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Design and Implementation of RF based Wireless Remote Control Generator System

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***Abstract*—this paper presents the design and implementation of RF based wireless remote control generator system that can be interfaced with automatic changeover. We noticed that generator system is designed to be powered ON by pressing a button or turning a key or drawing the rope tiled on its body. The generators are kept on the back corridor or outside of the house due to the noise they generate. The owners usually walk a distance where they are kept to switch ON or switch OFF the generator system. This has been a stressful process to the generator owners whenever the service of the generator is needed. This work is designed to bridge the gap (or distance) between the generator and the owner. The owner can remotely switch ON or switch OFF the generator kept at hundred (100) meter distance around his or her building which operates with a radio frequency of 435MHz.The remote controlled generator involves a transmitter unit which sends a wireless signal through an antenna and this signal is received by the reception unit. This signal is further processed by the controller unit and the processed signal is sent to relay which acts as a switch to trigger the generator ON or OFF. This work is tested with accuracy and finally interfaced with the automatic changeover.**

***Index Terms*—wireless remote, Arduino Uno, Generator system, radio frequency**

I. INTRODUCTION

Radio Frequency (RF) and wireless have been around for over a century with Alexander Popov and Sir Oliver Lodge laying the groundwork for Guglielmo Marconi's wireless radio developments in the early 20th century [1]. In December 1901, Marconi performed his most prominent experiment, where he successfully transmitted Morse code from Cornwall, England, to St John's, Canada. The ability of a system to operate autonomously, carrying out tasks that are unachievable by conventional machines, opens up an enormous range of applications that are uniquely suited to automated processes requiring wireless communication over a range [2]. Such systems need to operate over a wireless network in certain environments and achieve certain tasks. When we talk about wireless automation, we simply refer to radio frequency or GSM communication over the IOT (internet of things) platform [3]. However, the choice of which communication platform (network based or radio frequency based) to be used is largely dependent on the nature of task to be carried out and what parameters are concerned with the process and particularly the cost effective nature of each platform to be used. Such parameters as mentioned above have very vital effects over the nature of design [4]. For instance, a very important parameter is the range over which communication is to be established. This determines largely what decisions are to be made as regards the operation of the system. This is because a lot of other parameters will vary as the range increases or decreases. These parameters are tied primarily to the communication and the range of communication such as cost, signal strength, receptivity and the number of processes to be controlled or operated [5,6]. On the event of comparing varying effects of these mentioned parameters, radio frequency (RF) communication is preferred for short range wireless communication [7]. A maximum range of one hundred meters has been chosen as the required range over which communication is to be established and will determine the circumference of the work. In today's world as in [8,9], wireless communication over the embedded system platform has become a wide sphere of technological possibilities as very intelligent or complex processes requiring high precision in operation can be fully operated wirelessly, even from the comfort of one's home.

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II. METHODOLOGY

The design process of the RF wireless communication based system can be approached in several ways. This work employed the use of wireless transmitter-receiver interface via the microcontroller architecture to control the communication of two similar but distinct units. It uses encrypted header files for noise filtration and error checking during communication. During operation, it is expected that whatever is sent at the transmitter unit is received at the reception unit as long as the distance between the transmitter and receiver is between the range of zero to one hundred meters (0-100m), being the distance governing this research work. The various components required by the system are represented in block diagram as shown in fig 2.1 below.

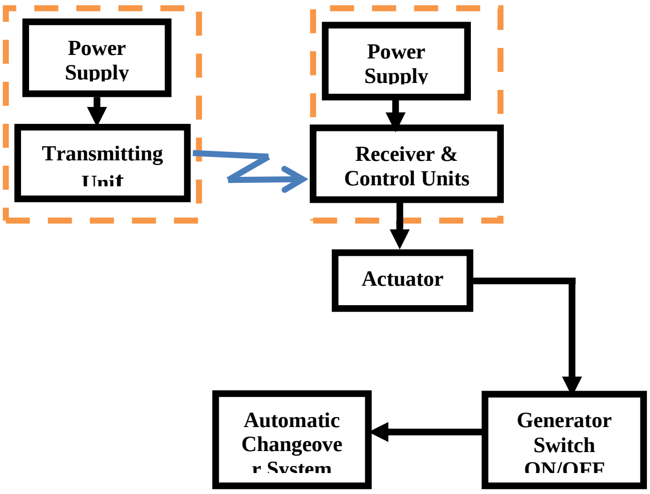

Fig. 2.1: Remote Control Generator block diagram

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A. Power Supply

The power supply unit is designed to make use of DC battery. The 9V and 3V batteries are connected in series in order to generate the required current for the system which is finally regulated with 7805 IC. The reason is that the transmitter unit (wireless remote control unit) can be moved from one point to another and should be able to start the generator system placed at 100m distance. The system power supply circuit diagram is shown in fig. 2.2.

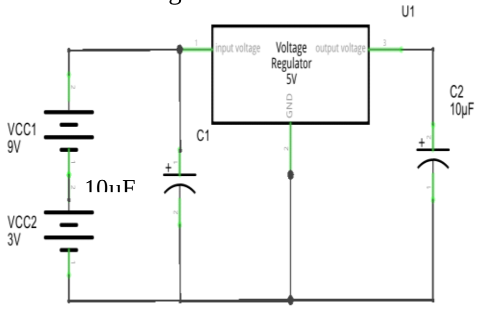

Fig 2.2.: Block diagram of System Power System

The battery always provides regulated +5V to the system for its operation. The battery can be changed when discharged or dies. The transmitting unit and receiving unit have separate power supply unit of the same rating.

B. System Transmitting Unit

The system transmitting unit is designed to operate at radio frequency of 435MHz which is compatible with the architecture of the Arduino microcontroller interface used. If there is a challenge of incompatibility, noise will be generated and most times, data/signals will not even be sent at all. The transmitter unit has four pins, two data pins, one HIGH pin and one LOW pin. The data pin is connected to the signal peripheral designated from our microcontroller while the power pins are all connected to their respective polarities. The transmitting unit has a supply voltage under which it can operate freely. Thus, the higher the supply or input voltage given to the transmitter (although within its rated range), the longer its transmission tends to go. The circuit diagram of the interface between the transmitter and the Arduino uno is shown in fig.2.3.

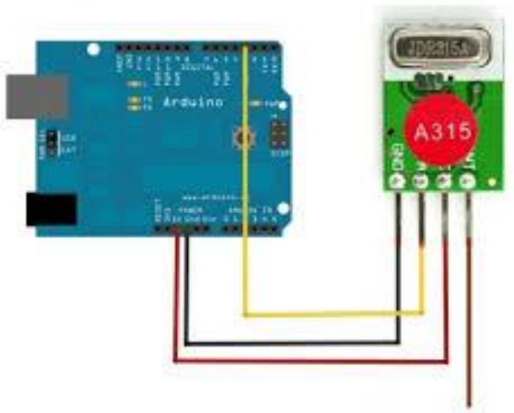

Fig 2.3: System transmitting unit circuit diagram

C. Reception Unit

The reception unit is designed to be compatible with the Arduino Uno architecture which is responsible for receiving, interpreting and actuating incoming data/signal from the transmission unit. It has three pins rather than four when compared with the transmitter. The three pins are for power, ground and data/signal transmission. The RF receiver works almost like the RF transmitter, but in a reverse manner. It receives data from the transmitter, send it to the controller unit which processes the data and triggers the relays to switch ON or OFF the generator system. The receiver interface with Arduino uno board is shown in figure 2.4.

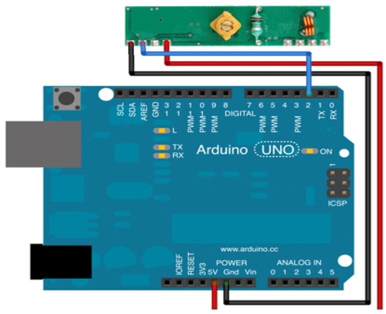

Fig 2.4: Microcontroller interfaced with RF receiver

D. Arduino Uno Board with Microcontroller

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analogue inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It can be powered by connecting it to computer with a USB cable or powered with an AC-to-DC adapter or battery. It receives inputs from the transmitter and triggers the actuator for proper action to be taken. The schematic diagram of the Arduino microcontroller board can be represented in figure 2.5.

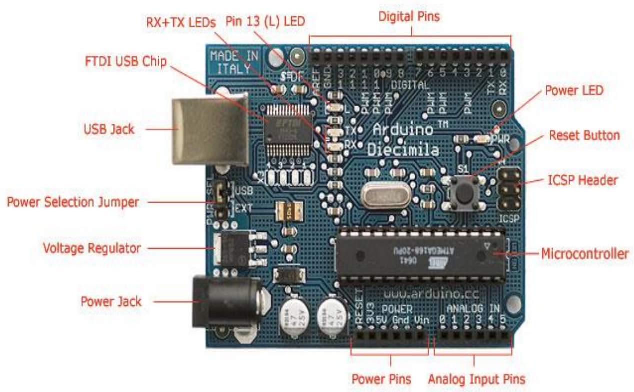

Fig 2.5: Arduino Uno board with Atmega 328

E. Actuator (Relay) unit

A relay is usually an electromechanical device that is actuated by an electrical current. The current flowing in one circuit causes the opening or closing of another circuit. In this work, relay is employed to switch ON or OFF the generator system. The controller activates the relay for necessary action. The Arduino uno board interface with the relay is shown in figure 2.6.

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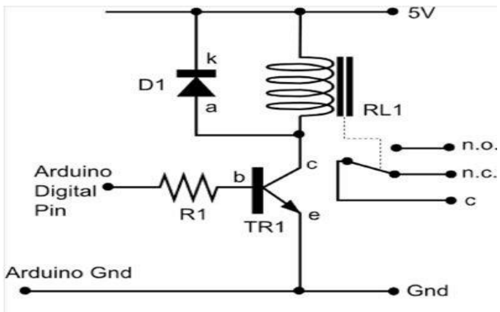

Fig.2.6: Relay interface with Arduino uno board

F. *Operation of RF Transmitter and RF Receiver*

The RF transmitter and receiver operate with a frequency of 435MHz. To transmit and receive radio signals within the specified frequency, an antenna is used at both ends. Since antenna is designed to pick up thousands of radio signal at a time, a radio tuner is necessary to tune the required frequency. When the user presses a button on the wireless remote at the transmitter unit, the controller picks the signal and encode it, then send the encoded signal to the antenna which broadcast it on the space. The receiver at the other end traps the signal via its antenna. The signal is sent to the controller which decodes it and triggers the actuator to switch ON/OFF the generator system depending on the button pressed at the transmitter end. Also signal is sent to the automatic changeover system for proper changeover. When there is light, the user initiates the OFF command button and the generator is switched OFF and changeover returns back normal. The transmitter and receiver algorithms are shown in figure 2.7

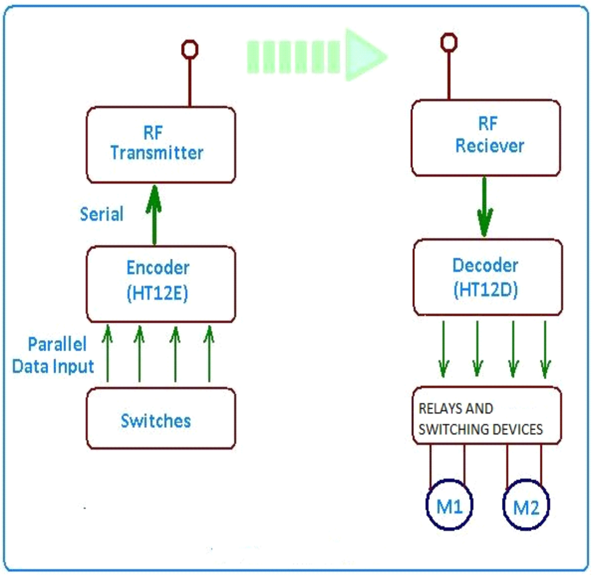

Fig.2.7: RF Transmitter & Receiver mode of operation

G. *Transmitter Unit Flow Chart*

The transmitter flow chart comprises of five processes and one conditional statement. The operation commences when the circuit is initialized and ready for input signal as expressed in the flow chart shown in figure 2.8. The switch input button is triggered on, which converts the input signal (16-bits binary word) and transmits it in hexadecimal signal (8-bits word). When the conditional statement is true, the conditional statement ensures that the transmitter comes ON and transmits a signal through radio frequency to the receiver. However, if the conditional statement is false, the relay is energized and reproduce hexadecimal equivalent of switch binary inputs by C based conversion which acts as a loop or feedback.

H. *Receiver Unit Flow Chart*

The receiver flow chart comprises of four processes and one conditional statement. The operation commences when the circuit is initialized and ready for receiving signal as indicated in the flow chart shown in figure 2.9. As soon as signal is sent from the transmitting unit, it is broadcast at frequency 435MHz. At the receiving unit, the antenna picks the signal, send it to controller which converts data from hex to binary and trigger relay/switch to start the generator and initiate automatic changeover.

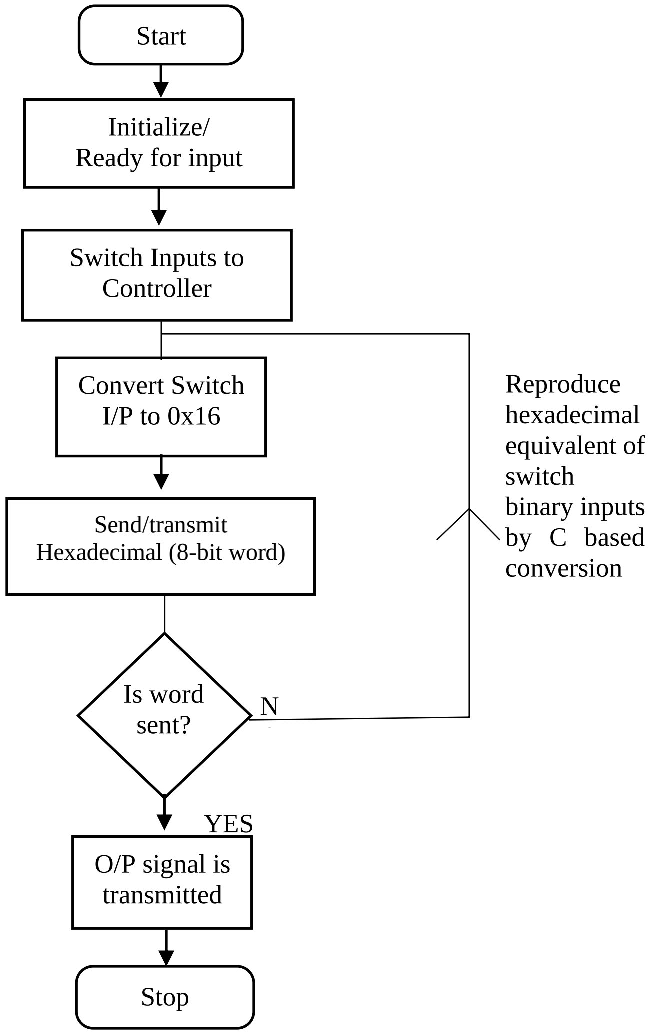

Fig 2.8: Transmitter unit flowchart

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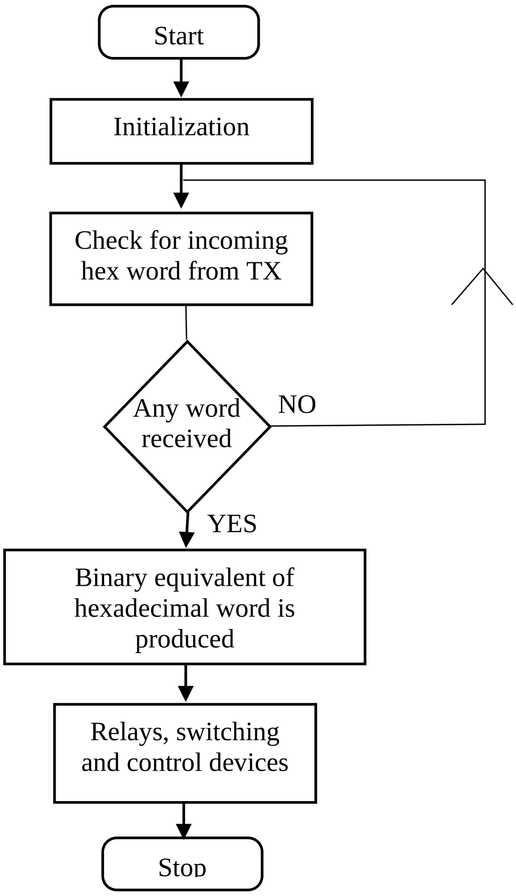

Fig 2.9: Receiver unit flowchart

III. RESULTS AND DISCUSSION

A. System testing

- **Baud rate test**

The baud rate test is a test that describes or analyses the communication speed or rate of communication between transmitter and receiver. It analyses the rate at which the transmitter converts binary input to hexadecimal equivalents, processes the result and transmits the signal down to the point where the reception unit receives the signal, processes the binary equivalent and conveys an actuation vehicle in switching relays which is actually the core of the work. After this test, our baud rate was set at a value that is centralized to avoid being too fast or too slow thereby introducing latency in communication.

- **Input power test**

The effect of the input power to the range of communication was tested here, and the corresponding readings were taken as shown in table 3.1.

Table 3.1 showing input power and range relationship

Input Power	Range/Distance	Analysis
5V	20 meters	Communication established
5V	30 meters	Weak signal is received
7V	30 meters	Communication established
7V	60 meters	Weak signal is received
9V	60-90 meters	Communication is established

From the simple analysis gathered by the input power test, it was practically observed that the theoretical range of communication is quite different from the operational range. As the DC transmitter input/supply voltage increases, the operational range also increases. A 5V reference voltage supply is used to analyze and check for the varying effects. It is observed that as the range between transmitter and receiver is increased for voltage supply of 5V DC, the signal strength experiences a drop and irregularities are observed over the baud rate.

- **Interference test**

The interference test is a transmission test. Here, effects of various parameters are observed on the transmission. Some of these parameters that have interference effects are walls, Objects and Frequency interference.

Walls and objects: - A transmission test was carried out in both open field and walled environments; it was observed that the walls and huge objects had interference on the communication efficiency as the radio signals are not always able to diffract through the objects.

Frequency interference:-Another test that was to be carried out was the frequency interference test which was to check the effect of other ongoing transmissions on our own radio frequency communication. This test was not actually carried out in the practical sense as no exact frequency transmission could be generated to carry out the test.

B. Packaging

After the testing of different units of the system, the transmitter unit and receiver unit of the system casing were carefully constructed. The interior and exterior transmitter units are shown in fig.3.1a and fig.3.1b. Also the internal and exterior receiver units are shown in fig. 3.2a and fig.3.2b respectively.

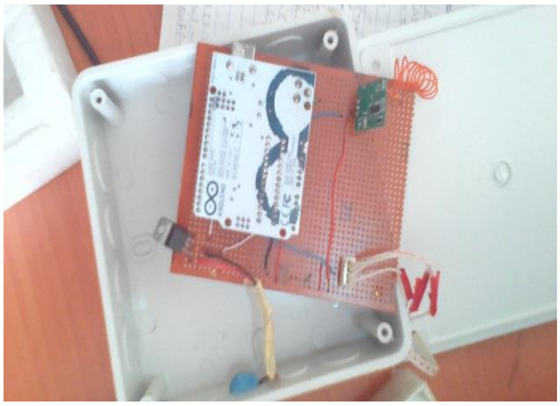

Fig.3.1a: interior view of transmitter unit

Fig.3.1b: Exterior view of transmitter unit

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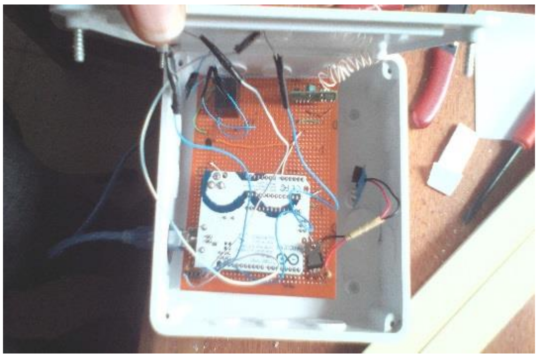

Fig.3.2a: interior view of the receiver unit

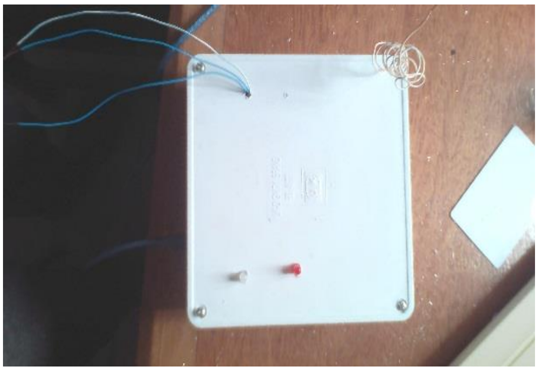

Fig.3.2b: Exterior view of the receiver unit

IV. CONCLUSION

Having two or more intelligent systems being able to communicate with each other wirelessly over a distance opens lots of possibilities. Remote sensors for temperature, pressure alarms, Robot control and monitoring from 50 feet to 2000 feet distances, Remote control and monitoring of nearby or neighbor-hood buildings, Autonomous vehicles of all kinds as well as a whole lot of other factors that have evolved through the use of wireless communication technology. It is observed that in the nearest future of embedded systems application to industrialized systems, very smart operations would evolve where control of certain systems would be fully unmanned or autonomously guided or controlled. This would range even down to applications of radio frequency controlled robots for Rigs and also for oil and gas systems. Smarter versions of remotely operated vehicles would also be developed and would also open the windows of international bodies to third world countries like Nigeria in research and development.

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