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PROTOTYPE OF AUTOMATED SIGNAL STRENGTH LOCATOR FOR TV ANTENNA

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Highlights

- The prototype employs automatic scanning by rotating 360° counter-clockwise then clockwise with an inclination of 45°. The signal strength finder sensor determines the value of the signal strength of the TV Antenna and then interpreted by the microcontroller. The servo motor provides an inclination for the device. If the signal strength at zero-degrees (0°) inclination is greater or equal than the 45° inclined, the EasyDriver triggers the stepper motor to rotate counter-clockwise, maintaining the zero degrees (0°). Otherwise, the EasyDriver triggers the stepper motor to rotate counter-clockwise with an inclination of 45°.
- Manual scanning involves the user to determine what location has better clarity. Saving the desired position can be done by pressing the number button from 0-9 of the remote control. Repeat the process until all channels have their positions stored. Press the exit button when completed. After storing some data, channel selection includes the pressing of the number button to which the data had saved, and the stepper motor rotates accordingly. The user has an option of inclination. Zero-degrees (0°) is the default elevation.
- Ten (10) consecutive trials with a series of nine (9) different TV stations were being carried out to show the functionality testing of the TV Reception Accuracy. Results showed that during the ten (10) trials, the signal strength locator accuracy and the motor control positioning was successful.

Abstract

Televisions often require rooftop antennas directed to receive optimum signal strength. This study underscores the development of a prototype of Automated Signal Strength Locator for TV Antenna capable of finding the highest signal strength value. The researchers have also included an algorithm for manual scanning by storing the desired position of the best reception. The design includes two sensory nodes (such as SF95DT Digital Video Broadcasting – Terrestrial Finder sensor and Infrared Receiver module sensor) in gathering relevant measures and two motors (such as Stepper Motor (Nema 17) and Servo motor (MG995 Tower Pro)) for the control system. The design mechanism employs one revolution, each at given two elevations, which are 0 and 45. The microcontroller compares the obtained values, and stores the position with the highest signal strength value as the final direction of the antenna. Ten (10) consecutive trials were performed to gather data. With manual-scanning, 3 out of 9 different TV stations achieved an excellent number-of-success of 10 out of 10, the remaining six (6) TV stations also did an acceptable average of 8 number of successes. Auto-scanning takes 1-2 minutes before reaching the interpreted location. Function tests showed a consistent level of accuracy in locating the highest signal strength through automatic scanning. With the result and analysis of the data gathered, proponents have proven that the signal strength location accuracy and motor control positioning were successful. This innovative device is recommended to lessen the burden of continuous manual adjustment of the antenna households, and most especially to those homeowners that are far away from the broadcast towers.

Key Words: Signal Strength; Arduino Uno; Auto-scanning; SF95DT DVB-T; Manual Scanning; Control System

1. Introduction

TV antennas can be challenging to determine its proper reception for the best quality image. Given identical broadcast conditions, a digital TV signal does not travel as far as an analog TV signal because of earthbound constraints. Torres (2016) stated that things affect reception include roof, wall, hills, trees, and the wind. A digital signal is so sensitive that an individual that is walking ahead of it may knock it offline. In comparison, an analog signal is quite a roach. It's going to take over somebody ambling around of the antenna to drop the signal. Johan (2016) states that the antenna position is a factor in getting a better reception within a satisfactory spot. Finding the right orientation for the TV antenna makes an effort to discern out. In most instances, the higher the height of the antenna, the better the reception. However, fixing the azimuth for the antenna could not work for some. The development of a prototype of an automated signal strength locator for TV antenna allows aid in optimizing the better reception of television broadcast signals with less hustle and effort.

Conducted studies exist in the design of a control system for signal strength locator device. They were designed to automatically locate or track a satellite by using appropriate motors, tracking algorithms, and compatible drives. Kurtulan et al. (2009) study accomplished to automatically point Direct Current (DC) servo motor driven parabolic antennas to moving targets, notably in satellite tracking, to maintain the desired line of sight for quality communication. Lee et al. (2003) affirmed that a step-tracking controller is one of the conventional tracking controllers that operate by regularly jogging the antenna up/down and clockwise/counterclockwise for re-positioning to the point of maximum signal reception. Woodford (2017) discussed that stepper motors are different from dc motors, and once stepper motor rotated through a particular angle, it could stay still in that precise location. This feature is sometimes called holding torque or cogging torque. Emartee (2017) states that EasyDriver requires a 7V to 30V supply to power the motor and can power any voltage of the stepper motor. Voltage and torque have a directly proportional relationship at high speeds. The EasyDriver has an onboard voltage regulator for the digital interface and set to 5V or 3.3V.

From 150mA/ phase to 750mA/phase is the adjustable current control of this driver. Very High Frequency (VHF) and Ultra High frequency (UHF) is the range of broadcasting television stations. Antenna Theory (2009) says that Yagi-Uda antennas contain a high gain, generally better than ten (10) decibel(dB) and usually function within the HF to UHF bands (about three (3) MHz to three (3) GHz). To develop a program that can support the automated signal strength for a TV antenna includes which language to use for programming. The Arduino Uno hardware has a language based on basic C++, which has a processing-based Arduino software Integrated Development Environment (IDE) (D'Ausilio, 2012).

Systems of the related studies require much cost and complexity to the user. Designing a smaller footprint allows the creation of a more straightforward system that could save time, not take much effort and energy, and ease their work in adjusting the TV antenna.

The general objective of this study is to develop a prototype automated signal strength locator for a TV antenna. The specific objectives are as follows: (1) to design a control system for signal strength locator device; (2) to construct a circuit according to the design; (3) to develop a program that will drive the device; (4) to conduct and test the reception accuracy, motor control positioning, and signal strength location accuracy; (5) to present the cost of the Prototype of Automated Signal Strength.

The outcomes from this study will offer an improved TV reception from the antenna which will be remotely controlled by the use where the consumers that are far away from the towers are the primary concern. Also, the study can be a baseline for future developments in automated signal strength locator.

The focus of this study is to locate the highest signal strength value and adjust TV antenna's position; manually or automatically. To beat several of disturbances regarding control system, the researchers used a gyro sensor device that has a three (3) axes such as Yaw, Pitch, and Roll. To respond instantly to the disruption, proponents designed the two-axis motor with a purpose of controlling the precise location of the system. Also, the researchers programmed a circle tracking algorithm and applied it to the system. The proponents set some conditions to follow such as 1, 550 steps of the stepper motor is equivalent to the actual 360° scan rotation of the device; the full scale of the signal strength meter would equal to the maximum analog data (1023) which has read by Arduino Uno. Limit switch was put for the indication of the full rotation of the device. This research is intended for those who are not capable of doing a heavy-duty workload which is to climb up and down to adjust the antenna's position for better reception manually. Do not let the device get wet hence using the prototype on rainy days is not recommended. Even with such limits, researchers can reassure to consumers that the quality of the device can still be high-end.

2. Methods

2.1 Conceptual Framework

The system starts with the trigger points of the mechanism, as shown in Fig. 1. The main inputs are the signal strength and position, and with the others, the device meets its expected outcome. A single-board computer carries out the pre-processing and the interpretation of the received signal strength and position. After the interpretation of variables, the TV Antenna is positioned automatically by a control system towards the best signal reception.

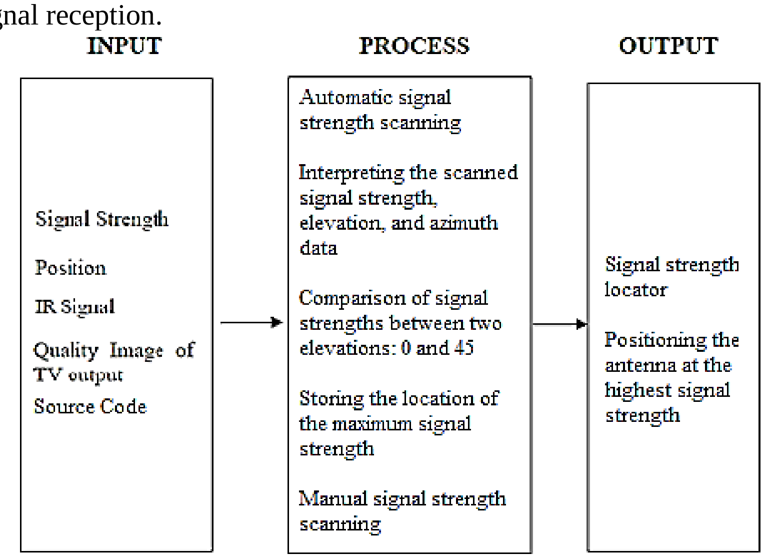

Fig. 1. Conceptual framework.

2.2 Design and Construction

The design and construction of this study started with the hardware layout that includes the schematic diagram and physical structure. After which is the coding of the microcontroller for its control system.

The focal part of the hardware is the signal strength locator device and control system. Hence, in creating the signal strength locator device and control system, the maximum measurement of the signal strength read by the microcontroller must be equal or directly proportional to the signal strength finder sensor. After building the schematic design, the researchers created a program that is responsible for the whole operation of the mechanism. The code programmed in the microcontroller must control all the components present in the device, and the circuit and the program should work together to get the desired output.

2.3 Functional Diagram

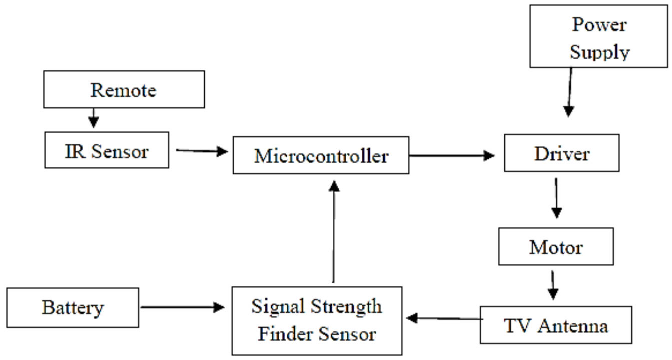

Fig. 2. System Design.

As shown in Fig. 2, an infrared (IR) remote control sends information and goes to the IR receiver. The microcontroller, which is Arduino Uno, processes the received signal and acts as the brain of the device. After diagnosing the data, a control system consists of a stepper and servo motor does the movement of the antenna to the desired position. EasyDriver triggers the stepper motor for the antenna's azimuth rotational motion, which is from 0° to 360° and requires a 12V DC supply. The microcontroller controls the elevation of the servo motor and is programmed capable of an inclination of 0° and 45°. Automatic signal strength locator includes a signal strength sensor that requires a 9V DC battery supply working with the control system. Input to the microcontroller is the acquired signal strength and location for processing and interpretation. The output, therefore, drives the control system for the final position of the antenna towards the highest signal strength.

The processes discussed above would result in a better reception for the TV.

2.4 Schematic Diagram

The second objective of this study is to construct a circuit according to the design. In this section shows the whole circuitry of the research study.

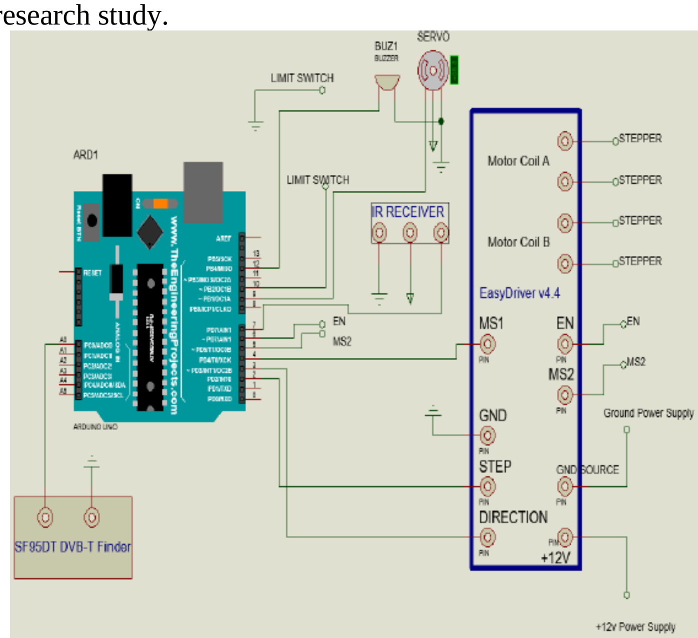

Fig. 3. Arduino Uno with the Over- all Circuitry for signal strength locator.

Fig. 3 is the over circuitry of the signal strength locator of the device. It consists of an IR Receiver, SF95DT Digital Video Broadcasting – Terrestrial (DVB-T) Finder, EasyDriver v4.4, Buzzer, Stepper Motor, Servo Motor, Arduino Uno and a simple limit switch.

2.5 Physical Structure

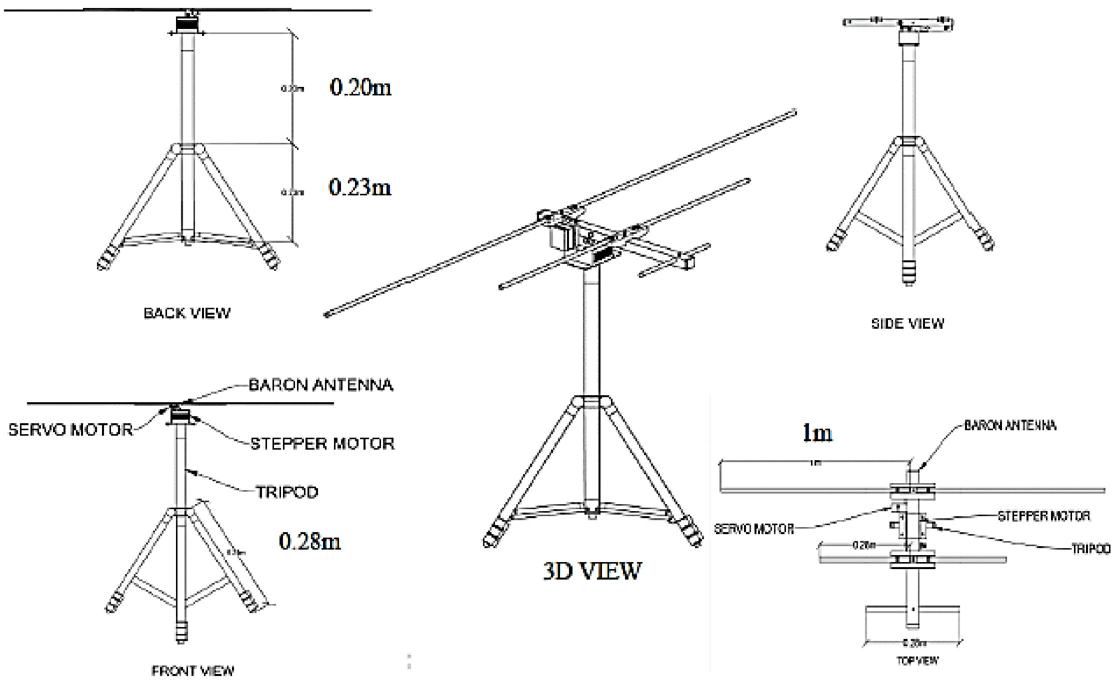

Fig. 4. 3D design with dimension.

Shown in Fig. 4 is the 3D design and dimension of the prototype of an automated signal strength locator for a TV antenna. A 0.43-meter high tripod holds the entire device. The design implements a Baron Antenna with a 2-meter reflector, one 0.28-meter director, and a 0.56-meter dipole as the driven element. The three elements are constructed equally spaced by 0.112 meters. The Baron Antenna mounted over the NEMA 17 Stepper Motor and MG995 Tower Pro Servo Motor.

2.6 Control System

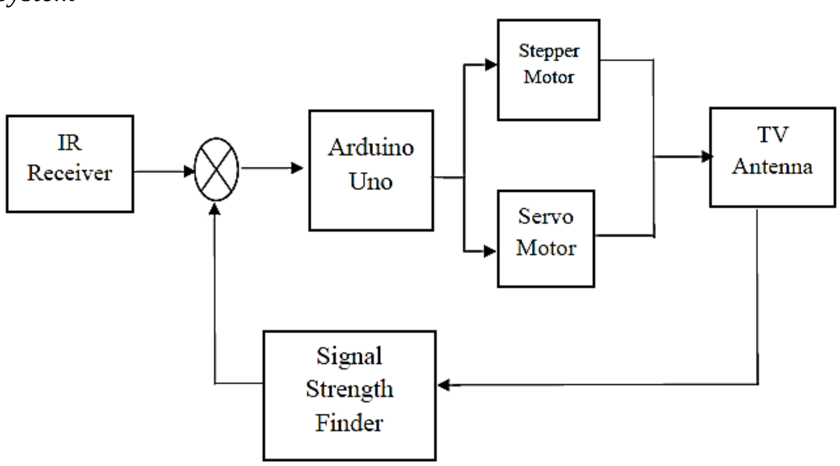

Fig. 5. Transfer Function for the control system.

Fig. 5 shows the control system of the entire device. The IR Receiver and the Signal Strength finder functions as the input of the mechanism. They are responsible for gathering the data to be interpreted by the microcontroller, which is the Arduino Uno. The Arduino Uno serves as the head control of the system. It was programmed to decode data and to control the stepper motor and servo motor to perform its designated tasks. Those two motors are responsible for locating the highest signal strength with a rotation of 360° counter-clockwise and clockwise for the stepper and inclination for the servo motor. The output of the system is the stepper motor and the servo motor.

2.7 Process Flow Diagram

This section shows the flow diagram of the whole system. The researchers have created an algorithm to serve as the user's guide from start to finish.

Auto-scanning

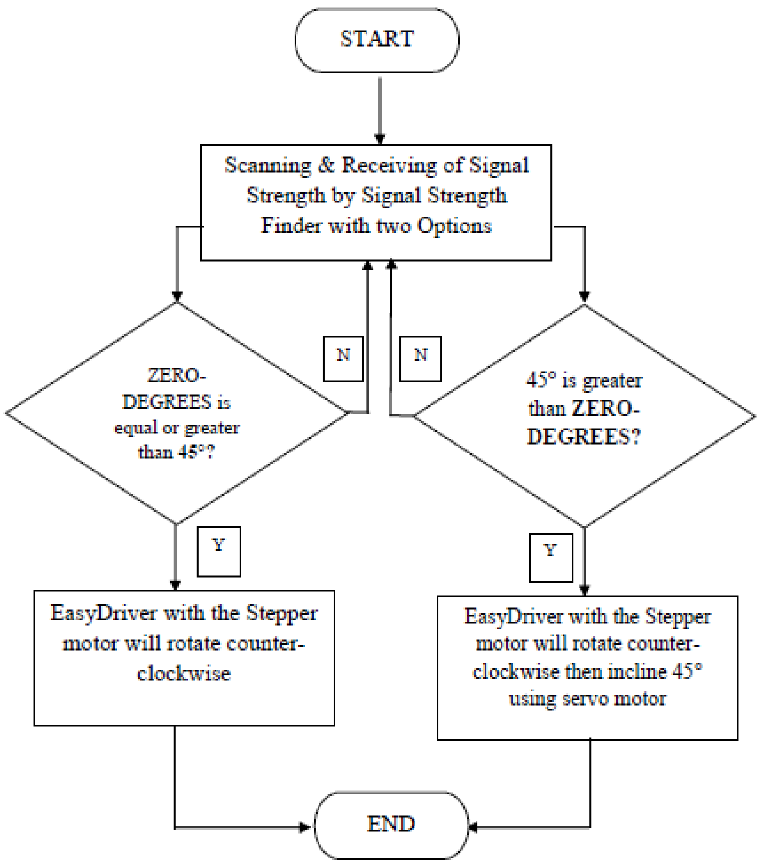

Fig. 6. The process flow diagram for the Auto-Scanning.

The system starts by pressing the power button of the remote, the response of the command activated the system by entering MODE ONE, which scanning automatically by rotating 360° counter-clockwise, then clockwise with an inclination of 45°. The signal strength finder sensor determines the value of the signal strength of the TV Antenna and then interpreted it by the microcontroller. Servo Motor provides an inclination for the device. If the signal strength at zero-degrees (0°) is greater or equal than 45°, then the EasyDriver drives the stepper motor to rotate counter-clockwise, and the servo motor maintains zero degrees (0°) inclination. Otherwise, if acquired signal strength at 45° is more significant than zero degrees (0°), then the system rotates counter-clockwise and 45° inclined.

Manual-scanning

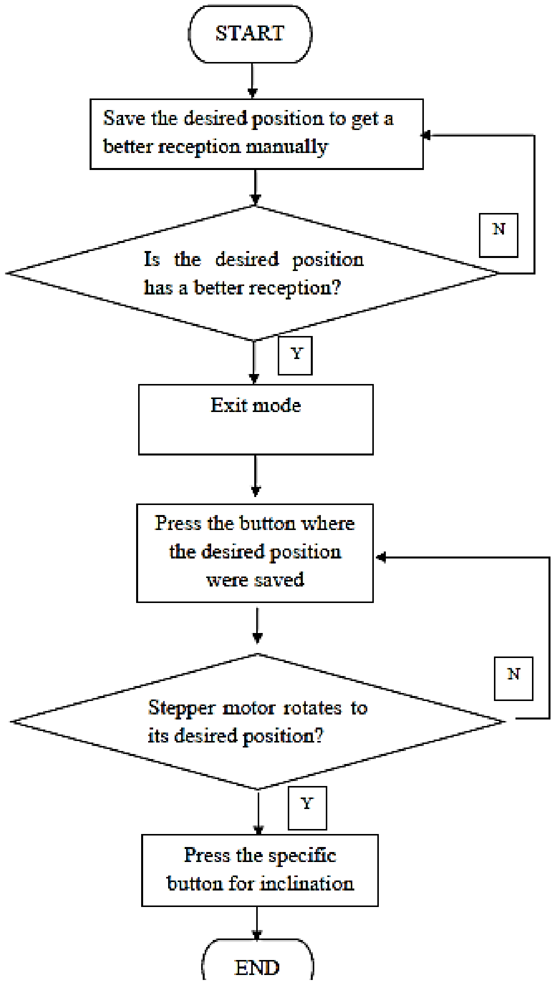

Fig. 7. The process flow diagram for the Manual-Scanning.

The flow chart shows that initiating the system is initiated starts by pressing the button at the lower left of a remote. By doing so, the setting changes to MODE TWO, which is the manual scanning for better TV reception. Manual scanning requires the user to determine the location with the better reception; then, by pressing the number button from 0-9 (which found on the remote), that position is saved as the desired position. Repeat the process until all channels have their position stored. Then press the exit button. After storing some data, press the number button to which the user wishes to recall the saved channel, and the stepper motor rotates accordingly. The user also has an option of inclination. Zero-degrees (0°) is the default inclination.

2.8 Functionality

The third objective of the study is to develop a program to support the device. Mutabvuri (2016) states that Functional tests can have, as their test basis, the functional requirements. It includes both those prerequisites that are implied and inscribed in a manuscript. The field knowledge of the checker can also be part of the test basis. Functional tests differ by the level of assessment or phase. An operating integration test focuses on the functionality of a collection of interfacing modules, usually regarding the partial or complete user workflows, use cases, operations, or features these modules provide. An operational system test concentrates on the functionality of the application as a whole, conditions, and procedures. It also tests the end-to-end functionality, which covers the entire set of systems.

2.9 Costing of the Device

The fifth objective is to present the cost of making the Prototype of Automated Signal Strength Locator for TV Antenna. To achieve a better output of the device, the researcher thoroughly selected all the required materials and components to fulfill the desired output. Such modules or elements which had used by the proponents are as follows: TV antenna, stepper motor, servo motor, Easydriver v4.4, SF95DT DVB-T Finder, IR Receiver sensor, electronic materials, electrical materials and microcontroller which is Arduino Uno.

3. Results and Discussion

This section discusses the actual structure of the device and the discussion of the result from the function test. As presented in the methodology, the microcontroller interprets the value of the signal strength of the TV antenna connected to SF95DT DVB-T Finder.

3.1 Actual Device

Figure 8 shows the actual image output of the prototype of an automated signal strength locator for a TV antenna. The TV antenna is attached to a stepper motor and servo motor, which is responsible for the positioning and inclining the device, respectively. A Splitter, which input has connected to the TV antenna, has two outputs; one for the SF95DT DVB-T Finder and one for the Television (TV). SF95DT DVB-T Finder serves as the deciding factor for finding the highest signal strength value. The location of the stepper motor as to where it should stop and the inclination of servo motor corresponds to the interpretation of the microcontroller's received data, which has the highest signal strength value. The purpose of the SF95DT DVB-T Finder is to measure or determine the signal strength value.

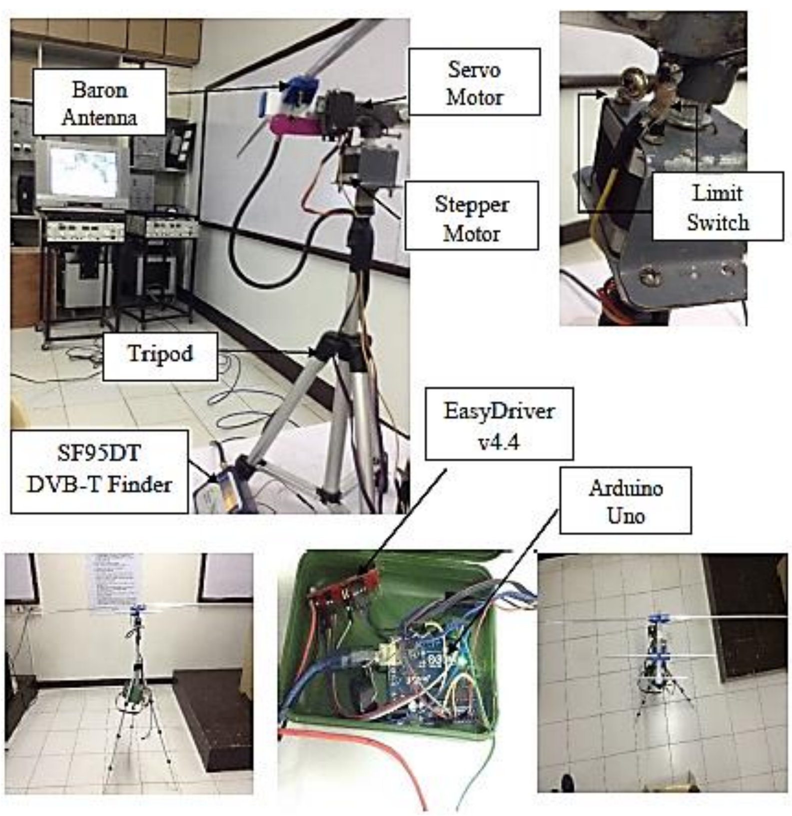

Fig. 8. Actual Device.

Figure 9 shows the button of the remote to be pressed by the user to the IR Receiver Module are as follows:

Power Button = MODE 1
PIP Button = Entering MODE 2
OK Button= Exit MODE 2
Channel Arrow Up Button = Counter-clockwise Rotation
Channel Arrow Down Button = Clockwise Rotation
Volume Plus (+) Button = Inclined Up
Volume Minus (-) Button = Inclined Down.

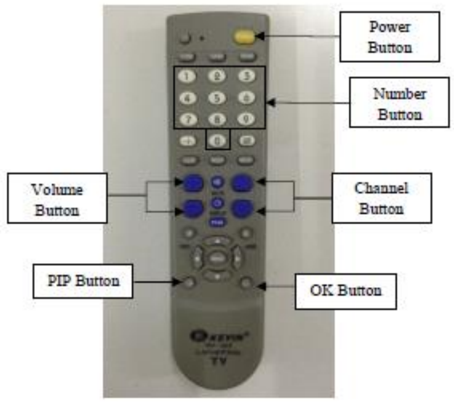

Fig. 9. Infrared Transmitter Remote.

3.2 Functional Diagram

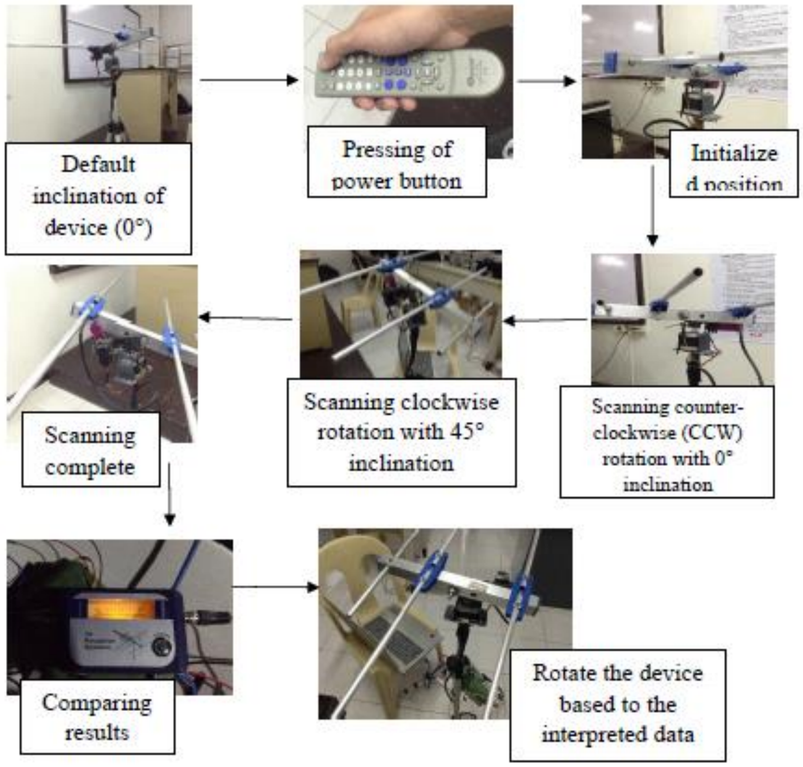

Fig. 10. Functional Diagram for Auto-Scanning.

Figure 10 shows the functional diagram for the auto-scanning of the device. The first of the block diagram indicates the default inclination of the TV antenna, which is zero-degrees (0°). Pressing of the power button of the remote by the user sends a signal for initialization. The stepper motor rotates to its initialized position, and a message displayed informs the user that the device would process the command. After initializing, the stepper motor turns the TV antenna into a counter-clockwise (CCW) position (0°-360°) at 0° elevation. After a full 360° (CCW) rotation, displayed in a serial monitor is the highest signal strength value acquired, and its azimuth. The servo motor then inclines to 45°, and the stepper motor rotates clockwise for one revolution. After auto-scanning, the microcontroller interprets received data and compares which has the highest signal strength between the zero-degrees (0°) and 45°. The resulting higher signal strength value and position is the final output of the device. The control system directs the antenna towards its final location. The last block of the diagram shows the output of the device for auto-scanning.

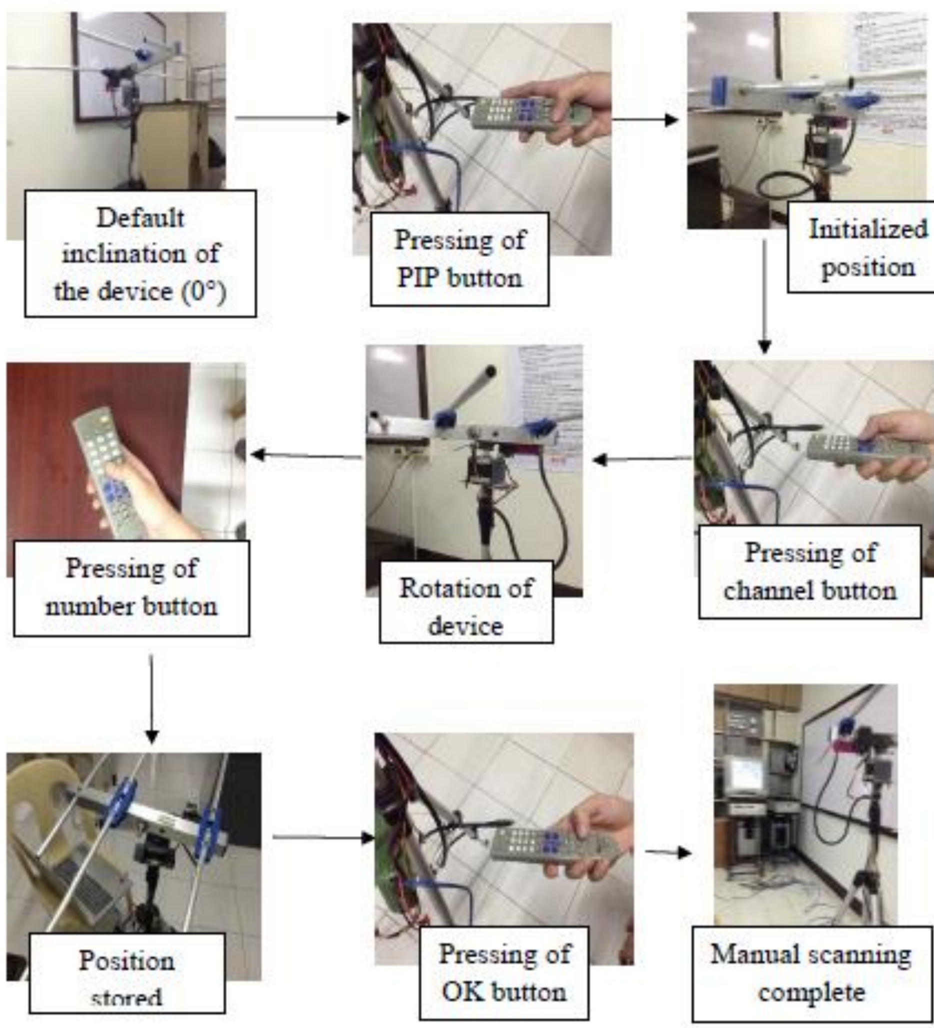

Fig. 11. Functional Diagram for Manual-Scanning.

Figure 11 shows the functional diagram for the manual-scanning of the device. The first of the block diagram indicates the default inclination of the TV antenna, which is zero-degrees (0°). The next block diagram shows pressing picture-in-picture "PIP" button of the remote by the user. A display of a message indicating that the stepper motor rotates to its initialized position to inform the user that the device will process the command. The user may now manually control the rotation of the device by pressing the channel up & down button. After getting the right reception, save the desired position by pressing any from the number button (0-9). Once all channels or TV stations have their own desired location, press the "OK" button to exit Mode 2. Then press the number button (0-9) again to rotate accordingly to its stored location. The last block of the diagram shows the output of the device for manual-scanning.

3.3 Functionality Test

The results of the functionality test shown in this section. Researchers conducted a ten (10) consecutive trials with a series of different TV stations. The gathering of data was carried out on a mostly cloudy afternoon rainy season at the Quijano's Residence Island Garden City of Samal (IGACOS). And for the verification of the device's functionality, another test was conducted at the University of Mindanao Electrical (EE) Laboratory on a humid afternoon.

With Manual-scanning data gathered

Every TV stations have their position giving the best reception. The desired position was being scanned manually by the proponents. By pressing the number button of the TV remote, the device rotates accordingly to its saved position. The inclination of the TV antenna is on a default angle (0°).

Ten (10) consecutive trials with a series of nine (9) different TV stations were being carried out to show the functionality testing of the TV Reception Accuracy and the table of all data gathered by the researchers. Based on the quality output of the television, researchers saved some desired position into the system before performing the gathering of the data.

Table 1. Summary table of data gathered for Manual-scanning.

TV Stations	Azimuth	Number of Success (10 trials)
TV5 Network Inc.	198°	8
ABS – CBN Corporation	139°	7
GMA Network Inc.	18°	8
Radio Philippines Network and Nine Media Corporation (CNN Philippines)	40°	8
People's Television Network (PTV)	62°	10
Intercontinental Broadcasting Corporation (IBC)	147°	9
ABS – CBN Sports And Action	26°	10
GMA News TV	26°	10
AksyonTV	10°	8

Table 1 shows a summary of the functionality test of the TV reception accuracy. Manual scanning involves a subjective decision of the user as to what position has the best reception. The user scans for one revolution, identifies and saves the desired location, to be specific, the azimuth of the stepper motor. During the function test, the proponents did the manual scanning and stored positions for each of the 9 different TV stations. Ten (10) trials were made to test the success of the device in locating the stored position for each of the TV stations. During the process, the serial monitor displays the azimuth of the stepper motor, and 3 out of 9 different TV stations were functioning well, which has a perfect score of trials, such as PTV, Sports and Action, and News TV. However, several TV stations have committed a malfunction in rotating to its

designated location. Nevertheless, from the 10 trials, an average of 7.8 number-of-success is still a high score to conclude that the manual scanning of the device is fully functional. *Note: Proponents held the gathering of data on IGACOS – Quijano's Residence.*
Upon data gathering, some errors found due to cogging torque. Lui et al. (2017) stated at the article that the primary component that would result to a torque ripple is the cogging torque. It always has the barrier for reaching the lowspeed, and high-performance drive systems. Zhu et al. (2000) mentioned that the results from airgap permeance harmonics due to slotting and interaction of permanent magnet magnetomotive (MMF) harmonics is the cogging torque. And with this, induce vibrations and speed ripples were produce, especially at low speed and light load. Fišer et al. (2010) discussed that torque ripple prevents smooth rotation of the motor by inherent cogging torque. Nevertheless, the impact of a speed ripple can become significant in some applications (De Kooning, 2013).

To reach the desired output which is to smoothen the rotation of the device, Kordik (2015) discussed that by achieving constant speed and acceleration, the torque demand would be reduced to overcome friction. Kordik (2015) also says that, in reality, step motors perform much better because high torque utilization typically occurs when accelerating. Thus, by applying this kind of solutions, the device can be be fully functional.

With Auto-scanning data gathered
In this section is the table of all data collected by the proponents for the signal strength location accuracy. Results should be discussed thoroughly in this section, if necessary, with the aid of figures and tables.

Table 2. Summary table of data gathered for Auto-scanning.

Trial #	Azimuth (inclined 0°)	Serial Monitor Analog Value (inclined 0°)	Azimuth (inclined 45°)	Serial Monitor Analog Value (inclined 45°)
1	45°	1023	346°	1023
2	46°	1023	353°	1023
3	46°	1023	357°	1023
4	54°	1023	350°	1023
5	48°	1023	356°	1023
6	49°	1023	351°	1023
7	46°	1023	353°	1023
8	49°	1023	352°	1023
9	44°	1023	346°	1023
10	46°	1023	342°	1023

Table 2 shows all the data that was gathered by the proponents in testing the functionality of the automatic signal strength scanning. The device takes 1-2 minutes to finish its auto-scanning before reaching the interpreted location data. Results show that during the ten (10) consecutive trails on IGACOS in Quijano's Residence, the highest signal strength value recorded in the serial monitor of the Arduino was 1023. Both

0- and 45-degrees elevation achieved the same 1023 signal level. This value was marked as the maximum meter scale of 10 of the SF95DT DVB-T Finder and as the reference level for optimum signal reception.

Table 3. Data Gathered for the signal strength location accuracy (IGACOS).

Trial #	Azimuth	Elevation	Signal Strength Finder Reading (meter scale)
1	45°	0°	10
2	46°	0°	10
3	46°	0°	10
4	54°	0°	10
5	48°	0°	10
6	49°	0°	10
7	46°	0°	10
8	49°	0°	10
9	44°	0°	10
10	46°	0°	10

After comparing the highest signal strength value between the angles of elevation of 0° and 45°, EasyDriver triggers the stepper motor to rotate counterclockwise for the azimuth, and the microcontroller drives the servo motor for the inclination of the device. Table 3 shows the gathered data in location accuracy. With the 1023 signal strength set as the highest achieved from table 2, the proponents observed that 10 out of 10 trials, the servo, and stepper motor were accurate in locating the position. Correlating the data obtained from table 2 and table 3, a notable 0° elevation was held of the output. Therefore, it shows the execution of the control system of the device since the logic condition is that, if signal strength at 0° is greater than or equal to that of the 45° inclined, then the servo motor maintains the 0° elevation. Findings attest that the device was able to position at an optimum reception accurately. Hence, the control system of the automatic signal strength locator is successful. *Note: Proponents held the gathering of data in IGACOS (Quijano's Residence)*

Table 4. Data Gathered for the auto-scanning (EE Laboratory).

Trial #	Azimuth (inclined 0°)	Serial Monitor Analog Value (inclined 0°)	Azimuth (inclined 45°)	Serial Monitor Analog Value (inclined 45°)
1	35°	366	200°	322
2	162°	581	220°	965
3	90°	156	120°	269
4	289°	270	357°	221
5	75°	338	17°	1023
6	62°	552	313°	482
7	28°	1023	288°	905
8	40°	1023	266°	1023
9	29°	663	295°	562
10	48°	1023	315°	678

Table 4 shows all the auto-scanning data that was performed at the EE Laboratory of the University of Mindanao to verify further the functionality of the device. The device ran the auto-scanning for 1-2 minutes before reaching the interpreted location data on both 0° and 45° elevation. This time, the strength of the scanned signals from the 10 trials was variable, ranging from 156 to 1023. The proponents consider this variance as the factor of the testing location since the University of Mindanao EE Laboratory is not an open-field. Despite that, a 1023 highest signal strength was still successfully scanned, as displayed in the Arduino serial monitor. The proponents, therefore, recorded 1023 as the maximum meter scale equivalent to 10 of the SF95DT DVB-T Finder. On the contrary, the lowest signal strength value was 156, which ranges from 1-2 in the meter scale of the SF95DT DVB-T Finder. Overall, the results confirm that the auto-scanning of the highest signal strength can be done successfully by the device.

Table 5. Data Gathered for the signal strength location accuracy (EE Laboratory).

Trial #	Azimuth	Elevation	Signal Strength Finder Reading (meter scale)
1	35°	0°	4
2	220°	45°	9
3	120°	45°	3
4	289°	0°	3
5	17°	45°	10
6	62°	0°	5
7	28°	0°	10
8	40°	0°	10
9	29°	0°	6
10	48°	0°	10

Running the comparison between the angle of elevation of 0° and 45°, the EasyDriver triggers the stepper motor to rotate counterclockwise for the azimuth, and the microcontroller triggers the servo motor for the inclination. Table 5 shows the data gathered in testing the location accuracy of the device. Equating the data from auto-scanning (table 4) and location accuracy (table 5), the proponents observed absolute location accuracies of maximum signal strength achieved between each trial. The proponents interpreted the performance of the control system as fully functional as it certainly positions the device towards the highest signal level scanned. That during the ten (10) consecutive trials, the servo and the stepper motors were all working according to the design.

Hence, the signal strength locator accuracy and the motor control positioning was successful.

3.4 Cost of the device

The proponents have found out the total cost of the prototype of an automated signal strength locator for TV antenna after acquiring all the desired components or materials in making the mechanism. The table below shows the prices of constructing the device:

Table 6. Cost of the components of the system.

Material	Cost
Microcontroller (Arduino Uno)	P 600.00
SF95DT DVB-T Finder	P 650.00
Infrared Receiver Module	P 150.00
EasyDriver V4.4	P 250.00
Stepper Motor (NEMA 17)	P 1000.00
Baron TV Antenna	P 700.00
Servo Motor (MG995 Tower Pro)	P 900.00
Tripod	P 400.00
Total	**Php 4650.00**

4. Conclusions and Recommendation

Based on the functionality tests done by the proponents, the research study for the Prototype of Automated Signal Strength Locator for TV Antenna has been completed and was fully functional. The researchers have concluded that:

1. The proponents were able to design a control system for signal strength locator device for the TV antenna.
2. The researchers were able to construct a circuit according to the design.
3. The researchers were able to develop a program that will drive the device.
4. The proponents were able to perform the function test successfully and accordingly with the desired and expected output.
5. The researchers were able to present the cost of making the device.

After completing all the procedures in designing a prototype of automated signal strength locator for TV antenna, the system functioned accordingly. Therefore, the proponents successfully achieved the objectives of this study.

To further develop the research, the following recommendations are stated by the proponents for the target beneficiaries and to the future researchers. The researchers would like to recommend the study which is Prototype of Automated Signal Strength Locator for TV Antenna for those homeowners especially who were far away from the broadcasting towers or located in distant places.

For the target beneficiaries:

1. This device will be of great use.
2. Be responsible for using the device.
3. Do not let the wiring or the device get wet, place it in a safe location.

For the future researchers:

1. Develop a signal strength locator for Digital TV;
2. Parameters must be well identified and defined in fabricating the hardware to lessen the errors and discrepancy as well as to minimize cost;
3. Compare the accuracy of the system tested between different antenna locations.
4. Include system performance analysis considering different weather conditions or atmospheric parameters such as temperature, pressure, the humidity of the atmosphere, and wind.
5. Assess the developed algorithm' results as compared to existing signal strength locator algorithms to establish the difference and similarities of both.
6. Use Parabolic dish type TV antenna;
7. Develop a control system according to the type of antenna that will be used and to better the quality of the output;
8. Consider the height factor of a TV antenna for developing a control system;
9. Use raspberry pi as your next microcontroller.

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