# Implementation of Signal Sensing and Direction Fixing RF Antenna using ATmega328 and RC522 Module

**Sujithkumar M A[1], Samritha D[2], Viboosithasri N S[3], Gowtham Easwar K[4]**

*[1-4]II Year Students, Dept. of Electronics and Communication Engineering, PSG College of Technology, Coimbatore, Tamilnadu, India*

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**Abstract -** *The requirement of antennas is always essential as it is the only way by which wireless communication can happen. The antenna can act as a directional device as well as a probing device. An efficient antenna can considerably improve overall system performance. In this paper, we propose a signal sensing antenna system which uses a Radio frequency Identification (RFID) Antenna and a microcontroller called ATmega328 as its main components. The idea is to avoid the task of changing the orientation of the antenna manually in the direction of the main beam. The system will be able to sense and fix the direction of maximum radiation and the antenna will be controlled using a servo motor. The maximum range through which the antenna (or module) in the system can block the direction of maximum radiation and start receiving the signals. The response and the throughput of the proposed system are observed and proper inferences are made.*

***Key Words*: Arduino UNO, RFID, Antenna, Servo, Radiation, Parallel Processing**

## 1. INTRODUCTION

An antenna is a transducer which converts any electrical signal to an electromagnetic radiation and radiates it in free space. At the same time, it receives the electromagnetic radiation and transforms that to an electrical signal. Wireless communication is made possible through antennas. Antennas play a vital role in the field of communication especially Mobile communication. While receiving the signal using antennas, it is very much required that the antennas receive the signals with high gain so that the information is not lost. It is essential to determine the direction of arrival of the signal before receiving the signals. Modern Smart Antennas use several signal processing algorithms to determine the direction of the signal arrival. In this project, a simple low-cost system is proposed to detect the direction of signal arrival.

The aim of the project is to integrate an antenna with a specific microcontroller to control its orientation because the latter has a computational intelligence. For prototyping purposes, the inbuilt RF Antenna in the RC522 module is used. It is augmented with a servo motor. The servo motor will be given power continuously in order to rotate the module. Since, the nature of RC522 module is to wait for the tag. The servo motor is also made adaptive to it and it makes the antenna in the servo motor to rotate continuously and wait for the signals to receive. Once the signal is received, the signal sensing system called as the RC522 indicates the microcontroller ATmega328 since they are interfaced. Depending on the signal, the microcontroller will send the control signals to the motor to stop and fix the direction of signal arrival immediately. The angle of reception may be received and a feedback control algorithm may be designed to make sure that the antenna is not deviating from its position. There may be wastage of power if no signal is received for a long time to tackle those, some improved designs are proposed in the paper itself. To practically make this prototype as a product, a suitable microcontroller which is capable of controlling any practical antennas like Yagi Uda Antennas, Loop antennas and so on with an uninterrupted power supply to rotate the motor can be used to fix the direction and receive the signals. The system is simple and hence the design complexities are mostly avoided compared to the existing smart antennas.

## 2. PROPOSED SYSTEM

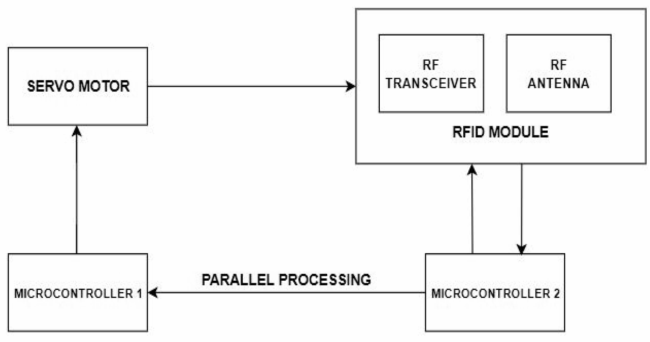


**Fig -1**: Block diagram of system

The system consists of two microcontrollers. Both are ATmega328 since it has to drive the motor by sending the orientation signal and also make the RC522 module wait for the tag. Once the tag is kept near the RFID module, the microcontroller 2 will send a high bit to the microcontroller 1. Once the bit is received from the microcontroller 2. The microcontroller 1 will stop rotating the servo motor and the direction will be fixed and the angle of orientation will be printed in the serial monitor for prototyping purposes.

## 3. BLOCK DIAGRAM EXPLANATION

### 3.1 ATmega328


**Fig -2**: Arduino UNO

For the purpose of prototyping, The Arduino Uno board is used. The Arduino Uno board uses a microcontroller called ATmega328 has 32 Kilobytes of Flash Memory, 2 Kilobytes of Static RAM and 1 KB of EEPROM. It can drive 40 mA at the output pins and that will be enough to give signals to the servo motor. The modes of communication possible in Antenna are UART, I2C and SPI. It works at a clock speed of 16 MHz which will be able to fix the antenna in the exact direction with a minimal amount of error. The Arduino board also has another microprocessor caller ATmega16U2 specifically programmed as a USB-to-serial converter.

There is a 5V supply which can be connected to the Vcc of the servo motor. It also has features like 14 digital I/O pins out of which six can be used as Pulse width modulation outputs, a Power jack, a ICSP header and a reset button. We can give power supply to the Arduino either by using the USB to serial connection or a reset button.

### 3.2 RC522


**Fig -3**: RC522

Radio Frequency Identification (RFID) consists of two system, Transponder - the tag/key and Transceiver - the reader (i.e., RF module with antenna). The working of RFID module is that the module generates high frequency EMF which is received and transmitted by the tag/key, when the tag/key is in the vicinity. In other words, it is a RF sensor. The RC522 RFID Reader module is designed in such a way that to create a 13.56MHz electromagnetic field to communicate with the RFID tags/key which has a read range of 5 cm and of memory 1KB. It is an eight-pinout module with pins as; VCC, RST, GND, IRQ, MISO/SCL/Tx, MOSI, SCK and SS/SDA/Rx.

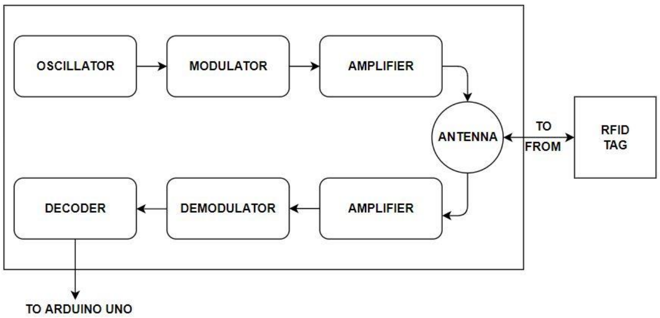


**Fig -4**: Block diagram of RC522

### 3.3 Servo Motor

Servo motor is an automated electric device, which is nothing but a motor coupled with a sensor to rotate with high precision like particular angle, velocity and position. The servo motor works in a closed loop mechanism which consists of a Controller circuit, Amplifier, encoder, servo motor and shaft, where the controller circuit plays a major role in positioning. There are two types of servo motor, which we use as a DC servo motor. The Servo motor works on the principle of Pulse Width Modulation, so that the rotation angle is controlled by the pulse duration. Basically, a servo motor is controlled by a potentiometer and some gears.

Here, the speed is directly proportional to the supply voltage with a constant load.


**Fig -5**: Servo Motor

## 4. PROTOTYPE IMPLEMENTATION

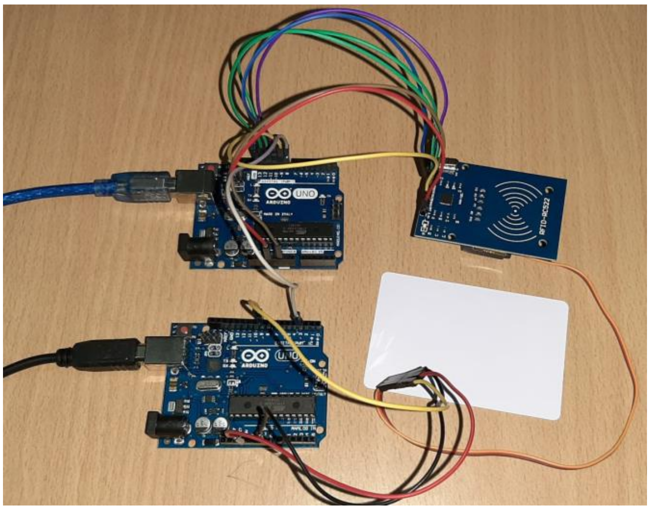

**Fig -6**: Hardware Modelling

## 5. FLOWCHART

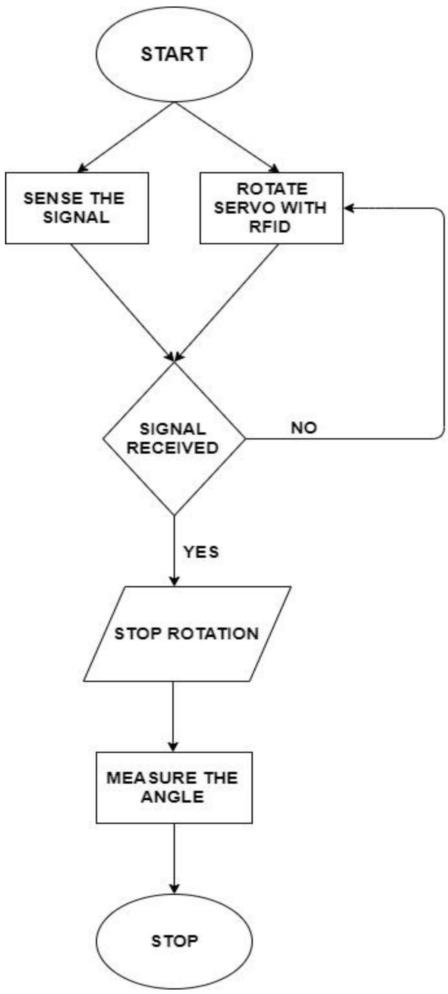


**Fig -7**: Flow of the algorithm

## 6. DESIGN IMPROVEMENTS

### 6.1 Using NPN Transistors

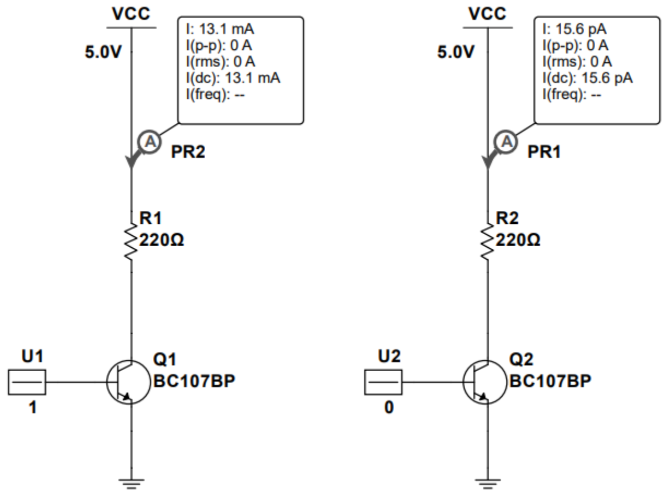


**Fig -8**: Simulation of NPN transistor controller

The proposed design can be improved by the usage of NPN transistors as controllers which eliminates the purpose of a second microcontroller. Assume the load resistor as a motor. In the transistor, when a high input is given at the base, the circuit is complete and the current flows through load which is assumed as a motor. When a low input is given at the base, the circuit is open and there is no flow of current across the motor. This behavior of the transistor will help us to reduce the usage of two microcontrollers. When the signal is received in the system, we can stop the rotation of the servo motor by giving low input to the base. When the circuit is open, reverse saturation current passes through the motor and transistor. From this, it's possible to check the open or short condition of the circuit. This method is only for analyzing theoretically and it cannot be implemented practically since this will result in heating of the whole system. Although the system cannot be implemented with the transistor, a suitable control logic circuit can be designed which exhibits the replica of the transistor which will avoid the use of microcontroller.

### 6.2 Using Solar Panel as Power source

The servo along with the RFID module rotates all the time, continuously tracking the incoming signals. Using a battery to power these would be impractical. Instead, a solar board is used which is a more convenient and sustainable source of power. A 7V solar panel can be approached for use here.

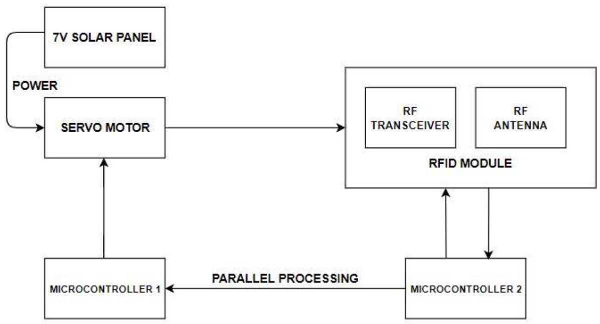


**Fig -9**: Revised Block diagram with Solar Panel

## 7. RESULT

### 7.1 Output

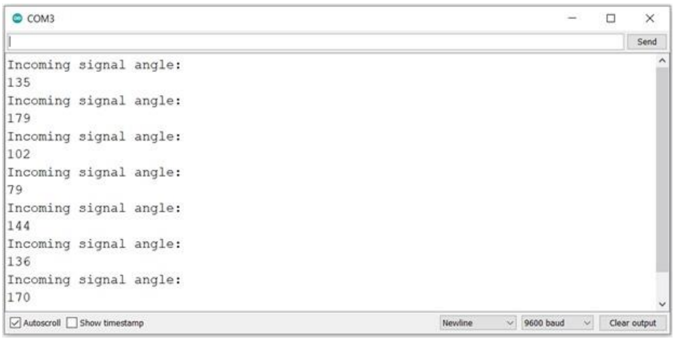


**Fig -10**: Serial monitor output

Serial communication is initiated and the results are printed in the serial monitor. When sending the control input to stop the servo motor, the microcontroller prints the angle (or position) of the antenna in the serial monitor in order to give us the information. The tag is kept at different angles for 7 trials. The signal is sensed at different angles. They are measured and printed at the serial monitor.

To detect the tag, RFID uses a hex code. the hex code is converted to a decimal code. Upon conditional checks on the decimal code, the tag is detected and it is indicated to the processor.

### 7.2 Cost analysis

| S. No | Component | Quantity | Cost (in Rs.) |
|---|---|---|---|
| 1 | Arduino Uno | 2 | 800 |
| 2 | Servo motor | 1 | 180 |
| 3 | RFID module including card/tag | 1 | 130 |
| | **Total** | | **1110** |

**Table -1:** Total Cost of the components

## 8. CONCLUSION

This algorithm and the design are very simple and effortless as compared to the existing signal processing algorithms in smart antennas as they are much complicated. This simple smart antenna precisely detects the RF signal using the transmitter, receiver and emitter in the module which showcases the influence of antennas and plays a major role in every Electronics and Communication device.

## REFERENCES

[1] Balanis E S, "Antenna Theory Analysis and Design", 5th Edition, John Wiley and Sons Inc, Singapore, 2016.

[2] Massimo Banzi, “Getting Started with Arduino”, 2nd edition, O’reilly, 2011.

[3] V. Daniel Hunt, Albert Puglia, Mike Puglia, “A Guide to Radio Frequency Identification”, Wiley, 2007.

[4] Lal Chand Godara, “Smart Antennas”, CRC Press, 2004.

[5] Joseph C. Liberti, Theodore S. Rappaport, “Smart Antennas for Wireless Communications: IS-95 and Third Generation CDMA Applications”, Prentice Hall PTR, 1999.

**BIOGRAPHIES**

**SUJITHKUMAR M A**, currently doing his under graduation in Electronics and Communication Engineering from PSG College of Technology.

**SAMRITHA D**, currently doing her under graduation in Electronics and Communication Engineering from PSG College of Technology.

**VIBOOSITHASRI N S**, currently doing her under graduation in Electronics and Communication Engineering from PSG College of Technology.

**GOWTHAM EASWAR K**, currently doing his under graduation in Electronics and Communication Engineering from PSG College of Technology.