Intelligent Line Inspection Robot

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Abstract— This project aims at long transmission lines run across the world to provide electricity in different states, territories, cities, blocks and houses. The major problem here is to maintain the reliability and the efficiency of these transmission lines which is being achieved by regular inspection, done either manually or by using helicopters which is known as aerial inspection and are considered to be expensive as well as difficult modes of inspection. This professional use of a robot would make the inspection and detection reliable and increases the data accuracy. This is similar to a lineman inspecting the transmission lines manually. It consists of a camera which can take image and can inspect ground clearance such as measuring the distance between line and ground. Also TLIR can detect the voltage drop, current drop, theft in electricity, break in the circuit. The whole inspection can be monitored and controlled by the person visualizing it.

Key words: Robot, TLIR

I. INTRODUCTION

In electrical utilities, transmission lines form the backbone of power systems. With regard to reliability and expenses due to power delivery, exact fault location for transmission lines is of vital importance in storing power service, and reducing service time as much as possible. An electric power system consists of electricity generators, power transformers, conducting lines etc. Most of the faults which occurring the transmission lines can cause flow of unusual current causing damages. Because of this which there are increased chances of fire, damage to the devices, and irregularity in power supply etc. Thus there is need for protective system to be installed in the power generating unit which can make the transmission lines safe and various devices from getting damaged.

In addition to the presence of various factors for the failure of transmission lines, installation of new methods of prevention of transmission lines can lead to a power system by modifying transient stability, increasing power transfer capability, preventing massive loss of energy and eliminating the need for more parallel and uneconomical transmission methods. Various factors can cause the physical damage to the transmission lines, such as broken trees, large number of trees blocking the road, increase the load on the line to be broken and theft of low voltage lines. The occurrence of such incidents is one of the reasons for the creation of the fault in the transmission lines.

Transmission line inspection robot helps to inspect the physical condition of overhead transmission line. It is used to detect the damage to transmission line conductors and associated fittings. Robot can travel along the line and pick up any defects in conductors. The fault identified by the robot in the transmission line is then sending to nearby KSEB unit. Many sensors are used to detect the fault of the transmission line very easily. The GSM unit will help to inform the fault messages to nearby KSEB unit.

II. LITERATURE SURVEY

1) According to Abdolhamid Rahid, Mohsen Gitizadeh, SirusMohammadi, this is about a fault location technique for Transmission Line using Phasor Measurement. This paper presents a fault location technique, which combine overhead lines with underground power carrying conductors, using synchronized phasor values acquired by global positioning system (GPS) based or digital relays with embedded PMU or by fault-on relay data synchronization algorithms. The technique is developed with synchronized phasor measurements as inputs. A novel fault section choosing device is proposed to select the fault conducting section in advance. The proposed technique has the ability to locate a fault no matter where the damage is on the transmission line or underground power cable. Both extensive simulation results and line test results are proved to demonstrate the effectiveness of the proposed scheme. Up to the present, the proposed technique yields outstanding performance in practice.

2) According to Balcerek, P Wroclw University of Tech Poland this is about Improved Unsynchronized double end algorithm for locating fault in the power transmission line. A new two-end algorithm for locating faults in aunique power transmission line is presented. A distance to fault is determined from unsynchronized measurements of voltages from two line ends and with additional, controlled use of currents. Measured currents are used under the condition that they come from power units which are not saturated. As a result of that, certain modification of fault location - when comparing to the other known methods - is achieved. The sample examples and results of faulty points accuracy evaluation are reported and discussed in the paper.

3) According to Deepak Kumar Patel, Shudhanshu Tripathi, Ankit Tiwari , a novel anti-theft and monitoring method of streetlamp power cables is presented in the paper. A current signal with frequency varying is injected to the lamp power system, then the resonant frequency can be found the capacitance and the coaxial cable length can be calculated. Whether the cable is theft or not can be judged, and the fault locations can be calculated. This method is not necessary to add device to the end of streetlamp power cables, and it’s not influenced by power transformer varieties and the length of the cable. Simulation tests are carried out. Simulation results show that the method is simple and correct. The thief pays more attention to the cables because of its characteristic of low transmission voltage, dispersed layout and high containing Cu. The public utilities are brought to a great deal of troubles and danger. Take the case of Changsha, the economic loss due to cable stolen was from 6million to 8 million RMB every year since 2005. Meanwhile, it will cause the street lamp not to work and bring inconvenience to the people’s lives. There are four main
methods of anti theft and detection of the cable, such as leakage current measurement method, working current measurement method, DC impedance measurement method, power line carrier method. The first method is that the leakage current is produced artificially, and the leakage current is detected in switch box. This method is affected easily by the climate condition and it is operated only when the street lamp is on. The second method is also operated when the light is on, and the working current is affected by the voltage fluctuation. The third method can be operated when the light is off, but it needs to installed DC load to the end of street lamp cable. In addition, considering the cables buried under ground suffer from heavy rain, its DC impedance is not infinite. Therefore it has a high false alarm rate. The fourth method needs to install power wave carrier receive equipment to the end of the cable, its cost is very high. And this method can’t detect the location of the breaking line. In order to improve the monitoring precision and extend the monitoring range, a novel antitheft and monitoring method of street lamp power cables is presented in this paper. The capacitance of the cable and the load can be calculated through the resonance measurement method, and then the length of the cable can be calculated. Whether the cable is stolen or not can be judged, and the location of the breaking line the transformer type, its detection range is not limited, and it still can work when the streetlamp is off. The simulation results show that the method is simple and correct.

Capacitance current measurement principle: a current signal with frequency varying is injected to the system through an inductor which is in series connection or parallel connection with the street lamp circuit. The circuit capacitance can thus be calculated using the resonance frequency. A current signal with frequency varying is injected to the system, then the return voltage signal \( U \) can be detected. Comparing phase difference between the current signal and the return voltage signal, when it is zero (that is resonance), this signal angular frequency \( \omega_0 \) is the resonance angular frequency of the system. Based on resonant principle, we can derive: \( C = 1/(\omega_0^2 L) \). False alarms exclusion: The lamp cables can be considered to be stolen when the capacitances decrease through analysis above. However, there are another two kinds of conditions in which the capacitances also decrease, the false alarms are produced. The false alarms and its exclusion are introduced as follow: 1) The capacitance damage: With the compensate capacitance of the power line and the capacitance of the current limiter aging or breakdown, the capacitance value will decrease, the false alarm is produced. 2) Single-phase break circuit: When the single-phase break circuit is happened, the voltage can’t be detected and the false alarm will be produced. In the false alarm condition above, it’s just that the single phase capacitance changes, which only affects the resonance frequency of the fault phase, without influence of the resonance frequency of the sound phase.

### III. DESIGN OVERVIEW

**BLOCK DIAGRAM**

The block diagram mainly consist of the following systems:

- **Microcontroller PIC 16F877A**
  The microcontroller that has been used for this project is PIC 16F877A. PIC microcontroller is the first RISC based microcontroller fabricated in CMOS which uses separate bus for data and instruction allowing simultaneous access of program and data memory. The combination of CMOS and RISC provides an advantage of low power consumption resulting in a very small chip size with a small pin count. The main advantage of CMOS is that it has noise immunity than other fabrication techniques. Flash technology is used in PIC16F877A, hence data is retained even when the power is switched off. Easy Programming and Erasing are other features of PIC 16F877A. Here the main aim of the microcontroller is to detect the voltage drop, current drop, crack detection, difference in temperature using sensors. When the robot moves through the transmission line it simultaneously measure the drops.

- **Motor Driver**
  L293D is a dual H-Bridge motor driver integrated circuit (IC). Motor drivers are similar to current amplifiers since it take a low-current control signal and provide a higher-current signal. To drive the motors this higher current signal is used.

- **GSM Module**
  Carry out wireless communication with mobile devices via the GSM module. It is used to send SMS and other GSM operations by controlling it through simple commands from microcontrollers and computers. This GSM Modem can accept any GSM network operator SIM card and is like a mobile phone with a unique phone number. Advantage of using this modem will be that its RS232 port is used to develop embedded applications. Applications such as SMS control, data transfer, remote control and logging can be developed easily. The modem can be directly connected to PC serial port or to any microcontroller. It can be used to send and receive SMS.

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Current sensor
A current sensor is a device that detects electric current (AC or DC) in a wire, and generates a signal which is proportional to it. This signal could be analog voltage or current or even digital output. It is then used to display the current measured in an ammeter or can be stored for further analysis in a data acquisition system.

Display
Liquid crystal displays (LCD) is an alphanumeric display. It is widely used recently as compared to LEDs. It is because of the decreasing prices of LCD, the ability to display characters and graphics, numbers, incorporation of a refreshing controller into the LCD by releasing the CPU of the task of LCD refreshing and also the ease of programming for characters and graphics. The LCD that has been used for this project is 16*2 LCD. Liquid crystal display (LCD) is an optical device shaped into a flat -thin panel made of any number of colour or monochrome pixels with liquid crystals filled in it and arrayed in front of a reflector. It is often utilized in battery-powered electronic devices since it uses only a small amount of electric power.

Wireless camera
A big advantage of wireless camera system is that they do not require a line of site connection between the transmitter and receiver. Latest wireless camera systems are able to handle digital and analogue standard and high definition video signals as well as analogue, digital or embedded audio. Wireless cameras are also ideal for people rendering homes or apartments since there is no need of video extension cables to put through walls or ceilings. The wireless signal range depends on whether there are competing signals using the same frequency as the camera. Additional racking equipments allow operators to control many camera functions wirelessly, so wireless camera systems range about 1Km, although ranges vary depending on topography and surrounding buildings. Outdoors and with clear line of sight, digital wireless cameras typically have a range between 250-450 feet. Indoor range is limited to 100-150 feet.

Voltage Drop Sensor
Simple resistor dividers can be used as voltage sensors. The values of resistor are selected such that the AC mains voltage is divided down to fit the input range of the analog-to-digital converter. The resistor-divider circuit divides down the input voltage by around 1000.

IR Sensor
Infrared (IR) sensor is used here to detect the obstacles in front of the robot or to differentiate between colors depending on the configuration of the sensor. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode that is sensitive to same wavelength IR lights as that emitted by the IR LED. When IR light hits the photodiode, its resistance and output voltage change in proportion to the magnitude of the received IR light. This is the principle of working of the IR sensor.

IV. CIRCUIT DIAGRAM
The circuit diagram mainly consists of:
- Microcontroller
- IR sensors
- Current sensor
- Voltage sensor
- GSM module
- Wireless camera

The main parts of the circuit diagram are the power supply, microcontroller, sensors, motor driver, GSM unit. The microcontroller used here is the pic 16F877A. The microcontroller is provided with a power supply of 5v which is connected to 1st pin of microcontroller. The crystal oscillator is connected to the 13th and 14th pin of microcontroller. The main aim of the microcontroller is to detect the voltage drop, current drop, crack detection, difference in temperature using sensors. When the robot moves through the transmission line it simultaneously measure the drops. The current sensor is connected to 2nd pin ie, the A port of the microcontroller. The IR pair 1, 2 and 3 which is connected to the B port of the microcontroller measures the voltage drop, temperature difference and detect crack. The camera is connected to the 16th pin of the microcontroller, ie to the c port, continuously take image of the transmission line. The motor driver which drives the robot is connected to the A port (3rd, 4th, 5th, 6th pin). Then all the values measured by the sensor are displayed on the led which is connected to D port and C port of microcontroller. The image of the transmission line can be continuously imaged on a laptop present in the road side unit. The continuously measured voltage drop, current drop, temperature and the ground clearance are sent to the KSEB unit and road side unit.
upon is successfully finished. The project gave us more confidence that we will be able to put in practice the theoretical knowledge we gained during our course of study till now. It really persuades us to do more and more, perhaps in better way in our future.

VI. CONCLUSION

This project is mainly focused on a new and innovated ideas of detecting faults in the transmission line by using the robot. The small variations in the electrical parameters were inspected by the robot and sends message to KSEB unit, either by GSM or by zigbee depending up on the range. The PIC controller used here is the main part of the project. It provides maximum control to the other/external peripherals used to make this system more reliable. The robot moves through the transmission line and detect the faults. At the same time while using robot, there will be no electrical shocks. It reduces the man effort. This robot will continuously monitor the transmission line without any difficulties.

VII. FUTURE SCOPE

In this paper, a robot for the inspection of transmission lines, which reduces the cost and the requirement of man-power, while enhancing safety and improving reliability was proposed. This mobile robot can be used as basis for future developments and thus can be used to create a more efficient system for servicing of transmission lines. Among future developments, a tool to carry out repairs in damaged cables and finally a system to execute autonomous inspection through the recognition of damages in ground cables can be implemented. The project can be further extended by using the mobile robot with thermopile sensor and the robot can be made to move on the wires on the ground of the transmission line to monitor a vast area. By this any drastic change in the operating temperature will know earlier without the presence of human being and it can be also rectified. This will avoid unwanted power wastage. Now a day the transmission lines are made to operate at 200 to 300°C on aluminum conductor. Thermopile sensor can even work at this temperature. The sensors can be deployed to acquire data from the power lines and it is a future step. The robot can be modified in such a way that it can move from one line to another line and thus can acts as cable climbing robot. The future of transmission line robotics is likely to grow through collaboration among power utilities. The future includes high value applications such as detection of inner layer strands, often located underneath a hardware clamp. As robotic technologies enter the systematic inspection programs of utilities, it is responsible to predict that they acquire greater autonomy finally allowing detection and identification of potentially defective components along with autonomous crossing of obstacles.

REFERENCES