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ORIGINAL ARTICLE

Automatic Antenna Alignment Using PID Controller

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ABSTRACT

Antennas are customarily more directive, receiving and transmitting signal in one direction to another and alignment of the antenna is a very decisive operation to maintain the power of the wireless link. This paper describes an alternative method of prevailing the alignment process of the antenna. The system is capable to manipulate the antenna position for achieving the maximum receive signal level (RSL). The main perspective for this paper is the application of PID algorithm for automatic antenna alignment and this alignment is executed through a specific commute positioner and an exactly established algorithm provide the parameters to achieve the three-dimensional space. detection, processing, and choice of action. The system can enhance the signal's reliability and ensures the maximum power received at the end, correspondingly it generates the auto message to the service provider after accomplishing the process. The projected technique exposes its sensitivity to variations in the antenna directing precision and receiver calibration.

Keywords: Receive Signal level (RSL), PID algorithm, Positioner, detection, sensitivity to variations, receiver calibration

Author`s Contribution
[1] *Data analysis, interpretation and manuscript writing, Active participation in data collection*
[2] *Conception, synthesis, planning of research and manuscript writing*

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INTRODUCTION

Receive Signal Level (RSL). In the different overviews directed, it can be reasoned that the connection arrangement is not a one-off occupation to finish; actually, it is basic in takeoff and usage stage and additionally Operation and Maintenance. [1, 3]. Indeed, even with great nature of mounts, it is seen that there is a high plausibility for reception apparatus to lose its ideal bearing and consequently mislead the fundamental bar. There could be different explanations for the misalignment, for example, natural conditions, wear and tear of mounts and block in the way of two stations. [2, 9]. Nowadays, a majority of the communication systems are based on Wireless where indicate factor (P2P) or line of vision interaction (LOS) is needed. In satellite interaction, exact positioning of both interacting tools is one of the essential aspects of developing an effective as well as reliable communication [3, 4]. Automated antenna alignment has been the subject of research for many years. Many methods have been proposed to overcome problems pertaining to the stability, efficiency, and durability of such systems. The main purpose of antenna alignment is to :(a) Locate for the major lobe to get the

Maximum reception power. (b)To ensure the complete transference of information. Automated Antenna alignment is done by employing several methods [3, 5].Use of simple microcontroller programming and FPGA-based programming has been done.

The project is based on automation of antenna alignment through PID controller which ensures that proper alignment of antennas is done and thus receives enable the receiver antenna to receive maximum signal strength. [6,7]. In current era communication industry is looking for options which can eliminate the problems like reduced signal strength and link loss and they have to be economical and time efficient. These problems arise due to misalignment of antennas working on the principle of line of sight (LOS) and poor alignment can cause a company fortune.[3] By introducing the element of automation the said problems can be rectified as well as meeting the requirements of economics and human safety. Automation of receiver type antenna by using motors controlled by microcontroller has been discussed. [2][3] Microcontroller is fed with the PID routine and upon completion of the routine GSM module will send a message to the cell phone. [8,9]

SELECTION OF COMPONENTS

A. MICROCONTROLLER-PIC16f877A
B. GSM MODULE 900
C. DC GEAR MOTOR
D. ANTENNAS-YAGI UDA
E. MOTOTR DIRVER

SYSTEM CONTROL THEORY

Automated antenna Alignment is system is consists of an assembly. Motor (M1) is fixed on the tripod stand. The shaft of M1 is fitted with gears for generating more torque. ST1 will cause antenna assembly to rotate through 450 of the center on the azimuthal plane. ST1 is produced and is fitted with the base which consists of motor 2 (M2), working on 450 of the center on elevation plane. The shaft of M2 will have the antenna mounted on so that the rotation of M2 causes the elevation angle of the antenna to change.

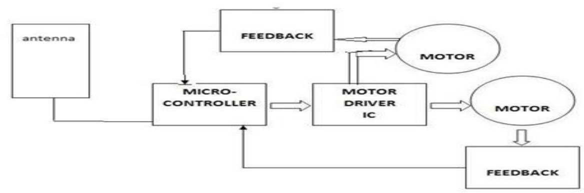


Fig 1.1 System Design

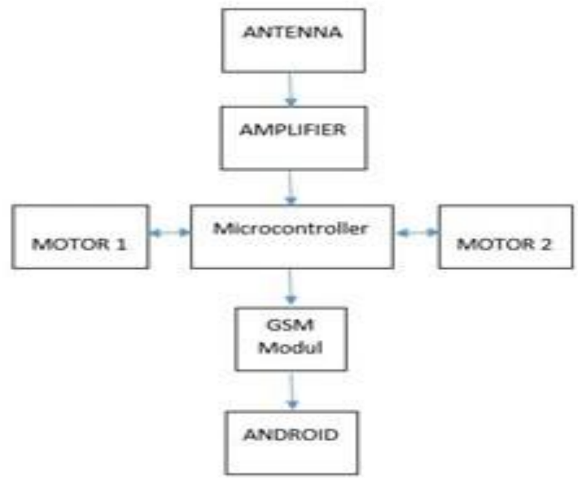


Fig 1. 2 Functional Block Diagram

SPECIFICATIONS

MICROCONTROLLER

- PIC 16F877A
- 40 Pins
- Operating Voltage : 5V DC

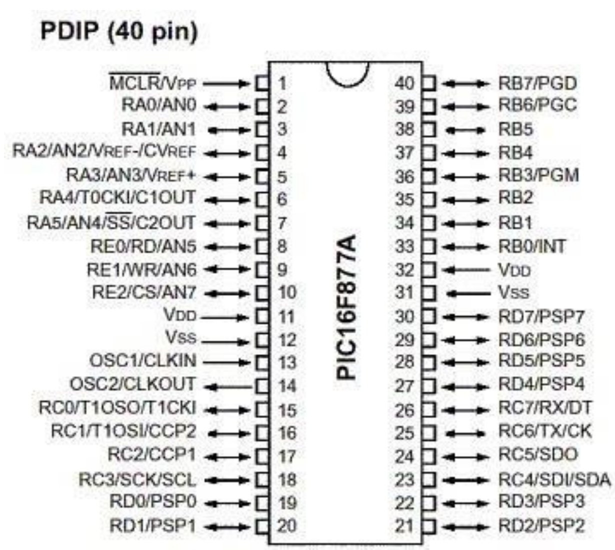


Fig 2.1 PDIP

DC GEAR MOTORS

- 2 DC gear motors are used.
- Operating Voltage: 12V DC
- Operating Current: 1.5A DC
- Gearbox integrated.
- 2 N-m

Fig 2.2 DC Gear Motor

GSM 900 MODULE

- GSM 900
- Operating Voltage: 12V DC

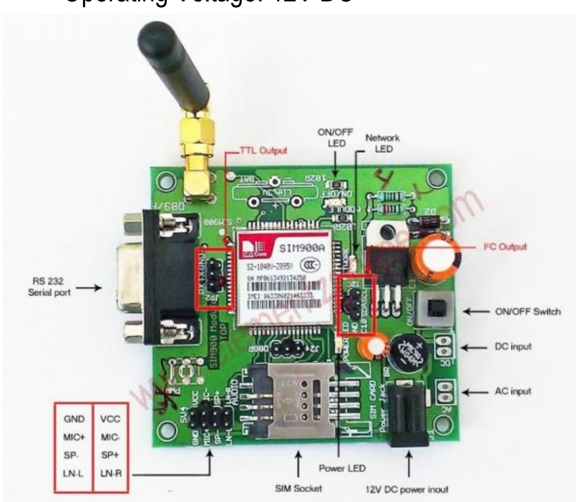


Fig 2.3 GSM 900 Module

YAGI UDA ANTENNA and RF DETECTOR

- Yagi UDA, 5 and single element
  Frequency:
- RF generator 750MHz (output adjustable)
- Tone Generator 1KHz (output adjustable)
- Directional Coupler Forward and reverse (selectable)
- Matching Stub Slider type
- Antenna Rotation 0-360 degrees.
- Resolution 1 degree
- Display Level adjustable meter
- Power Supply 230V ±10% 50/60Hz
- Weight (main unit) 3Kg approx.
- Receiving Antenna Folded dipole with reflector Detector

Fig 2.4 YAGI UDA Antenna

OPERATIONAL PHENOMENON

Mechanical Structure Functioning

The structure contains a Tripod. The structure is built considering two planes for antenna motion-elevation and azimuthal. For azimuthal motion, a DC gear motor is given which is clamped (vertically) inside Channel bracket. Channel bracket can be built using steel sheet. The shaft of the motor is fitted with the hollow shaft of a dismantled washing machine pulley. This arrangement gives the antenna its 360-degree motion. With the hollow shaft there is another channel bracket and inside it, a DC gear motor is given which is clamped (horizontally).The other part of the pulley and its hollow shaft is fitted with the shaft of the second motor. A right-angled bracket is bolted to the shaft which translates the rotator motion into elevational motion of antenna which is bolted with the right-angled bracket.

ANTENNA LOCALE

1. Transmitter type Yagi Uda (5E) is connected to RF
2. Generator and signal magnitude is set.
3. Receiver type antenna is connected to RF detector.

RF Detector Setting:

RF detector is connected with antenna (receiver type) and after the setting of RF. The output is connected to an analog input pin of the microcontroller.

Principles:

- PID

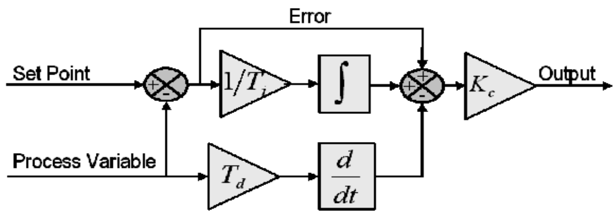


Fig 3.1 PID block diagram

Proportional term:

$$P_{\text{out}} = K_p\, e(t)$$

Integral term:

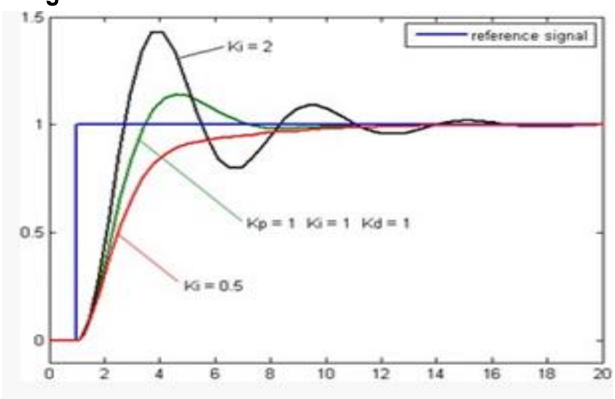


Fig 3.2 PV vs time Plot,

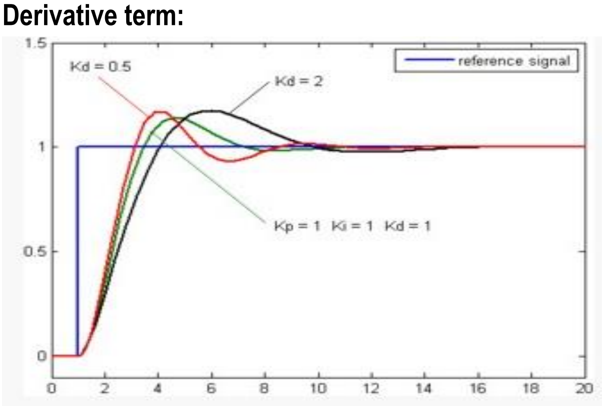
For three values of Ki (Kp and Kd held constant)

[2] The important in a PID controller is the amount of the rapid mistake gradually as well as offers the gathered counter that ought to have been dealt with formerly. [3]The gathered mistake is after that increased by the essential gain ( ) and added to the controller output.

The integral term is given by:

$$I_{\text{out}} = K_i \int_0^t e(\tau)\, d\tau$$

Derivative term:



The by-product of the procedure mistake is determined by establishing the incline of the error with time and also increasing this price of modification by the acquired gain Kd. The size of the contribution of the acquired term to the general control activity is labeled the acquired gain Kd.

The derivative term is given by:

$$D_{\text{out}} = K_d \frac{de(t)}{dt}$$

ANTENNA ESSENTIALS

Yagi Front to the Back ratio:

Among the numbers connected with the Yagi, the antenna gain is just what is labeled the front to back proportion, F/B. This is merely a proportion of the signal degree in the forward instructions to the reverse instructions. This is usually revealed in dB

Front to back ratio

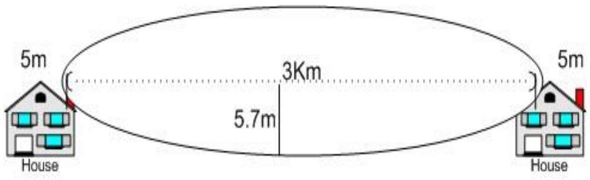
$$= \frac{\textit{Signal in forward direction}}{\textit{Signal in reverse direction}}$$

$$= \frac{F}{B}$$

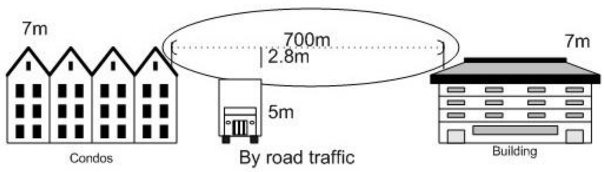
The front to back proportion is very important in conditions where disturbance or insurance coverage in the reverse instructions should be lessened. The problems within the antenna indicate that optimization has actually to be embarked on for either front to back proportion, or optimum ahead gain. Problems for both functions do not correspond, however, the front to back proportion could usually be optimized for a tiny deterioration of the forward gain.

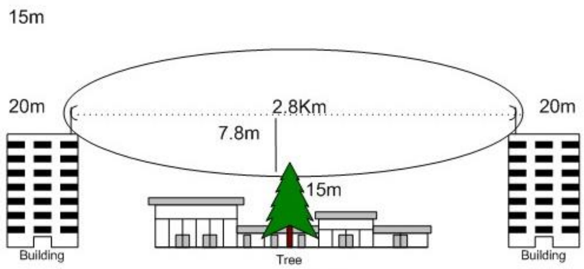
LOS:

Line-of-sight propagation is a characteristic of electromagnetic radiation or acoustic wave propagation. The electromagnetic transmission consists of light discharges taking a trip in a straight line. The waves or rays could be diffracted, refracted, mirrored, or soaked up by environment and also blockages with the product and also typically could not traverse the perspective or behind barriers.



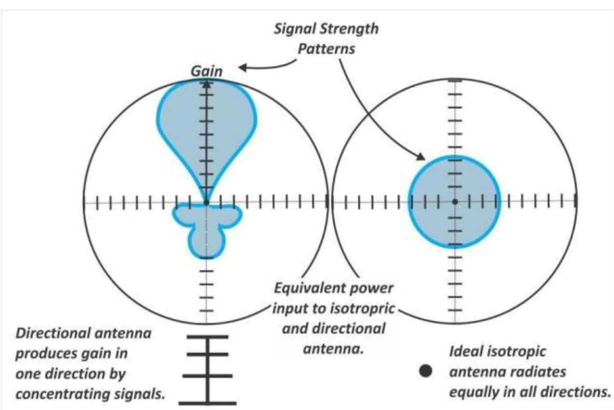
By the ground





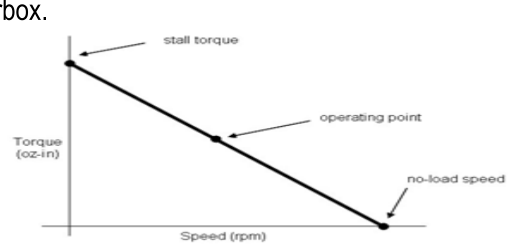
By an obstacle

YAGI UDA RADIATION PATTERN:



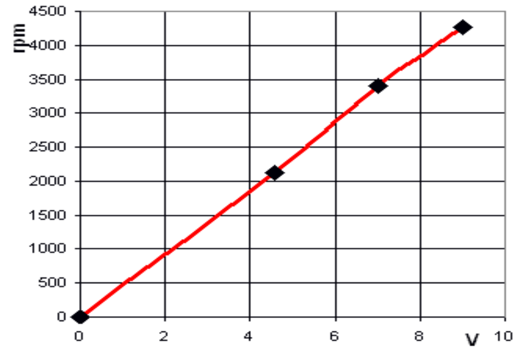
Gear Motor Rorque:

In order to increase the ability of motor the torque needs to be increased. Torque can be increased by reducing the speed of the motor. Torque is inversely proportional to speed. It can be achieved by adding a gearbox.



Voltage:

The voltage of the motor decides the load.



Test Analysis:

Firstly find the set value of the project by if-else programming technique and then put this value into PID programming.

- Test Microcontroller
- Test motor's rpm, current, voltage etc.
- Interface microcontroller and motor by using H bridge
- Use if else program to find out its max RSL. Max RSL in PID program and join if else and PID program.
- If an error is zero in the second program it high any pin.
- Later this pin is connected to GSM.

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