Pins. Then 4 Lines of Microcontroller can be saved, which pins can be used for other purpose.

LCD Pin Description in 4bit mode

Pin No	Symbol	I/O	Description
1	Vss	-	Ground
2	Vcc		+5V
3	Vee		Contrast Control
4	RS	Input	Command/Data Register
5	R/W	Input	Read/Write Register
6	E	Input/Output	Enable
7	DB0	Input/Output	Not Used in 4-Bit Mode
8	DB1	Input/Output	Not Used in 4-Bit Mode
9	DB2	Input/Output	Not Used in 4-Bit Mode
10	DB3	Input/Output	Not Used in 4-Bit Mode
11	DB4	Input/Output	Data Bus in 4-Bit Mode
12	DB5	Input/Output	Data Bus in 4-Bit Mode
13	DB6	Input/Output	Data Bus in 4-Bit Mode
14	DB7	Input/Output	Data Bus in 4-Bit Mode
15	Vcc	-	For LCD Back Light
16	Vss	-	For LCD Back Light

Flow chart of 4bit mode.



Buzzer system.

Buzzer is used for alerting purpose. It convert electrical energy into sound energy by using transistor and capacitor. It produces high frequency for hearing purpose.

When the required angle is achieved, the microcontroller takes quick action to activate or sound the alarm.

Magnetometer sensor.

The Honeywell HMC5883L is a surface-mount, multi-chip module designed for low-field magnetic sensing with a digital interface for applications such as low cost compassing and magnetometry. The HMC5883L includes a state-of-theart, high-resolution HMC118X series magneto-resistive sensors plus an ASIC containing amplification, automatic degaussing strap drivers, offset cancellation, and a 12-bit ADC that enables 1° to 2° compass heading accuracy. The I²C serial bus allows for easy interface.

Self-Test

To check the HMC5883L for proper operation, a self-test feature in incorporated in which the sensor is internally excited with a nominal magnetic field (in either positive or negative bias configuration). This field is then measured and reported. This function is enabled and the polarity is set by bits MS[n] in the configuration register A. An internal current source generates DC current (about 10 mA) from the VDD supply. This DC current is applied to the offset straps of the magneto resistive sensor, which creates an artificial magnetic field bias on the sensor.

Power Management

This device has two different domains of power supply. The first one is VDD that is the power supply for internal operations and the second one is VDDIO that is dedicated to IO interface. It is possible to work with VDDIO equal to VDD; Single Supply mode, or with VDDIO lower than VDD allowing HMC5883L to be compatible with other devices on board.

I²C Interface

Control of this device is carried out via the I²C bus. This device is connected to this bus as a slave device under the control of a master device which is a microcontroller.

This device is compliant with I²C-Bus Specification. As an I²C compatible device, this device has a 7-bit serial address and supports I²C protocols. This device supports standard and fast modes, 100 kHz and 400 kHz, respectively, but does not support the high speed mode. External pull-up resistors are required to support these standard and fast speed modes.

Activities required by the master (register read and write) have priority over internal activities, such as the measurement. The purpose of this priority is to not keep the master waiting and the I^2C bus engaged for longer than necessary.

I^2c Communication Protocol

The HMC5883L communicates via a two-wire I^2C bus system as a slave device. The HMC5883L uses a simple protocol with the interface protocol defined by the I^2C bus specification, and by this document. The data rate is at the standard-mode 100kbps or 400kbps rates as defined in the I^2C Bus Specifications. The bus bit format is an 8-bit Data/Address send and a 1-bit acknowledge bit. The format of the data bytes (payload) shall be case sensitive ASCII characters or binary data to the HMC5883L slave, and binary data returned. Negative binary values will be in two's complement form. The default (factory) HMC5883L 8-bit slave address is 0x3C for write operations, or 0x3D for read operations.

The HMC5883L Serial Clock (SCL) and Serial Data (SDA) lines require resistive pull-ups (Rp) between the master device (usually a host microprocessor) and the HMC5883L. Pull-up resistance values of about 2.2K to 10K ohms are recommended with a nominal VDDIO voltage. Other resistor values may be used as defined in the I^2C Bus Specifications that can be tied to VDDIO.

The SCL and SDA lines in this bus specification may be connected to multiple devices. The bus can be a single master to multiple slaves, or it can be a multiple master configuration. All data transfers are initiated by the master device, which is responsible for generating the clock signal, and the data transfers are 8 bit long. All devices are addressed by I^2C's unique 7-bit address. After each 8-bit transfer, the master device generates a 9^{th} clock pulse, and releases the SDA line. The receiving device (addressed slave) will pull the SDA line low to acknowledge (ACK) the successful transfer or leave the SDA high to negative acknowledge (NACK).

Per the I^2C spec, all transitions in the SDA line must occur when SCL is low. This requirement leads to two unique conditions on the bus associated with the SDA transitions when SCL is high. Master device pulling the SDA line low while the SCL line is high indicates the Start (S) condition, and the Stop (P) condition is when the SDA line is pulled high while the SCL line is high. The I^2C protocol also allows for the Restart condition in which the master device issues a second start condition without issuing a stop.

All bus transactions begin with the master device issuing the start sequence followed by the slave address byte. The address byte contains the slave address; the upper 7 bits (bits7-1), and the Least Significant bit (LSb). The LSb of the address byte designates if the operation is a read (LSb=1) or a write (LSb=0). At the 9^{th} clock pulse, the receiving slave device will issue the ACK (or NACK). Following these bus events, the master will send data bytes for a write operation, or the slave will clock out data with a read operation. All bus transactions are terminated with the master issuing a stop sequence.

I^2C bus control can be implemented with either hardware logic or in software. Typical hardware designs will release the SDA and SCL lines as appropriate to allow the slave device to manipulate these lines. In a software implementation, care must be taken to perform these tasks in code.

Mode of operation of the magnetometer.

This device has several operating modes whose primary purpose is power management and is controlled by the Mode Register. This section describes these modes.

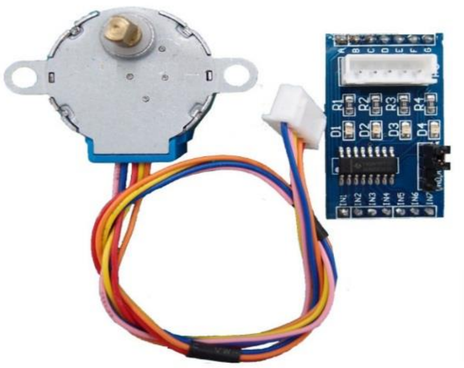
Continuous-Measurement Mode

During continuous-measurement mode, the device continuously makes measurements, at user selectable rate, and places measured data in data output registers. Data can be re-read from the data output registers if necessary; however, if the master does not ensure that the data register is accessed before the completion of the next measurement, the data output registers are updated with the new measurement. To conserve current between measurements, the device is placed in a state similar to idle mode, but the Mode Register is not changed to Idle Mode. That is, MD[n] bits are unchanged. Settings in the Configuration Register A affect the data output rate (bits DO[n]), the measurement configuration (bits MS[n]), when in continuous-measurement mode. All registers maintain values while in continuous measurement mode. The I^2C bus is enabled for use by other devices on the network in while continuous-measurement mode.

Stepper motor

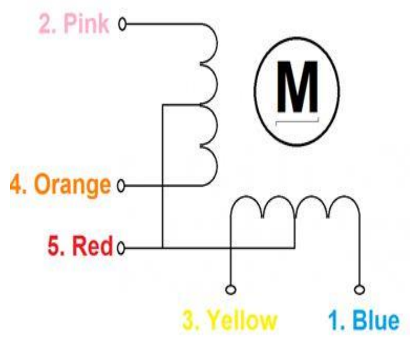
Stepper motors are increasingly taking its position in the world of the electronics. Starting from a normal Surveillance camera to a complicated CNC machines/Robot these Stepper Motors are used everywhere as actuators since they provide accurate controlling. In this project**,** 28-BYJ48 is used due to the fact that it is the most common/cheap available stepper motor 28-BYJ48. Unlike a normal DC motor this one has five wires of all fancy colors coming out of it.

First of all steppers motors do not rotate, they step and so they also known as step motors. Meaning, they will move only one step at a time. These motors have a sequence of coils present in them and these coils have to be energized in a particular fashion to make the motor rotate. When each coil is being energized the motor takes a step and a sequence of energization will make the motor take continuous steps, thus making it to rotate.



Mode of operation of the stepper motor.

Unlike a normal DC motor this one has five wires of all fancy colors coming out of it. First of all steppers motors do not rotate, they step and so they also known as step motors**.** Meaning, they move only one step at a time. These motors have a sequence of coils present in them and these coils have to be energized in a particular fashion to make the motor rotate. When each coil is being energized the motor takes a step and a sequence of energization makes the motor take continuous steps, thus making it to rotate.



It should be noted that it is a 5V Stepper motor since the Red wire energize with 5V. It is a four phase stepper motor since it has four coils in it. Now, the gear ratio is given to be 1:64. This means the shaft that seen outside makes one complete rotation only if the motor inside rotates for 64 times. This is because of the gears that are connected between the motor and output shaft, these gears help in increasing the torque.

Another important data to notice is the Stride Angle: 5.625°/64. This means that the motor when operates in 8-step sequence will move 5.625 degree for each step and it will take 64 steps (5.625*64=360) to complete one full rotation.

Calculating the Steps per Revolution for Stepper Motor.

It is important to know how to calculate the steps per Revolution for the stepper motor because only then it can be programed effectively.

In Arduino it is operating the motor in 4-step sequence so the stride angle will be 11.25° since it is 5.625°(given in datasheet) for 8 step sequence it will be 11.25° (5.625*2=11.25). Steps per revolution = 360/step angle. Here, 360/11.25 = 32 steps per revolution.

Data collection.

Experimental data collection method was used in this project. Experimentation normally involves the testing of a hypothesis about the relationship between the cause and an effect. In the natural sciences, this control is enhanced by use of a laboratory. Any change in the participant’s behavior should be the result of the change introduced by the experimenter.

3.2 METHODS USED

Examine the existing system

Experimentation:

This involves the deliberate manipulation of an intervention in order to determine its effects.

Reason why experimentation was used.

An experiment may compare a number of interventions with each other, or may compare one (or more) to a control group

Issues of generalizability (often called ‘external validity’) are usually important in an experiment, so the same attention must be given to sampling, response rates and instrumentation as in a survey (see above). It is also important to establish causality (‘internal validity’) by demonstrating the initial equivalence of the groups (or attempting to make suitable allowances), presenting evidence about how the different interventions were actually implemented and attempting to rule out any other factors that might have influenced the result.

3.3 DEVELOPING A NEW IMPROVED SYSTEM.

Experimentation:

This involved the deliberate manipulation of an intervention in order to determine its effects.

Reason experimentation was used.

An experiment may compare a number of interventions with each other, or may compare one (or more) to a control group

Issues of generalizability (often called ‘external validity’) are usually important in an experiment, so the same attention must be given to sampling, response rates and instrumentation as in a survey. It is also important to establish causality (‘internal validity’) by demonstrating the initial equivalence of the groups (or attempting to make suitable allowances), presenting evidence about how the different interventions were actually implemented and attempting to rule out any other factors that might have influenced the result.

Testing/validating the developed system Experimentation:

This involved the deliberate manipulation of an intervention in order to determine its effects.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 INTRODUCTION

As stated previously in the initial chapters, this project uses Bluetooth technology to communicate between the transmitting section and the receiving section. The transmitter section is used for sending commands on the receiver section which is the microcontroller. A microcontroller is fed with a code to control movements of the stepper motor being used in system build up. In this chapter, the process of the project buildup and the results are discussed.

4.1 RESULTS

System design.

The system is designed with the use of a combination of tools. These tools are categorized as hardware tools and software tools as elaborated below:

Hardware System Components

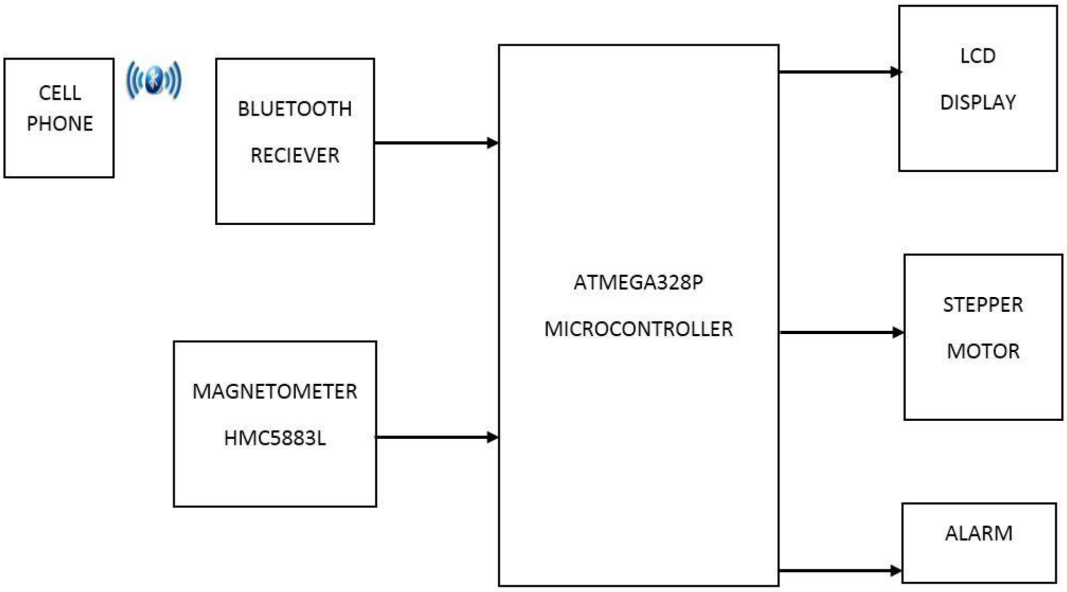
- Voltage Regulator LM7805.
- Microcontrollers ATMEGA328P.
- LCD JHD16X2A.
- Power supply section which contains a transformer, rectifier, filter, regulator which ensures a constant +5V.
- HC05 Bluetooth module.
- Magnetometer sensor.
- Smart phone.
- Crystal oscillator.
- Ceramic capacitors.
- Potentiometer
- Male to female jumpers.
- Metallic casing.
- Semiconductor diodes.
- Terminal blocks.
- Capacitors.
- Resistors.

Software

- Proteus
- Arduino IDE.

4.2 CONCEPTUAL DESIGN/BLOCK DIAGRAM.

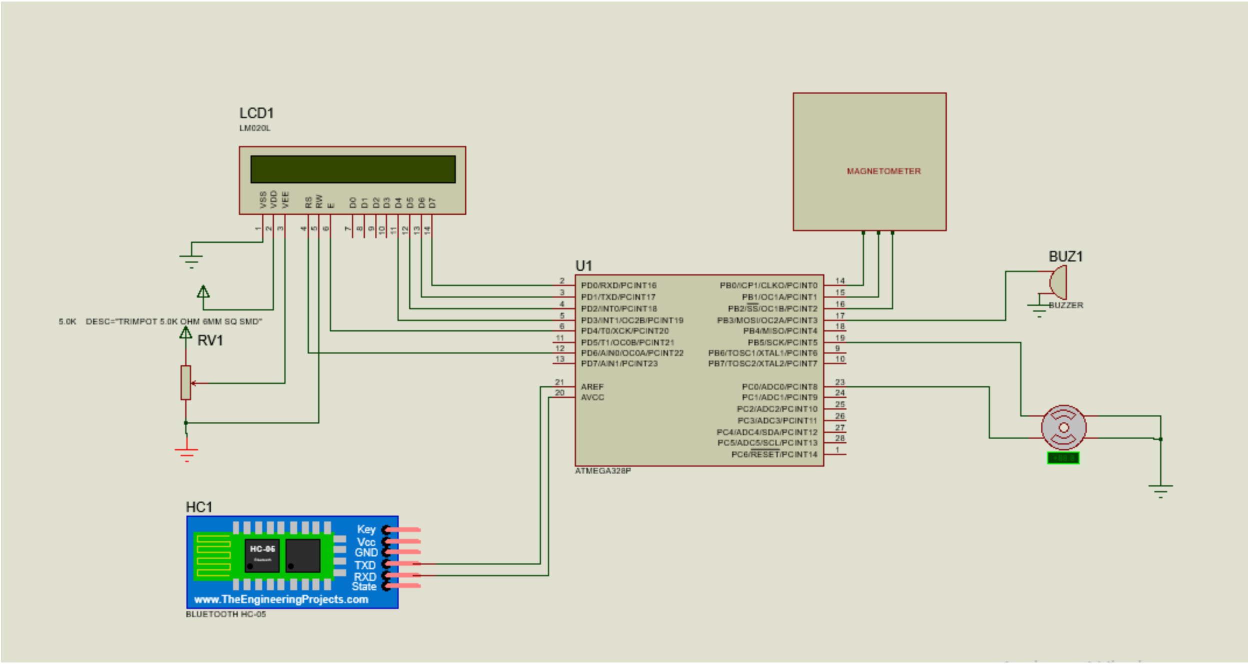
The block diagram consists of the cell phone, Bluetooth module, magnetometer, liquid crystal display, stepper motor, microcontroller and the alarm as shown below



4.3 WORKING PRINCIPAL OF THE PROJECT.

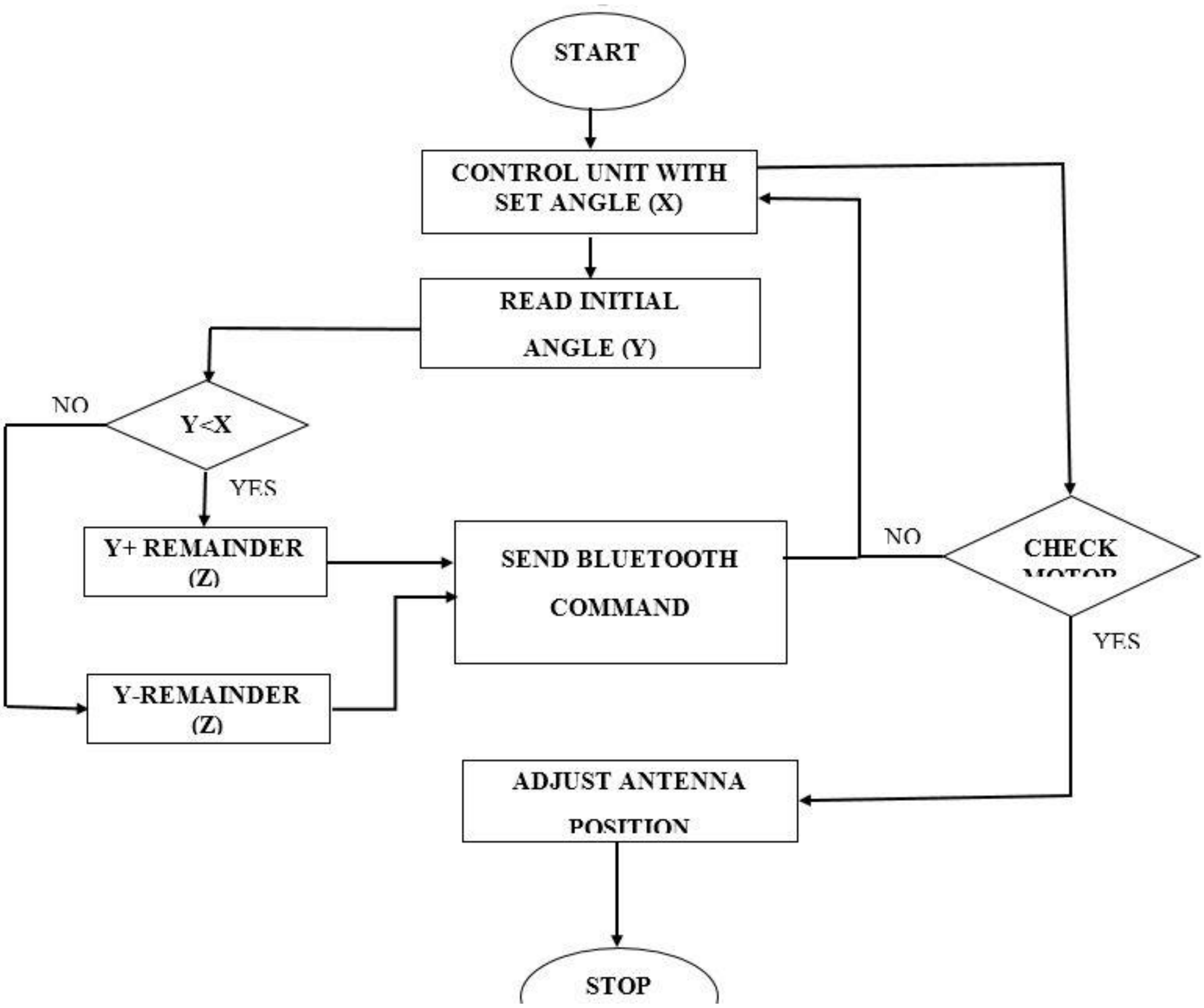
The project uses a Honeywell Hmc5883l series magneto-resistive sensors that enables 1° to 2° compass heading accuracy which is used to detect the actual direction of antennas mounted on the cell phone tower. This uses I^2C serial for easy interface. When hoisting of sector antennas is done durig BTS installation process, the next step becomes mounting the antennas on poles and finally finding the right azimuth for the antennas. Initial direction readings in degrees are provided by the magnetometer sensor which the user bases on to send commands through the mobile phone app for adjustments made by the stepper motor. Direction information is displayed on the liquid crystal display for easy monitoring.

CIRCUIT DIAGRAM.



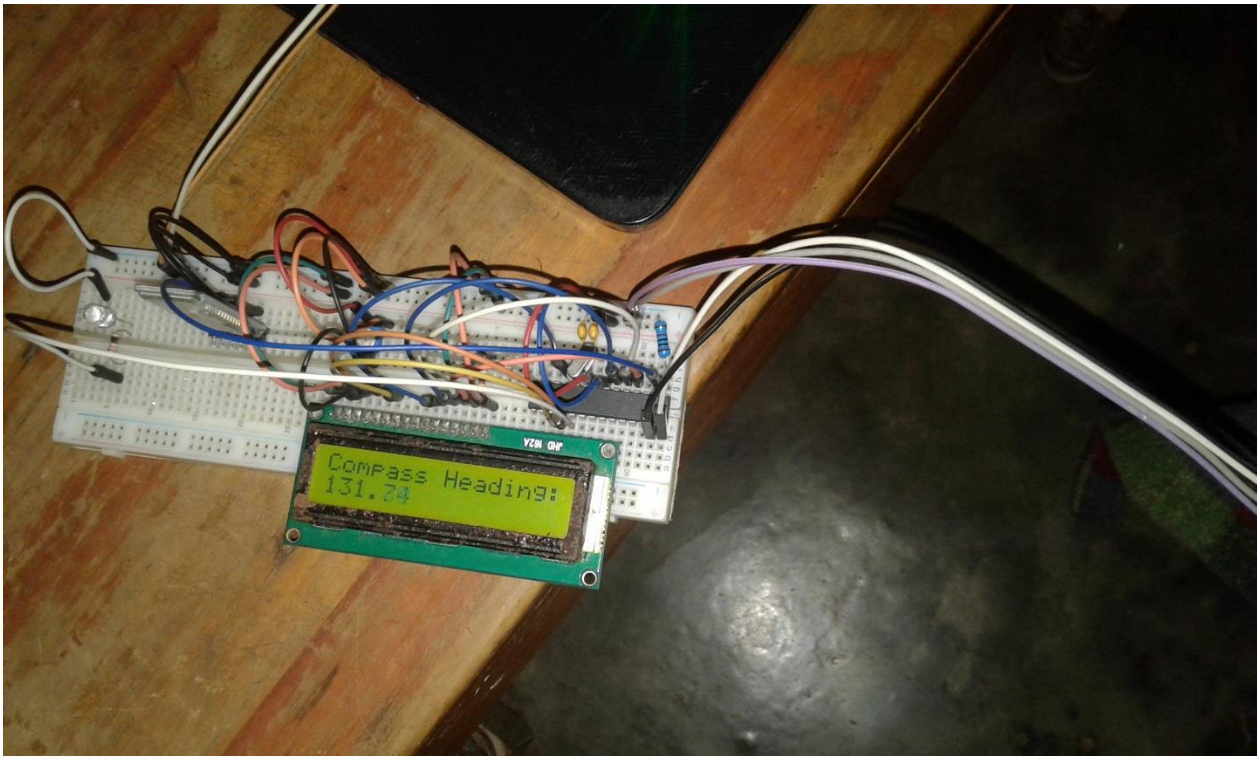
4.4 SYSTEM PROGRAMMING

All these functions were coordinated by a C code running in an Integrated Development Environment called Arduino. This software uses a programming board called Arduino Uno which programs AVR microcontrollers like ATMEGA32. The figure below shows the flow of the program.



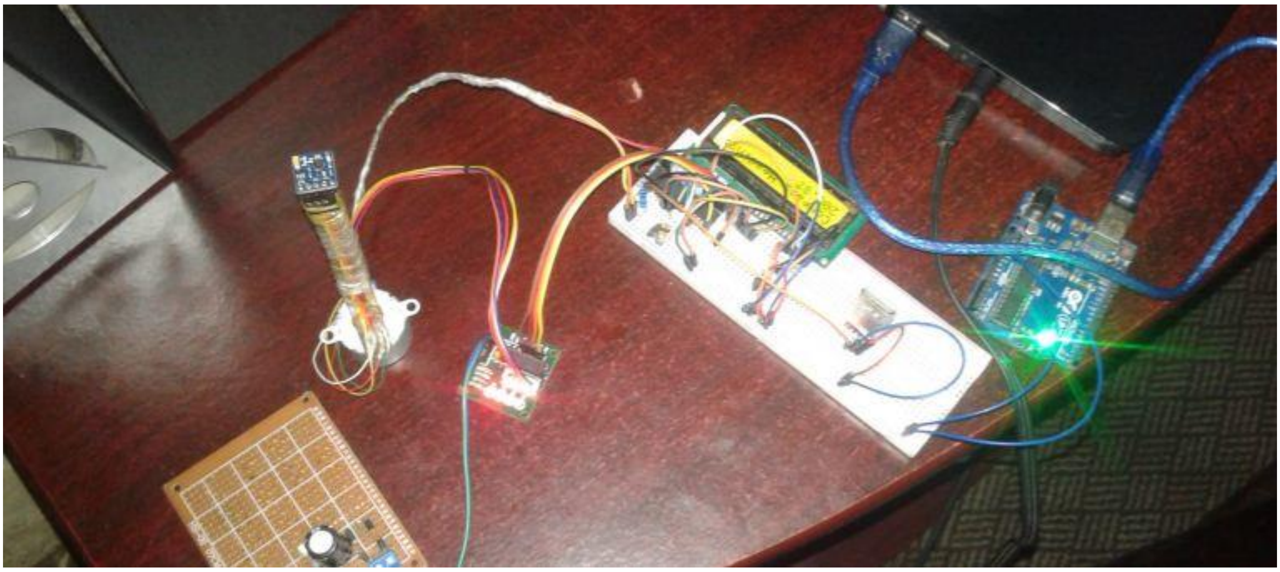
Breadboard components assembling.

Here, all components are first assembled on the breadboard, and the concept of the project operation tested before finally transferring the components to a printed circuit board (PCB).



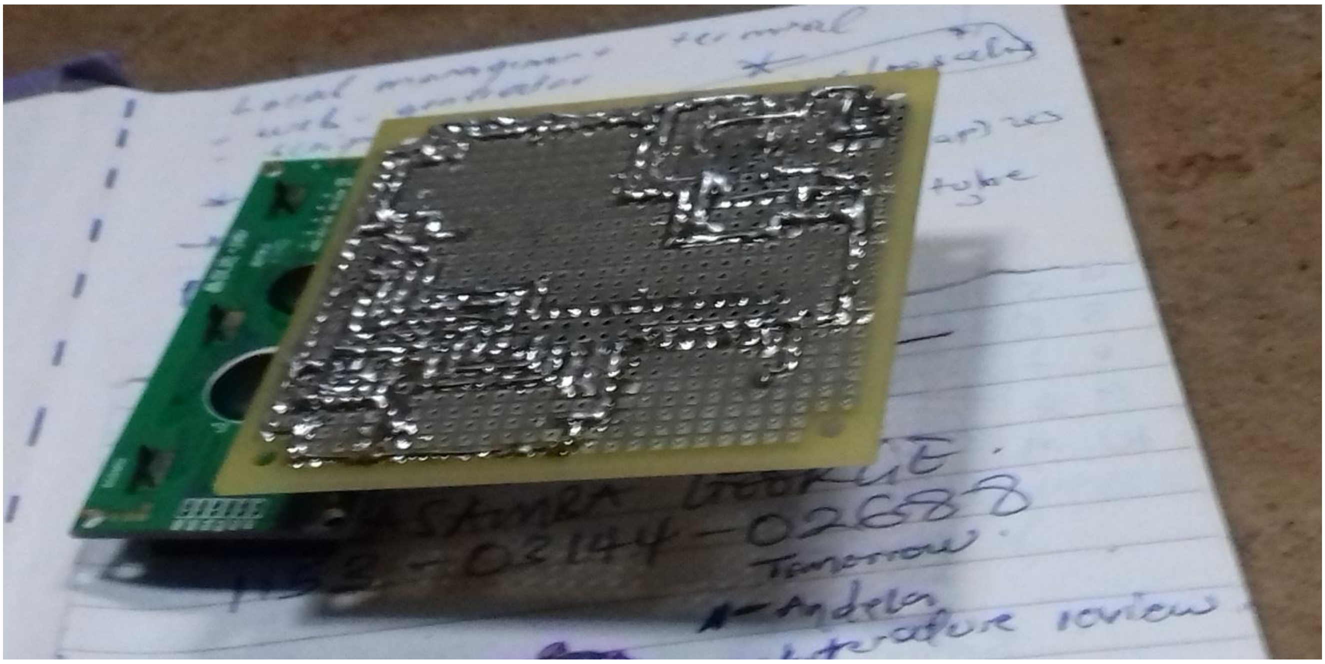
Breadboard results.

The results were positive as all components performed their tasks as expected, right from the +5v power source tapped from the laptop with the aid of Arduino Uno power cable (USB), through the board to all other components.



Soldering on printed circuit board.

This involved, placing components on a PCB and soldering them on with the aid of a soldering gun and lead. This marked a strong continuous outline of the circuit whereby all components were connected from point to point, from Vcc to ground and microcontroller connections.



Precautions Were Taken While Soldering.

- Keeping the heated/hot soldering gun tip away from body contact.
- Placing the hot soldering gun on a stand to prevent it from burning surrounding stuff.
- Ensuring the gun doesn’t burn the components as a result of overheating

Continuity testing.

After soldering was done, the continuity test was crucial for testing whether a line was continuous from one point to another and also to ensure there are no short circuits as a result of continuity between Vcc and ground.

Results on PCB.

A successful continuity test gave a go forward to power the circuit and hence all components successfully performed as anticipated.

CHAPTER FIVE

RECOMMENDATIONS AND CONCLUSION

5.1 CONCLUSION.

In this project, the system proves to be a best suit for the positioning and monitoring of directions of sector antennas mounted on cell phone towers to ensure proper coverage and network reliability. It was tested several times and its performance was perfect.

5.2 RECOMMENDATIONS.

I recommend people should stop using the previous version of manual adjustments to prevent accidents and use the developed new improved version of the system.

5.3 FUTURE SCOPE.

The following features can be added to this project design in the future.

The possibility of the project being able to detect changes in the set angles uses the cameras to take photos of the tower antennas and sends to the management team for critical analysis of the changes in direction.

Wireless control of the mechanical down-tilt with synchronous communication of the antenna positions to eliminate the burden of adjusting the tilt during antenna setup process.

In future the android based sector antenna positioning system can be advanced in a way that it records set positions and keep on reporting the cause of angular changes to the management team. In this way the system can also be remotely controlled to swap operational modes for example the automatic mode where by the system automatically restores the antenna position in case angular changes are detected.

CHAPTER SIX

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APPENDICES

Appendix A: source code.

```
#include <Wire.h> //I2C Arduino Library
#include <LiquidCrystal.h> //LCD Library
#include <Stepper.h> // Include the header file

#define STEPS 32
#define addr 0x1E //I2C Address for The HMC5883

Stepper stepper(STEPS, 4, 6, 5, 7);// create an instance of the stepper class using the steps
and pins
int val = 0;//setting the iniatial value for val

LiquidCrystal lcd(8, 9, 10, 11, 12, 13);
//char junk;
//String inputString="";

void magnetometor()
{
  int x,y,z; //triple axis data

  //Tell the HMC what regist to begin writing data into
  Wire.beginTransmission(addr);
  Wire.write(0x03); //start with register 3.
  Wire.endTransmission();



 //Read the data.. 2 bytes for each axis.. 6 total bytes
  Wire.requestFrom(addr, 6);
  if(6<=Wire.available()){
    x = Wire.read()<<8; //MSB  x
    x |= Wire.read(); //LSB  x
```

```
    y = Wire.read()<<8; //MSB y
    y |= Wire.read(); //LSB y
  }

float Pi = 3.14159; // Calculate the angle of the vector y,x
float heading = (atan2(y,x) * 180) / Pi; // Normalize to 0-360
if (heading < 0)
{
    heading = 360 + heading;
}
   lcd.clear();
   lcd.setCursor(0,0);
   lcd.print("Antenna position: ");
   lcd.setCursor(0,2);
   lcd.print(heading);
   lcd.print(char(223));
   delay(250);
lcd.clear();

 if (Serial.available()>0)
  {

    lcd.print("Turning antenna");
     val = Serial.parseInt();
    stepper.step(val);
    delay(1000);
    lcd.clear();
  }
  else
  {
   lcd.setCursor(0,0);
   lcd.print("Antenna position: ");
   lcd.setCursor(0,2);
```

```
   lcd.print(heading);
   lcd.print(char(223));
  }
}
void scroller()
{
    lcd.setCursor(0,0);
  lcd.print("SECTOR ANTENNA");
  lcd.setCursor(0,2);
  lcd.print("POSITIONER..");

   // scroll 13 positions (string length) to the left
  // to move it offscreen left:
  for (int positionCounter = 0; positionCounter < 13; positionCounter++) {
    // scroll one position left:
    lcd.scrollDisplayLeft();
    // wait a bit:
    delay(250);
  }

  // scroll 29 positions (string length + display length) to the right
  // to move it offscreen right:
  for (int positionCounter = 0; positionCounter < 29; positionCounter++) {
    // scroll one position right:
    lcd.scrollDisplayRight();
    // wait a bit:
    delay(250);
  }

  // scroll 16 positions (display length + string length) to the left
  // to move it back to center:
  for (int positionCounter = 0; positionCounter < 16; positionCounter++) {
    // scroll one position left:
    lcd.scrollDisplayLeft();
```

```
    // wait a bit:
    delay(250);
  }

  // delay at the end of the



delay(5000);
lcd.clear();
}
void setup()
{

  Serial.begin(9600);
  lcd.begin(16,2);

scroller();

  stepper.setSpeed(200);//set speed for the stepper motor
  Wire.begin();//begin the I2C



  Wire.beginTransmission(addr); //start talking
  Wire.write(0x02); // Set the Register
  Wire.write(0x00); // Tell the HMC5883 to Continuously Measure
  Wire.endTransmission();
}



void loop()
{
  for(;;)
  {
    magnetometor();//compass direction
```

Appendix B: Gantt chart showing the Project Timeline

Table 1 showing the project timeline

ANDROID BASED AUTOMATIC SECTOR ANTENNA POSITIONING	**MAY**	**JUNE**	**JULY**	**AUG**
DEFFENDING PROPOSAL				
SIMULATION				
GATHERING OF COMPONENTS				
DESIGNING A PROGRAM				
PUTTING TOGETHER HARDWARE COMPONENTS				
TEST				
IMPLEMENTATION				
PRESENTATION				

Appendix C: Project Budget

Table 2 showing project budget

Item No.	Item Description	Type	Quantity	Unit Price UGsh	Total Cost UGsh
1	Microcontroller Embedded Module Board	ATMEGA328P	1	50,000	50,000
2	Bluetooth module		1	40,000	40,000
3	magnetometer	HMC5883L	1	50,000	50,000
4	Buzzer	ION 820	1	5,000	5,000
5	Reset Bottom Switch	Digital	1	1,000	1,000
6	Light Emitting Diodes (LED's)	RED	1	500	500
7	Voltage Regulator	7805V	2	5,000	10,000
8	Diodes		8	1,000	8,000
9	Capacitor		6	1,500	9,000
10	LCD Module		1	40,000	40,000
11	Bolts and Nuts		20	100	2,000
12	Stepper motor		1	80,000	80,000
13	transformer		1	30,000	30,000
			Total		**375,500**