MONITORING AND FAULT DETECTION SYSTEM FOR POWER TRANSMISSION USING GSM TECHNOLOGY

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Abstract *- The efficiency of power systems is largely determined by the effectiveness of the inbuilt power equipment. Monitoring transmission parameters for faults and quick isolation of the system from faults helps to improve the efficiency of the power systems reliability. Current conventional method has its own limitations due to the reliance on technical team to carrying out visual inspection in order to identify any fault. Technologies such as Power line carrier communication and the use of internet based communication systems have their respective demerits. In this paper the scholars presents the study of the use of GSM technology, to provide a reliable monitoring and fault detection system. Appropriate designed specific sensors were used to monitor the changes in transmission parameters such as voltage, current, temperature and frequency. Whenever fault occurred the data acquired were transmitted to the utility mobile phone as SMS via the GSM wireless network. The system hardware was modeled using Proteus simulation tool while Mikro-C was used for the software. With this system, power transmission fault can be detected and isolated at the shortest possible time.*

Keywords: *Power transmission, PIC Microcontroller, GSM technology, Sensors, Efficiency, Transmission parameters.*

1 Introduction

Electrical equipment is prone to disturbances which are fault imposed on the system such as overloading and short circuit [1]. This in turn causes damage to the power equipment in the power system and also at the consumer's end. The impact can bring about a short or long-term loss of the electric power in an area. Prompt attention to power transmission faults is very vital in power systems, avoiding harm and instability to the system. To overcome these challenges, a power transmission monitoring and fault detection system using GSM technology is proposed. There are several existing systems that can be deployed but however they all have their respective limitations for electrical applications [2]. This is why GSM technology is chosen to deliver a cost effective, rigid and robust communication as it enhances speed of communication irrespective of distance [3].

Breach in pre-set short circuit limit is monitored by comparing the current sensed with the pre-set limit .If the current sensed is more than the pre-set current short circuit limit, the PIC Micro-controller sends a signal for the relay to trip off the system, else the system remains connected.

Whenever the set short circuit limit is breached, the system sends a fault detection SMS alert to the utility mobile phone a bi-directional communication was also achieved as the system can also receive command from the utility phone to set a short circuit limit [4]. With this system, an almost real time monitoring system is actualized However the power sector, right from generation to distribution of power is subjected to severe power losses [5]. it is quite paramount to ensure equipment such as transformers, circuit breakers, relays, panels etc. When power transmissions are been disturbed by fault, unless it is critical they tend to be overlooked. These faults, no matter how minor can lead to damage of the power system equipment and be a threat to human life. To overcome these, a GSM based monitoring and fault detection system is proposed to help monitor power transmission parameters. By incorporating fault detection also, the system can be isolated from the slightest fault occurrence promptly. Thus cost of maintenance is adequately contained to an extent. Power transformer which is regarded as the core of any electrical transmission and distribution system are used for stepping up voltage at the output of the generator [6].

2 Review of transmission power.

The transmission system plays significant roles in the supplying of power to the consumers uninterruptedly. Monitoring of these systems is very essential if supplying of healthy power to the consumers is to be achieved.

Incorporated in the transmission system is the protective system which helps in detecting the abnormal or fault signals. The protective relays in the protective system then isolate the faulted part from the entire system, ensuring minimal equipment damage and disturbance. Fault analysis is an essential concern in power system engineering in order to isolate faults quickly and ensure power supply is restored at the shortest possible time [7]. Power demand has resulted in higher line current loads, still bearing in mind that operators are limited by the system and line capacity [8]. Overloading the system will lead to overheating of the system insulation which ultimately result into the system failure [9]. Programmable Logic Controller (PLC). aids the improvement in power quality, ensuring a continuous and reliable supply of power to loads.

2.1 Short circuit fault

Basically, faults can exist in four forms: they include line-to-line fault, double line-to-ground fault, single line-to-ground fault and three phase fault. Different magnitude of fault current can result from each of these types of faults. Short circuits damage can be prevented by employing the use of circuit breakers, relays, or other protection as they help to disconnect the power in response to high current [10].

2.2 GSM technology

GSM stands for Global System for Mobile communications. Developed in 1990, it has become the most popular standard for mobile phones in the world. The implementation environment determines the coverage area of each cell. The boundaries of cells can overlap between adjacent cells (large cells can be converted into smaller cells) [11]. The technology uses a blend of frequency division multiplexing (FDM) and time division multiplexing (TDM). Different users at different time slot use different frequency, hence when user is ON, uses channel 900MHz for three seconds, then hop to channel 910MHz for the next three seconds and so on. Frequency Hoping is the term giving to such process. Amongst the various frequency of the GSM, 900MHz is the operational frequency. It has the ability to re-use frequencies in order to increase capacity and at the same time coverage [12-13].

2.3 Short message service (SMS)

Short Message Service is a common economically affordable service used for receiving and sending messages in text. It uses the GSM network to transfer information. This method of transmitting data is quite popular due to convenience and low cost factor. A single text message can consist up to 160 characters. SMS mobile originated is a term used when a message is sent by a mobile, however when a message is received by a mobile it is termed SMS mobile terminated.
Remote data communication and monitoring is supported by SMS due to it bi-directional data transfer and it stable performance. Amit sachen et al have discussed the user can read remote electrical parameters by sending a command in form of SMS messages [14]. Based on the setting, real time electrical parameter can be automatically sent in form of SMS periodically. Rectification of faults during occurrence of any abnormality in power lines and using SMS through GSM network to inform personnel of this action is also made available. Andriy Palamar et al proposed the system, a Cellular phone which as a Subscriber's Identifying Module (SIM) card with a specific number through which communication is made [15]. The medium of communication is wireless that works on the Global System for Mobile communication technology (GSM). Using cooperative relaying strategies [16-20] these gains are also possible for single-antenna nodes. The scholars considered the necessary parameters to monitor in this research, with the overall objective of improving the reliability of the power system as a whole. With a cloud-based remote management solution, user can have immediate access to generator parameters via a regular web browser. Temperature sensors is used to sense the temperature of the room and a message is sent to the master mobile whenever the temperature rises beyond the threshold parameter using the GSM modem [21-22].

3 Methodology

The system, shown in Figure 1, is used to detect fault and send a SMS alert using the GSM network once the fault is detected. The PIC microcontroller which serves as the heart of the entire system enables access to real time state of the system. It receives the perceived parameter during power transmission, detect breach in short circuit limit set by comparing the current sensed with the pre-set limit. If the current sensed is more than the pre-set current short circuit limit, the PIC microcontroller sends a signal for the relay to trip off the system, else the system remains connected. When the relay trips of the system, an SMS alert is sent to the utility mobile phone via the GSM network.
The GSM module and liquid crystal display (LCD) module are also connected to the PIC microcontroller. The LCD module displays the parameters being monitored in the system, they include; the temperature, frequency of the supply, voltage, current the power consumed by the load in the system.

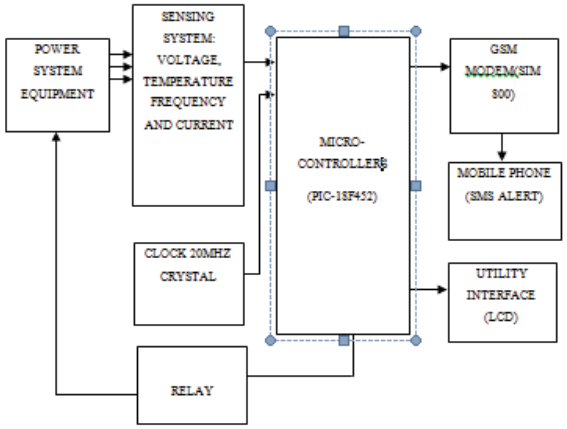

Figure 1. Block diagram of the fault detection system

The 5V regulated DC power supply, shown in Figure 2, was used to power the system components.

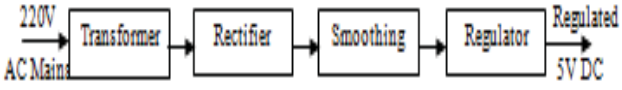

Figure 2. Block diagram of a regulated dc power supply system

Figure 3 is the complete system circuit diagram and Figure 4 is the flow chat.

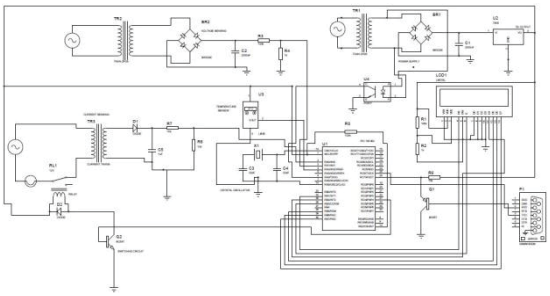

Figure 3. Complete system circuit

3.1 The communication system

The GSM modem is a wireless modem that works with a GSM wireless network. Unlike the dial-up modem, the GSM modem sends and receives data through waves. It requires a SIM card from a wireless network carrier to function. Whenever the set threshold is bridged, the system sends an instant message to the utility mobile phone, stating the existing fault and the location using the GSM modem.

3.2 Operation of the GSM

GSM Modems are controlled by the microcontroller using the AT commands. However the GSM modem supports a fixed and extended set of AT commands. Defined in the GSM standards are these extended set of AT commands which enables the following functions;

- Send SMS messages.
- Reading, writing and searching phone contacts.
- Monitor signal strength.
- Read, write and delete SMS messages

3.3 The switching device relay

The relay acts as an electrical disconnection to isolate the entire system on the occurrence of fault. It shut down or de-energizes other electrical equipment in the system, which will then allow work to be carried out further down the line. As an electrical device for automatic control, it is actuated by variation in the conditions of the electrical circuit.

3.3.1 Operation of the relay

The rated coil voltage of the relay used is 5V DC. This voltage is required for the relay to perform the function of opening or closing it switch. This 5V DC is fed to the relay coil terminals. The magnetic field within the coil collapse whenever there is a sudden interruption in the flow of current through the relay coil as a result of the switch opening. The coil will respond by producing a sudden, large voltage across its leads, causing a large surge of current through it.

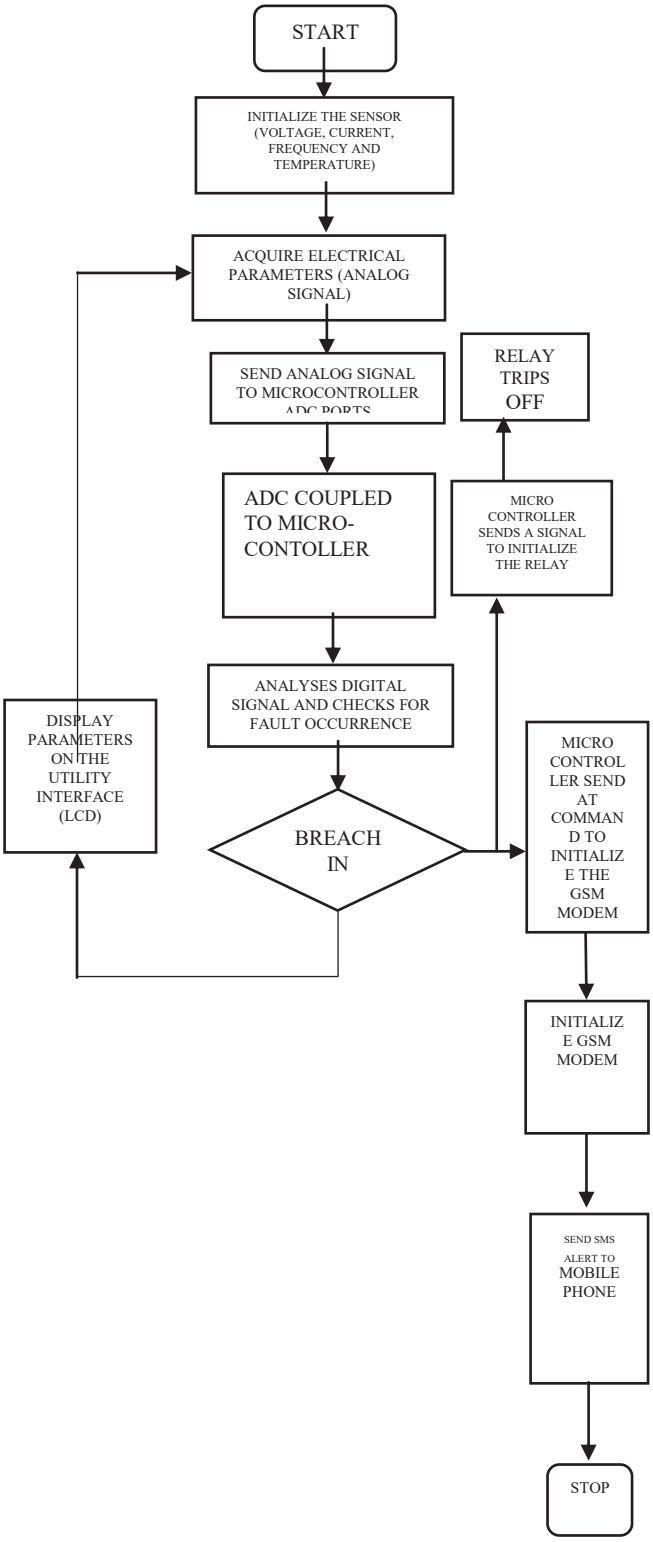

Figure 4. Flow chat

3.4 The sensing unit

The sensing unit consists of the voltage sensing, the current sensing, the frequency sensing and the temperature sensing, as it helps to acquire electrical parameter and make the respective signals available for the PIC to process.

4 Results and observations

The short circuit limit configuration was tested. A current limit of 50A was configured using a mobile phone. The current value set was sent to the SIM in the GSM module with the "#" symbol before the digits i.e. #50, as this is what the microcontroller recognizes (imputed in the code). This was executed by powering up the system and connecting a load with current rating exceeding the pre-set limit of 700W. For the purpose of testing, an electric iron device was used, as it had a befitting current rating of 1000W.

The system tripped off after the short circuit fault was imposed on the system. Hence confirming the test for fault detection and switching system (relay) functionalities.

4.1 Unit testing

The values of the output voltage of each power unit were observed and noted. These values were compared with theoretical values as shown in Table 1. Figure 5 is the graphical representation of Table 1.

Table 2 shows the values of the voltage from the sensing units and Figure 6 is its graphical representation.

TABLE 1: showing discrete voltage readings of the power unit.

S/N	Measurement	Voltage type (AC or DC)	Theoretical value (Volts)	Actual value (Volts)
1	From the Mains	AC	220	214
2	After Stepping down	AC	12	11.2
3	After rectification	DC	12	11.8
4	After regulation	DC	5	5.08

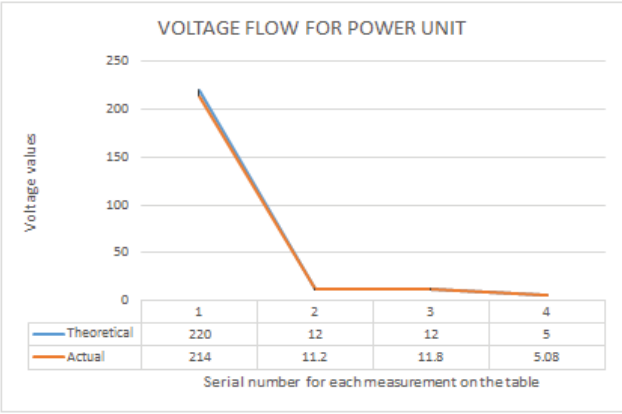

Figure 5: Graphical representation of Table 2

Table 2 shows the output and input voltage readings of each unit.

S/N	Measurement	Voltage type (AC or DC)	Theoretical value (Volts)	Actual value (Volts)
1	Voltage divider input for voltage sensor	DC	12	12.02
2	Voltage sensing output for voltage sensor	DC	0.0099	0.010
3	Voltage divider input for current sensor	DC	12	11.08
4	Current sensing voltage output	DC	0.0909	0.092
5	GSM module power input	DC	4.4	4.2

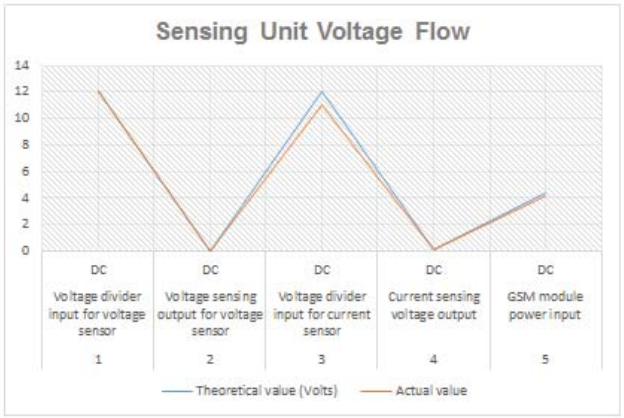

Figure 6 : Graphical representation of Table2.

5 Conclusion

A fault detection system enabled by the use of the GSM wireless network for communication was achieved.

The fundamental objectives of this research work were achieved as the system designed was able to detect transmission fault. The occurrences of faults were displayed and the message was sent through the GSM network over to the utility mobile phone. A bi-directional communication was established as the system was able to receive command from the utility phone to set a short circuit limit.

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