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Automatic continuity checking of power transmission lines with spot intimation

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***Abstract*— Due to natural disorder and climatic changes the overhead transmission lines through which power is transmitted is damaged and sometimes it may break the continuity of the transmission lines which in turn harms the other organism around that place. This paper illustrates how to overcome the above mention drawbacks. It was done by checking the continuity of power transmission lines for every instant of time and sudden discontinuity of power transmission line will automatically shutdown the power through that transmission lines by changing the state of the transformer from ON to OFF and it will be indicated to the nearby electricity board authority indicating spot where the discontinuity occurs through SMS. IR sensor is used for continuous monitoring of power transmission lines and if any change in continuity will switch off the transformer and intimate to authority by SMS using standard GSM module where PIC microcontroller controls the entire system.**

Keywords: power transmission lines, IR sensor, GSM module, PIC microcontroller, Keil C.

I. INTRODUCTION

Due to increase in population of the world, towns are expanding, many buildings construct near high voltage overhead power transmission lines. The increase of power demand has increased the need for transmitting huge amount of power over long distances. Electric power transmission is the bulk transfer of electrical energy, a process in the delivery of electricity to consumers. A power transmission network typically connects power plants to multiple substations near a populated area. The wiring from substations to customers is referred to as electricity distribution, following the historic business model separating the wholesale electricity transmission business from distributors who deliver the electricity to the homes. Electric power transmission allows distant energy sources (such as hydroelectric power plants) to be connected to consumers in population centers, and may allow exploitation of low-grade fuel resources such as coal that would otherwise be too costly to transport to generating facilities. High-voltage direct current systems are used for long distance transmission, or some undersea cables, or for connecting two different ac networks. Electricity is transmitted at high voltages (110 kV or above) to reduce the energy lost in transmission. Power is usually transmitted as alternating current through overhead power lines. Underground power transmission is used only in densely populated areas because of its higher cost of installation, maintenance and the difficulty of voltage control on long cables when compared with overhead wires. A power transmission network is referred to as a "grid". Multiple redundant lines between points on the network are provided so that power can be routed from any power plant to any load center, through a variety of routes, based on the economics of the transmission path and the cost of power.

Overhead conductors are not covered by insulator. The conductor material is nearly always an aluminum alloy, made into several strands and possibly reinforced with steel strands. Copper was sometimes used for overhead transmission but aluminum is lower in weight for equivalent performance, and much lower in cost. Overhead conductors are a commodity supplied by several companies worldwide. Improved conductor material and shapes are regularly used to allow increased capacity and modernize transmission circuits.

An overhead power line is an electric power transmission line suspended by towers or poles. Since most of the insulation is provided by air, overhead power lines are generally the lowest-cost method of transmission for large quantities of electric power. Towers for support of the lines are made of wood (as-grown or laminated), steel (either lattice structures or tubular poles), concrete, aluminum, and occasionally reinforced plastics. The bare wire conductors on the line are generally made of aluminum (either plain or reinforced with steel or sometimes composite materials), though some copper wires are used in medium-voltage distribution and low-voltage connections to customer premises.

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Overhead power transmission lines are classified in the electrical power industry by the range of voltages: Low voltage is less than 1000 volts, used for connection between a residential or small commercial customer and the utility. Medium Voltage (Distribution) is between 1000 volts (1 kV) and to about 33 kV, used for distribution in urban and rural areas. High Voltage (Sub-transmission if 33-115kV and transmission if 115kV+) – between 33 kV and about 230 kV, used for sub-transmission and transmission of bulk quantities of electric power and connection to very large consumers

A major goal of overhead power line design is to maintain adequate clearance between energized conductors and the ground so as to prevent dangerous contact with the line. This is extremely depending on the voltage the line is running at. Overhead line construction is less expensive than underground cabling for the same kVA load. In rural or semi-rural areas, the sheer cost of underground cabling would make it impossible for customers to be able to afford the cost of supply. The down side is that overhead lines operate under continual mechanical stress with exposure to varying climatic conditions. This results in progressive deterioration in time as a result of corrosion, mechanical wear and fatigue, timber rot, etc. All components must be periodically inspected and replaced as required. They are exposed to environmental impacts such as storms, lightning; wind-blown debris and traffic impact (of poles) which means overhead systems are rarely as reliable as underground ones. The greater spacing of overhead line conductors generally results in higher system inductance than cable system. This means an overhead line has a greater voltage drop than an underground cable of equal current-carrying capacity and hence cannot supply power over as long a distance as the underground equivalent, particularly for lower voltage distribution systems.

The reliability of underground distribution is greater than for overhead systems because of the lower number of fault interruptions, as discussed above. However, when interruptions do occur they are generally of much longer duration than those associated with overhead lines. Underground cables have comparatively higher capacitance, and under light load conditions can affect system power factor.

Twenty percent of the electrical accidents occur out of the factor poor maintenance. The reasons for inadequate or lack of maintenance are best known to the utilities / owners of installations. However, we are aware that lack of maintenance not only causes accidents but also results in prolonged interruption of supply affecting thereby revenue generation. It has been observed that organizations / utilities having a well-geared regular maintenance mechanism have been able to maintain an almost accident free record resulting in high morale of the operating personnel. The cost spent on maintenance is easily compensated by the additional revenue and goodwill of the consumers.

The most significant risk of injury from a power line is the danger of electrical contact. Electrical contact between an object on the ground and an energized wire can occur even though the two do not actually touch. Causes of conductor damage are Aeolian Vibration, galloping, sway oscillation, and unbalanced loading.

II. PROPOSED SYSTEM

The proposed system is used to check the continuity of power transmission lines for every instant of time and sudden discontinuity of power transmission line will automatically shutdown the power through that transmission lines by changing the state of the transformer from ON to OFF and it will be indicated to the nearby electricity board authority indicating spot where the discontinuity occurs through SMS. IR sensor is used for continuous monitoring of power transmission lines and if any change in continuity will switch off transformer and intimate to authority by SMS using standard GSM module where PIC microcontroller controls the entire system.

There are many overhead transmission line poles are separated from the distribution transformer. These transmission line poles are run across the streets. These transmission lines distribute power to the nearby houses. There are many reasons for the power interruptions such failure of transformer, discontinuity of power transmission line etc. Due to sudden discontinuity of power transmission line from the pole may harm the organism near to that place.

The proposed system overcomes the above mentioned issues through embedded system. It consists of PIC microcontroller, IR sensors, Solar panel, GSM module and alarm circuit.

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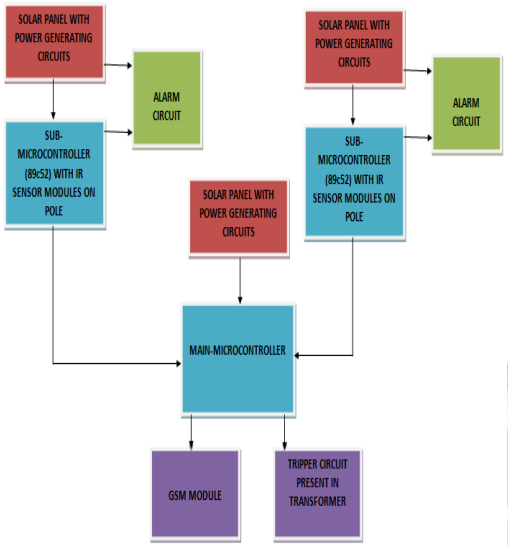

Fig. 2.1 Proposed Block Diagram

Proposed embedded system classified in two major sub-system they are on-pole subsystem and off-pole sub-system.

On-pole embedded sub-system:

It is placed at the top of the overhead power transmission line pole. This setup consists of the 8 IR sensor modules. Four IR sensor modules is placed in either side of the overhead power transmission line poles with an Microcontroller. IR sensor modules placed on the pole is fixed, exactly top of each wire with stiff firm arrangements and one feet apart from the transmission lines. Insulating plate is placed below the each IR sensor module (pointed area in the transmission line). IR sensor module placed above the transmission line will point the black insulating plate.

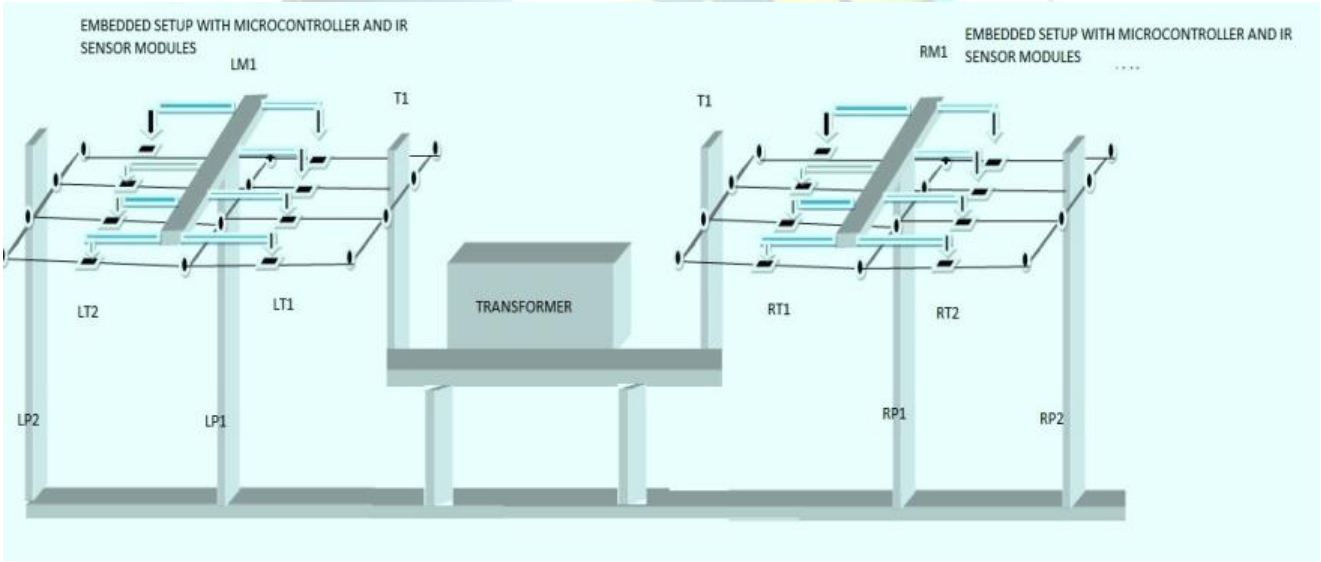

Fig.2.2 proposed model setup

Whenever IR sensor module feeds +5v to the microcontroller, it trigger the main microcontroller which in turn makes the decision to shut down the transformer , raise the alarm and sends the discontinuity pole location information to concern electricity board authority through GSM module.

Consider the figure 1 it consists of,
LP1-left side pole 1
Lp2-left side pole 2.
Lp3-left side pole 3, so on
RP1-right side pole 1
RP2-right side pole 2
RP3-right side pole 3 so on
LT1-transmission lines between LP1 and transformer.
LT2-transmission lines between LP1 and LP2
LT3-transmission lines between LP2 and LP3
LT4-transmission lines between LP3 and LP4

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RT1-transmission lines between RP1 and transformer.
RT2-transmission lines between RP1 and RP2
RT3-transmission lines between RP2 and RP3
RT4-transmission lines between RP3 and RP4
LM1-sub-microcontroller placed in LP1
LM2-sub-microcontroller placed in LP3
RM1-sub-microcontroller placed in RP1
RM2-sub-microcontroller placed in RP3

The power from the transformer is distributed to either side of the poles (LP1, RP1). The transmission line poles present in either side of the transformer is used to distribute the power to customers.

In between transformer and LP1 there are three phase transmission lines and one neutral transmission line, totally 4 lines (LT1). Consider the pole LP1, 4 IR sensor module setup is placed in transmission lines (LT1) and another four IR sensor modules setup placed in the transmission lines (LT2) from 1 feet apart from the pole. These 8 IR sensor modules are connected to the 8 input ports of sub-microcontroller (LM1). IR sensor modules produce the high voltage whenever discontinuity of the overhead power transmission line (LT1 or LT2) occurs. The sub-microcontroller triggers the main microcontroller and the alarm present in that pole.

In between transformer and RP1 there are three phase transmission lines and one neutral transmission line, totally 4 lines (RT1). Consider the pole RP1, 4 IR sensor module setup is placed in transmission lines (RT1) and another four IR sensor modules setup placed in the transmission lines (RT2) from 1 feet apart from the pole. These 8 IR sensor modules are connected to the 8 input ports of sub-microcontroller (RM1). IR sensor modules produce the high voltage whenever discontinuity of the overhead power transmission line (RT1 or RT2) occurs. The sub-microcontroller triggers the main microcontroller and the alarm present in that pole.

Similarly all the setup is placed in odd poles.(LP1,LP3,LP5…,RP1,RP3,RP5…,)
LP3 monitors the transmission lines LT3 and LT4.
RP3 monitors the transmission lines RT3 and RT4.

Off-pole embedded system:

It consists of main microcontroller, GSM module. Main microcontroller gets the input from sub-microcontroller. If the main microcontroller gets +5v from the sub-microcontroller it will shut down the transformer and sends the discontinuity pole location information to concern electricity board authority through GSM module.

III. HARDWARE DESCRIPTION

:

A) PIC Microcontroller(PIC16F877A):

PIC16F877A is an 8-bit microcontroller which has 40 pin DIP and is based on Harvard Architecture. PIC stands for Peripheral Interface Controller and F for flash memory. The PIC16F877A features 256 bytes of EEPROM data memory, self-programming, an LCD, 2 Comparators, 8 channels of 10-bit Analogue -to-Digital converter, 2 capture/compare/PWM functions, the synchronous serial port can be configured as either 3-wire Serial Peripheral Interface for the 2-wire Inter-Integrated Circuit bus and a Universal Asynchronous Receiver Transmitter . All of these features make it ideal for more advanced level A/D applications in automotive, industrial, appliances and consumer applications. So we have utilized the MICROCHIP PIC16F877A microcontroller in the project. Christo Ananth et al. [2] presented a brief outline on principles of electronic devices and circuits which forms the basis of this project.

Figure 3.1 PIC microcontroller

Reason for Selecting PIC16F877A:

Rich in peripherals: The PIC microcontroller has many built in peripherals which can be utilized for various purposes. The 40 pins of PIC make it easier to use the peripherals as the functions are spread out over the pins. This makes it easier to decide what external devices to attach without worrying too much if there enough pins to do the job.

Reprogrammable controller: The PIC16F877A has 8kb flash memory which can be used to erase and rewrite the programs for the controller. Hence the devices can be re-programmed up to 100,000 times.

Easy programming, cheap and reliable: It is easy to program the PIC microcontroller in embedded C language or assembly level language.

B) IR module:

An IR sensor is basically a device which consists of a pair of an IR LED and a photodiode which are collectively called a photo-coupler or an opto-coupler. The IR LED emits IR radiation, reception and/or intensity of reception of which by the photodiode dictates the output of the sensor. If the object is non-reflective, (Black or some other dark color), then most of the radiation will get absorbed by it, and will not become incident on the photodiode. It is similar to there being no surface (object) at all, for the sensor, as in both the cases, it does not receive any radiation.

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Figure 3.2 IR Sensor Module

The sensors used in them are based on reflective/non-reflective indirect incidence. The IR LED emits IR radiation, which in normal state gets reflected back to the module from the white surface around the black line, which gets incident on the photodiode. But, as soon as the IR radiation falls on the black line, the IR radiation gets absorbed completely by the black color, and hence there is no reflection of the IR radiation going back to the sensor module.

C) GSM Modem SIM900:

The GSM900 device integrates an analog interface, an A/D converter, an RTC, an SPI bus, an I²C, and a PWM module. The radio section is GSM phase 2/2+ compatible and is either class 4 (2 W) at 850/ 900 MHz or class 1 (1 W) at 1800/1900 MHz The TTL serial interface is in charge not only of communicating all the data relative to the SMS already received and those that come in during TCP/IP sessions in GPRS (the data-rate is determined by GPRS class 10: max. 85,6 kbps), but also of receiving the circuit commands (in our case, coming from the PIC governing the remote control) that can be either AT standard or AT-enhanced SIMCom type. The module is supplied with continuous energy (between 3.4 and 4.5 V) and absorbs a maximum of 0.8 A during transmission.

Figure 3.3 GSM Module

D) Buzzer:

The Buzzer Module can be used as either an output for creating sound, or as an input for detecting vibration or knocks. To generate tones the Sound and Buzzer Module should have one connection linked to GND (0V) on your microcontroller and the other connection linked to a digital I/O pin. By toggling the pin on and off at a high frequency, it is possible to generate tones.

Figure 3.4 Buzzer

E) Solar Panel

Solar panels will convert solar energy into electrical energy. The output is in Direct Current form. This is a 12V 8W panel. Hence the final output would be around 12Volts and up to 750milli Amp current.

Technical Specifications:
Expected life: 25yrs
Module dimensions 280 mm X 180 mm X 34 mm
Module weight 1.600Kg

Figure 3.5 solar panel

IV.SOFTWARE TOOLS

MikroC PRO for PIC has native support for the mikroICD In-Circuit Debugger feature of the fast USB 2.0 mikroProg-PIC programmer (in both on-board and standalone versions). MikroICD is a separate DLL module which supports Step-over, Step-Into, Step-Out, Run, and Run-to-Cursor debugging operations. Also, the debugger supports standard and advanced breakpoints. MikroC PRO for PIC comes equipped with fully functional software tools that can boost your efficiency and do the job for you, so you can be more productive in your work: LCD Custom Character Tool, GLCD Bitmap Editor, Seven-Segment Editor, UART

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Terminal, UDP Terminal, and HID Terminal, ASCII Chart, Active Comments Editor, Advanced Statistics and more.

The compiler easily becomes your GLCD and TFT GUI design studio when used with Visual GLCD and Visual TFT additional software. Even total beginners will be able to create amazing GUIs. The Drag-and-drop development environment of those programs ensures that you spend less time programming, allowing you to focus on functionality and design. Distribute your projects with the free Package Manager software and your end users will have powerful single-click package extraction and installation of your code.

V. CONCLUSION

This paper illustrates how to check the continuity of power transmission lines for every instant of time and sudden discontinuity of power transmission line will automatically shutdown the power through that transmission lines by changing the state of the transformer from ON to OFF and it will be indicated to the nearby electricity board authority indicating spot where the discontinuity occurs through SMS.

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