NOVEL APPROACH OF DETECTING FAULT IN POWER LINE USING WIRELESS SENSOR NETWORK

Abhijit A Dutta[1], Shivpal R Verma[2], Harsha B Sarvaiya[3]

[1]*Department of Electrical Engineering DBACER, RTM Nagpur University, India*
[2]*Department of Electrical Engineering DBACER, RTM Nagpur University, India*
[3]*Department of Electrical Engineering PIET, RTM Nagpur University, India*

Abstract

Fault occurring in power line are mostly asymmetrical in nature thereby detecting and locating fault is very necessary for healthy operation of distribution system. Fault which occurs in system makes the working of system untrustworthy. In this paper a novel concept using wireless sensor for detecting fault which includes phase to phase, short circuit and mainly line to ground fault is analysed. In the proposed concept power line is divided by WSN (wireless sensor network) nodes which will sense the faulty condition in power line send command to ARDUINO board and via ATmega328 microcontroller, displays to operator and send SMS through GSM modem to service engineer. This is well demonstrated with the help of hardware model and encouraging results are obtained which can make WSN an attractive instrumentation solution in electrical distribution networks and also a viable tool for detecting fault in power transmission line for its accurate fault detection

Keywords: *Wireless Sensor Network, Optimum operation, Arduino, hall-effect current sensor, sensor nodes.*

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1. INTRODUCTION

The demand for a reliable electric power has become necessary parameter in power sector where even a single or small fault can hamper the economy of the country thus the power system should operate at normal operating condition or at no fault condition. Generally our system is prone to various fault condition or abnormal condition which may be due to natural events like lightening, falling of trees etc.. or due to various transients , power swings occurring from time to time and frequency disturbance. This fault affects the reliability or reliable operation of system such as voltage instability, over current in turn power quality degrades due to fault. There are various types of fault occurring in Power system they are Line to Line Fault, Line to ground fault and Three phase fault out of which the frequency of Line to ground fault is most. To prevent people and property from damage or injury, electrical faults in a power system must be cleared as soon as possible.

In the proposed concept with the use of wireless sensor network exact location of fault can be diagnosed. There by providing optimum operation of electric power. The purpose of this paper is to provide a solution in simple manner to detect the fault and to locate the exact position of fault which will ultimately lead to optimum operation of the whole system and to improve the reliability of distribution network.

Also the electric distribution network is divided into pieces of wireless sensor node which will constantly interact with primary node which will be in server room. Each sensor node comprise of three components namely A] ACS712 hall-effect current sensor B] Arduino mini pro C] nRF24l01 transceiver. Each sensor node is given a unique address on different electric pole. During the normal operation the sensor node communicate with the main primary node giving conformation that the operation of power line is normal. Any fault occurred in between any node will be sensed by the sensor node and it will send the report to primary node. Then the arduion will compare the data and if difference in data then the condition is termed as faulty. Thus giving us the exact location of fault occurred. Repair team will be send to the faulty location. After a delay a SMS will be send to service engineer in case the operator did not corresponded. Proto type hardware is been by our team.

2. ARDUIONO TECHNOLOGY

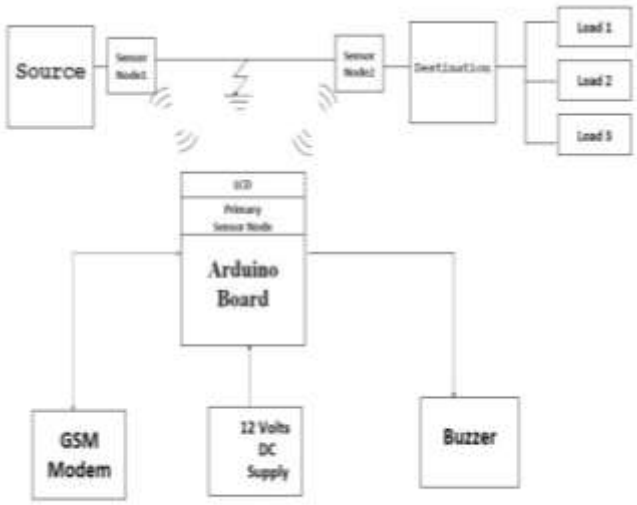

Fig 1 Block Diagram of ARDUINO Concept

In block diagram of our proposed concept is shown in figure 2. We take on one side a source and on another side destination and in between sensor node is deployed. Sensor node will measure the current value through power line and will send it to primary sensor node which is interfaced with arduino uno. Arduino will execute the program embedded it in and will compare the value of s_1 and s_2 for any fault in power transmission line it will sense and send SMS to service engineer with the help on GSM modem incorporated.

2.1 ARDUINO

It's a great tool for developing interactive objects which takes input from various sensors, actuators, switches and controls the output for obtaining desired result. [4] Arduino can sense, control and calculate more easily than any existing fault calculating method. It's an open source computing platform which is based on simple microcontroller board and a development environment for writing software.[8]

There are many advantages[5] using arduino:

(a) It is a open-source hardware. The software is also easily accessible to all without prior permission to use.

b) One of the greatest advantage of using arduino is that it can be runned on any operating system such as windows, Macintosh, Linux unlike other micro controllers which are limited to windows.

c) As arduino is open-source software platform so you can get lots of source code available on online forum & communities related to arduino.

Here we use two different arduino namely arduino uno & arduino pro mini. The main difference between both of them is its microcontroller chip arduino uno uses Atmega328 & arduino mini pro uses ATmega168.

Fig 2 Pin layout of ATmega328

2.2 nRF24l01 Low Power Transceiver

As shown in the figure 3 [6] The nRF24L01 integrates a complete 2.4GHz RF transceiver, RF synthesizer, and baseband logic including the Enhanced ShockBurst hardware protocol accelerator supporting a high-speed SPI interface for the application controller. The nRF24L01 module is worked at 3V voltage level. Figure 4 shows the interfacing of arduino with nRF24L01 transceiver. GND of arduino is connected to GND of nRF24L01, VCC of Arduino is connected to VCC of nRF24L01, CE of nRF24L01 is connected to pin 13 of arduino, CSN of nRF24L01 is connected to pin 10 of arduino, CSK of nRF24L01 is connected to pin 13 of arduino, MOSI of nRF24L01 is connected to pin 12 of arduino.

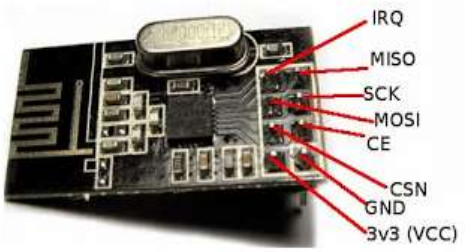

Fig 3 nRF24L01Pin Layout

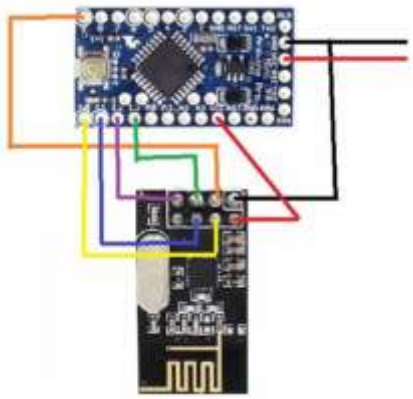

Fig 4 Interfacing of Arduino & nRF24L01

2.3 ACS712 Hall-Effect Current Sensor

The ACS712 is a bi-directional hall-effect current sensor. That means that it will detect positive and negative flowing currents. Since the module runs on 5V, the output of the ACS712 is set to 1/2Vcc or approximately 2.5V to represent zero current flow.

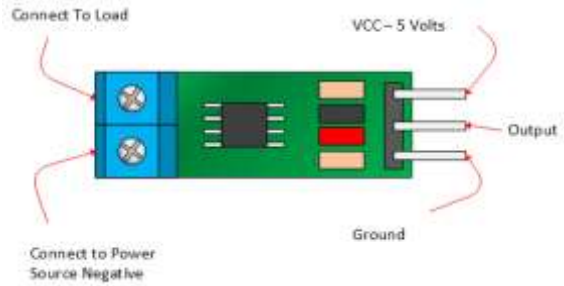

Fig 5 ACS712 HALL-EFFECTS CURRENT SENSOR

Table 4.1: Forward direction current through ACS712

Current	Voltage	+2.5
1	0.185	2.685
2	0.370	2.870
3	0.555	3.05
4	0.740	3.24
5	0.925	3.42

Table 4.2: Reverse direction current through ACS712

Current	Voltage	-2.5
1	0.185	2.315
2	0.370	2.130
3	0.555	1.945
4	0.740	1.760
5	0.925	1.575

So a negative current flow will go from 2.5V down and a positive current will go from 2.5V up. Allegro ACS712 is a device which provides an economical and precise way of sensing AC and DC currents based on Hall-effect phenomenon, which was discovered by Dr. Edwin Hall in 1879. We use ACS712 current sensor to measure current flowing from power line As shown in figure 6 ACS712 is connected in series to power line. And corresponding voltage is given through output pin. Table 1 and table 2 shows the forward and reverse direction current flowing through the hall-effect current sensor. [7]The sensitivity of the current is 185 mV/A. i.e. if 1 amp current flows through ACS712 then 185 mV will be the corresponding voltage through output pin.

2.4 SIM900 GSM Modem

This is a GSM wireless modem that works with GSM wireless network. A wireless modem is similar to a dial-up modem. The main difference is that these modems transmits data via wireless communication system whereas a dial-up modem transmits data through a data communication line which is made up of copper tracks. Mobile phone can be used as a wireless modem. To send SMS, a SIM card is inserted into a GSM modem. Which will then get connected to Arduino through Rx and Tx cable. Thereafter a communication is made between GSM modem and microcontroller by sending instruction set.

2.5 Multiceiver

Multiceiver feature is used in RX modes that contain a set of 6 parallel data pipes having distinctive addresses. A data pipe has a logical channel embedded in outer RF channel. Each data pipe has its respective address which is decoded in nRF24L01. PRX (primary receiver) using multiceiver nRF24L01 can receive data addressed to six different data pipes in one frequency channel; each data pipe has its sole address and can be configured for individual events. Up to six nRF24L01s can be configured as PTX which can exchange data with one nRF24L01 configured as PRX. All data pipe addresses are searched at the same instance. Only one data pipe can accept a packet at a time. All data pipes can perform Enhanced ShockBurst functionality.[9]

Data pipes Common settings are:

- CRC ON/OFF (always ON when Enhanced ShockBurst is ON)
- CRC encoding scheme
- Width of RX address
- Frequency channel
- Rate of air data
- LNA gain

2.6 Piezo Electric Buzzer

The buzzer is a sound-producing module it will generate continuous sound when the +5V is available. The transistor act as a switch and it follows the commands from MC. if the base of the transistor is low the buzzer in off condition due to transistor in cutoff state, and it will give sound when the base is in high logic due to transistor is in active state. Resistor act as a current limiter for transistor.

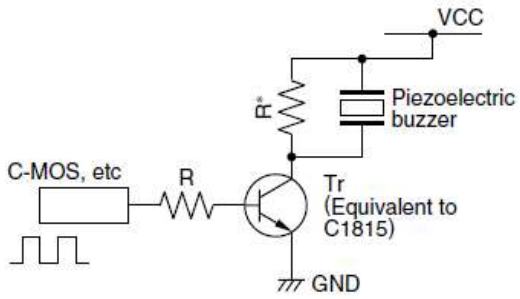

Fig 6 Schematic diagram of Piezo Electric buzzer

Piezo buzzer is an electronic device which generate sound. Reduced weight, simple construction and cheapness makes its use suitable for various applications like reversing indicator (in car, busses, trucks etc…), computers, call bells etc. The phenomenon when mechanical stress is applied to these materials energy is produced. Such materials are known as piezo electric materials. Piezo electric materials are available naturally or manufactured. Piezoceramic is a manufactured material, which possess Piezo electric effect are generally used to make disc, which is a basic part of piezo buzzer. When AC Voltage is applied they get widen or they are compressed, with respect to frequency of the applied voltage thus produce sound. The buzzer produces a loud sound irrespective of the voltage varied to it. It also contains piezo crystals between two conductors. When voltage or potential difference is applied across these crystals, they push one conductor and pull the other these results in a sound wave. Buzzers produce sound in the range of 2 to 4 kHz.[10]

3. RESULT AND DISCUSSION

Basically in our project we have used the following components ACS712 current sensor, Arduino mini pro and nRF24L01 Transceiver initially the current sensor is interfaced with Arduino mini pro pin of ACS712 is connected with (ADC3) of Arduino UNO ATmega328. ACS712 is giving the corresponding output voltage and pin no. 3 and 4 is generally connected to power line in series as

well as pin 2 and 1 commonly connected to power line in series With power line. Now this data is analog and because Arduino microcontroller only read digital voltage so, analog to digital conversion is done at Arduino mini pro and to transmit this data to the primary node wireless nRF24L01 is used which transmit the data to the primary node.

Power line carrying power through will be measured by the hall-effect current sensor ACS712. ACS712 is interfaced with arduino mini pro which will convert the analog measured current value into digital form and then it will transmit the data to the main primary node through nRF24l01 transceiver. This process will happen on both sensor nodes, let say sensor node 1 and sensor node 2 and all the parameters will be calculated in arduino ATmega328 UNO. LCD is interfaced with arduino which will display measured value of s1 and s2. For creation of fault we apply 100 watt bulb in between s1 and s2 thus the phase to ground fault is produced there by creating difference in reading of s1 and s2 due to faulty condition. We gave condition, if s1 is greater the s2+ fault current then fault occurs. So, it will display on LCD screen and buzzer will buzz to alert the operator at server station, at the same time SMS will be sent through GSM modem to on duty service Engineer with exact fault location detail.

Specification:

Destination side load= 100 watt bulb

Power line= 230 volt

Creation of fault= 100 watt bulb in between s1 & s2

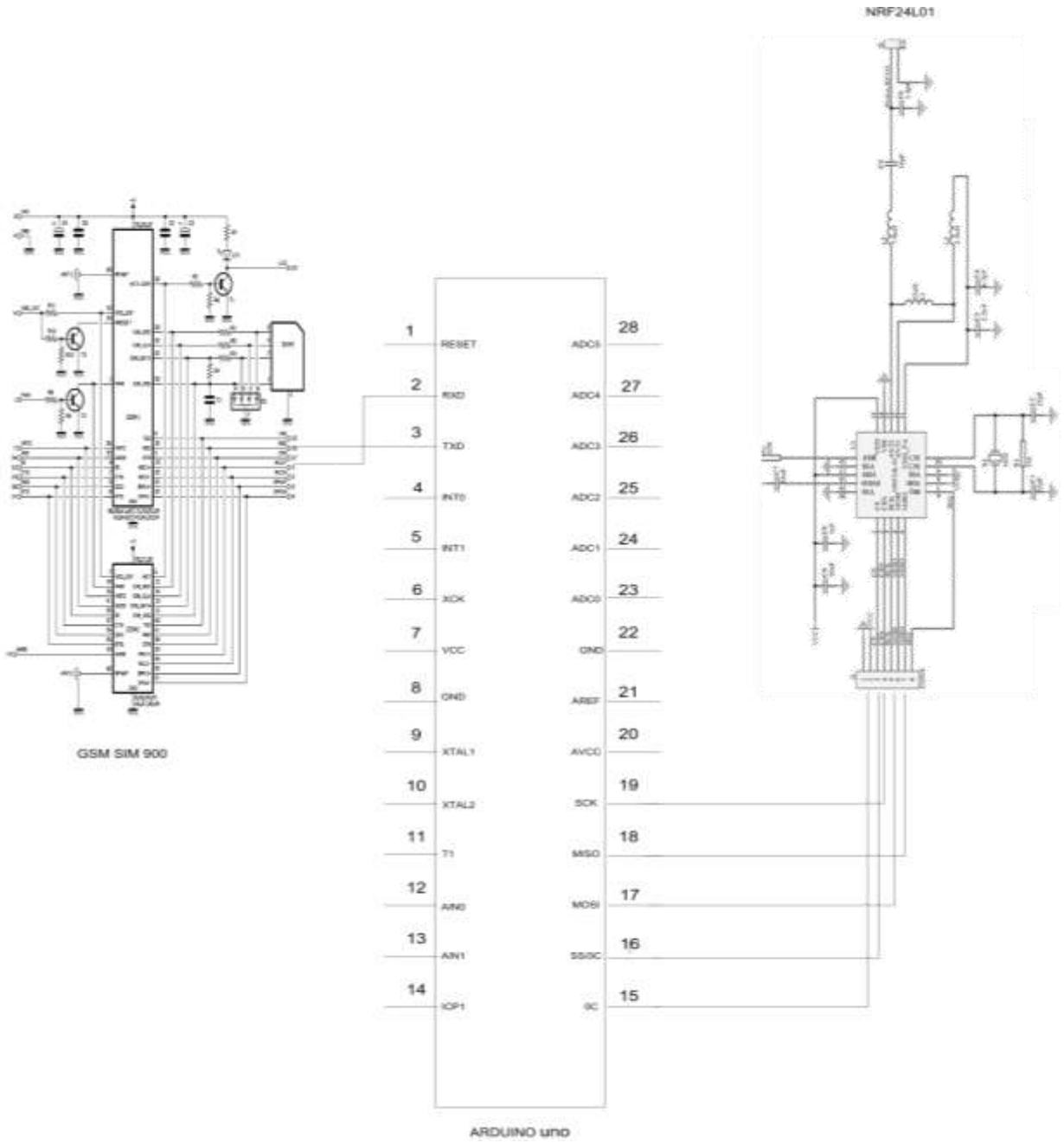

Fig 7. Connection from Receiver Side

4. CONCLUSION

This proposed paper "Fault detection in power line using Arduino and GSM technology" has been properly fabricated and tested. It is quite clear from the above discussion that fault detection in power line Arduino and GSM technology is one of the comprehensive system that clear the fault occurred in power line

Locating fault in a power transmission line is a complicated and severe problem in power system. This concept successfully analyze the asymmetrical faults which occurs in power transmission line. Wireless Sensor Network (WNS) current sensor ACS712. ACS712 interfaced with arduino mini pro converts the analog measured current value into digital form and then transmits the data to the main primary node through nRF24l01 transceiver. Parameters calculated in arduino ATmega328 UNO transmits data to control panel or substation so that immediate action can be done with the help of GSM technology. We have successfully found out the exact location of fault

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