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Implementation of Embedded Based on Smart Antenna Orientation

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ABSTRACT: The basic components Antenna forms any RF/Microwave System that uses Free Space propagation for Communications, Radio Detection, Remote sensing, etc and are important part of the modern communication system. Antenna is transitional device between free space and guiding device like Waveguides or transmission lines. Transmitting Electromagnetic energy from the source to the antenna. Without Antenna either message can be transmitted nor received. The proposed system Antennas on to the system is programmed to automatically oriented towards direction of Maximum signal strength to ensure better signal strength for clear Audio and Video Signals at the receiver side. This system is ideal for service providers of satcom, World space radios, Live Event coverage and Transmission, All Line of sight communication etc.,

KEYWORDS*:* Antenna, Maximum Signal strength

I. INTRODUCTION

Antennas are eyes and ears of the modern world. Since the early days of wireless communications, there has been the simple dipole antenna, which radiates and receives equally well in all directions. To find its users, this single-element design broadcasts Omni directionally in a pattern resembling ripples radiating outward in a pool of water. While adequate for simple RF environments where no specific knowledge of the users' whereabouts is available, this unfocused approach scatters signals, reaching desired users with only a small percentage of the overall energy sent out into the environment. In addition, other users will experience the power radiated in other directions as interference.

In recent years, the limitations of broadcast antenna technology on the quality, capacity, and coverage of wireless systems have prompted an evolution in the fundamental design and role of the antenna in a wireless system. However in order to accomplish maximum signal strength, user often has to adjust the antenna manually. A Smart Antenna Orientation System will do this automatically and increase the spectrum efficiency.

II. BLOCK DIAGRAM

A) Description

The proposed system any Antennas mounted on to the system is programmed to automatically orient towards direction of Maximum signal strength to ensure better signal strength for clear Audio and Video Signals at the receiver side. This system is ideal for service providers of SATCOM, World space radios, Live Event coverage and Transmission, All Line of sight communication etc.,
The Transmitter part of the "Orientation System" consists of microwave source, a VCO in this case operating in c-band at a frequency of 2-4 GHz (can be operated in s and x band if required) which generates a radio frequency altering current, which is applied to the transmitting antenna. When excited by this alternating current this antenna radiates radio waves.

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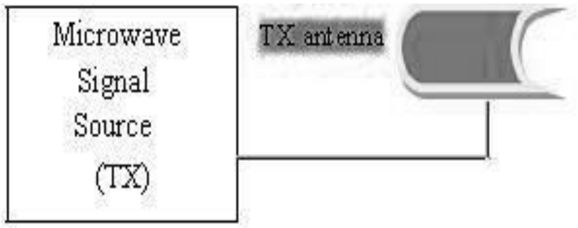

Fig 1: Transmitter

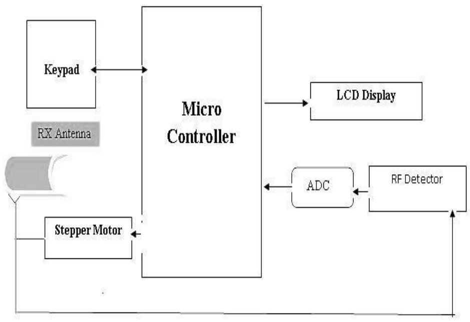

Fig 2: Receiver with **PIC18F452**

The transmitting and receiving antenna[2][3] used for demonstrating purpose is a Patch Antenna, whose directionality is greater compared to other antenna. Patch antennas are low cost, have a low profile and are easily fabricated. At the receiver side, the receiving antenna (i.e patch antenna) is mounted on a stepper motor using a mounting rod. The stepper motor is controlled using a PIC controller.

The received signal is detected using a RF detector and converted in to a digital signal using the ADC inbuilt in PIC. The received signal is detected for every angle (1.8 per step) by rotating the stepper motor. The corresponding power levels are displayed on LCD. The keypad (4×4) is used for aligning, resetting the module, to find maximum and pausing the module.

B) Methodology

Step 1. Microcontroller is initialized and request for alignment (Initially).
Step 2. The stepper motor rotates the receiver antenna for 360 degree and microcontroller scans for the signal strength. The power intensity (highest value) is stored in internal memory of the microcontroller.

Step 3. It automatically aligns to the angle of last found maximum signal direction.

Step 4. The device continuously monitors the power/signal strength. If any change it
Automatically aligns to the direction of maximum signal strength.

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C) Assumptions

- The system Antennas should have very low side lobes. The Gain of the Antennas should be high. Higher the Gain of the receiver antenna, better the performance of the setup.
- The return loss of the antenna used should be reasonable around -10 db and above for optimum performance.
- At some point the transmitter and receiver antenna may be slightly out of sight line, but the signal level may still be high, this may be due to multiple reflections the receiving antenna may receive at that point.

III. PATCH ANTENNA

A patch antenna (also known as a rectangular microstrip antenna) is a type of radio antenna with a low profile, which can be mounted on a flat surface. It consists of a flat rectangular sheet or "patch" of metal, mounted over a larger sheet of metal called a ground plane. The assembly is usually contained inside a plastic random, which protects the antenna structure from damage. Patch antennas are simple to fabricate and easy to modify and customize. They are the original type of microstrip antenna described by Howell; the two metal sheets together form a resonant piece of microstrip transmission line with a length of approximately one-half wavelength of the radio waves. The radiation mechanism arises from discontinuities at each truncated edge of the microstrip transmission line. The radiation at the edges causes the antenna to act slightly larger electrically than its physical dimensions, so in order for the antenna to be resonant, a length of microstrip transmission line slightly shorter than one- half a wavelength at the frequency is used. A patch antenna is usually constructed on a dielectric substrate, using the same materials and lithography processes used to make printed circuit boards.

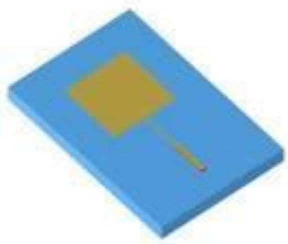

Fig 3. Patch Antenna

A) Properties of a Basic Microstrip Patch

A Microstrip or patch antenna is a low profile antenna that has a number of advantages over other antennas it is lightweight, inexpensive, and easy to integrate with accompanying electronics. While the antenna can be 3D in structure (wrapped around an object, for example), the elements are usually flat; Hence their other name, planar antennas. Note that a planar antenna is not always a patch antenna.

The following drawing shows a patch antenna in its basic form: a flat plate over a ground plane (usually a PC board). The center conductor of a coax serves as the feed probe to couple electromagnetic energy in and/or out of the patch. The electric field distribution of a rectangular patch excited in its fundamental mode is also indicated. The electric field is zero at the center of the patch, maximum (positive) at one side, and minimum (negative) on the opposite side. It should be mentioned that the minimum and maximum continuously change side according to the instantaneous phase of the applied signal.

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The electric field does not stop abruptly at the patch's periphery as in a cavity; rather, the fields extend the outer periphery to some degree. These field extensions are known as fringing fields cause the patch to radiate.

B) Gain

The gain of a rectangular Microstrip patch antenna with air dielectric can be very roughly estimated as follows. Since the length of the patch, half a wavelength, is about the same as the length of a resonant dipole, we get about 2 dB of gain from the directivity relative to the vertical axis of the patch. If the patch is square, the pattern in the horizontal plane will be directional, somewhat as if the patch were a pair of dipoles separated by a half-wave; this counts for about another 2-3 dB. Finally, the addition of the ground plane cuts off most or all radiation behind the antenna, reducing the power averaged over all directions by a factor of 2 (and thus increasing the gain by 3 dB). Adding this all up, we get about 7-9 dB for a square patch, in good agreement with more sophisticated approaches.

A typical radiation pattern for a linearly-polarized 900-MHz patch antenna is shown below. The figure shows a cross-section in a horizontal plane; the pattern in the vertical plane is similar though not identical. The scale is logarithmic, so (for example) the power radiated at 180° (90° to the left of the beam center) is about 15 dB less than the power in the center of the beam. The beam width is about 65° and the gain is about 9 dBi. An infinitely-large ground plane would prevent any radiation towards the back of the antenna (angles from 180 to 360°), but the real antenna has a fairly small ground plane, and the power in the backwards direction is only about 20 dB down from that in the main beam.

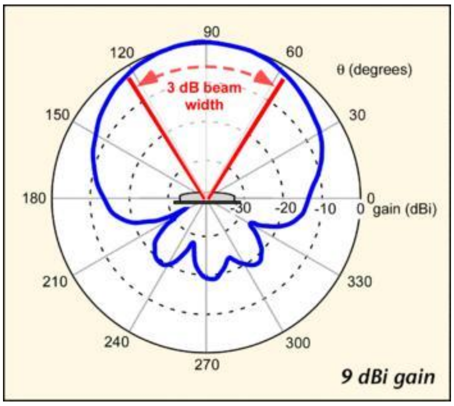

Fig4 Radiation Pattern

C) Impedance Matching

Looking at the current (magnetic field) and voltage (electrical field) variation along the patch, the current is maximal at the center and minimal near the left and right edges, while the electrical field is zero in the center and maximal near the left and minimal near the right edges. The figures below clarify these quantities.

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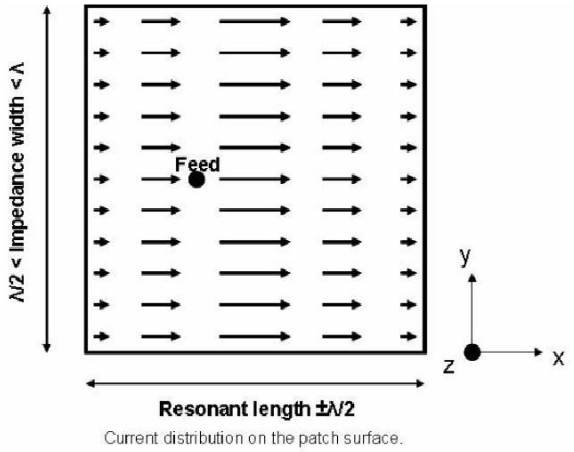

Fig 5 Current distribution on the Patch Antenna

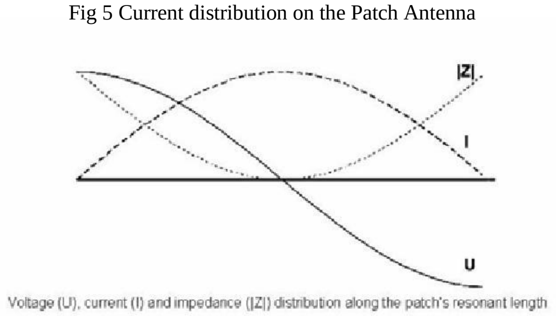

Fig 6 U, I, Z Distribution along the Patch's resonant length

From the magnitude of the current and the voltage, we can conclude the impedance is minimum (theoretically zero W) in the middle of the patch and maximum (typically around 200 W, but depending on the Q of the leaky cavity) near the edges. Put differently, there is a point where the impedance is 50 W somewhere along the "resonant length" (x) axis of the element.

IV. SOFTWARE DESCRIPTION

A) Embedded Systems Programming

Embedded systems programming is different from developing applications on a desktop computers. Key characteristics of an embedded system, when compared to PCs, are as follows:

- Embedded devices have resource constraints(limited ROM, limited RAM, limited stack space, less processing power)
- Components used in embedded system and PCs are different; embedded systems typically uses smaller, less power consuming components.

- Embedded systems are more tied to the hardware. Two salient features of Embedded Programming are code

speed and code size. Code speed is governed by the processing power, timing constraints, whereas code size is governed by available program memory and use of programming language. Goal of embedded system programming is

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to get maximum features in minimum space and minimum time.

B) MPLAB IDE v8

The current version of MPLAB IDE is version 8.90. MPLAB IDE v8.92 which is due to be released in June 2013 , will be the last MPLAB 8 version that will contain new device support. It is a 32-bit application on Microsoft Windows and includes several free software components for application development, hardware emulation and debugging. MPLAB IDE also serves as a single, unified graphical user interface for additional Microchip and third-party software and hardware development tools. Both Assembly and C programming lang--ages can be used with MPLAB IDE v8. Others may be supported through the use of third- party programs. Support for MPLAB IDE, along with sample code, tutorials, and drivers can be found on Microchip's website. MPLAB IDE v8 does not support Linux, UNIX or Macintosh operating systems.

C) X-CTU

X-CTU Figure 3 shows the S-DES encryption algorithm in greater detail. As was mentioned, encryption involves the sequential application of five functions. We examine each of these

Fig 7: Icon on PC Desktop

V. ADVANTAGES AND DISADVANTAGES[3]

A) Advantages

- Fully Automatic, Intelligent unit, no need of manual adjustments
- Highly Efficient, Easy to implement.

- The size of the antenna used here is small compared to the antenna arrays.
- Highly secure - Because the signals from smart antennas are specifically focused rather than transmitting in a random way, they offer more security for the user. Anyone wanting to intercept a communication would need to be in the exact location as the antenna and the communication device it was connected to.

B) Disadvantages

- Power supply is required for embedded system and stepper motor for continuous monitoring of power level. But this can be overcome by using solar energy.

- The system needs to be aligned before use to adapt to different environments.

- The output depends on the environment in which area it is implemented (reflections)

C) Applications

- Military Application- Light weight video displays with inbuilt smart antenna are used to exchange real time maps and pictures

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- Satellite Communication- Base stations are employed with smart antenna
- Mobile communication
- Wireless sensor network-Increased gain preserves connectivity
- Terrestrial television reception

VI. RESULTS

The entire setup for mounting and aligning the antenna is as shown below

Fig 8: setup for maximum power transmission

VII. CONCLUSION AND FUTURE SCOPE

Smart Antenna Orientation is very useful Based on the direction of signal arrival. We can use more than one antenna to create an antenna pattern which takes in to account Signal of Interest (SOI) and Signal not of Interest (SNOI) and also using Monopulse techniques in the above setup the accuracy of angle measurement can be improved. There is scope of improving the accuracy of determining where the maximum signal occurs.In the above setup the side lobe of the antenna should be low which means gain of the antenna should be high. Higher the gain better the performance of the setup.

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