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Development of an Inspection Robot for EHV Power Transmission Line Using Embedded Technology

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ABSTRACT:*The study is based on monitoring the parameters of High-Voltage transmission lines through various sensors. The proper maintenance of High-voltage transmission lines is of vital importance, since any problem may result in the interruption of electricity, with many negative impacts to health, sanitation, transportation, and safety. Preventive maintenance is the best way to avoid problems with infrastructure, by detecting them in an early stage and responding accordingly with action plans for repairs or improvements. However, inspection of high voltage transmission lines is a very risk operation, as workers must move on the lines several tens of meters above the ground, in very demanding and stressful conditions. To make this work safer, sometimes the transmission of electricity is interrupted for the inspection operation. However, this may not be possible always, since it would overcharge other parallel lines. In times of high demand, such as in summer and winter, the utilities may have to pay hefty fines for the reduction in capability to provide electricity.Preventive maintenance is the best way to avoid problems with transmission line, by robot detecting them in an early stage and responding accordingly with action plans for repairs or improvements.*

KEYWORDS: *Embedded Technology, Extra High Voltage Transmission Line, Sensors, Controllers, RF Transmission.*

I. INTRODUCTION

The purpose of power transmission line inspection tasks is to check the running state and find damages of high voltage power transmission lines. Up to now, extra-high (EHV) voltage power transmission line equipment is still inspected manually by workers with a telescope on the ground. Sometimes, they have to climb the towers or ride in gondolas suspended on the overhead ground wires. These working modes have many disadvantages, such as long inspection cycle, high working intensity, huge expenseand high danger. Performing the inspection by helicopters, as the other method, is high efficient compare to manually operation. Despite a higher efficiency, the disadvantage of this method is that it is more expensive and climate-dependent. Since the early 1990s, many researchers have investigated in the development of inspection robots to assist people or to replace people to work on power transmission line(PTL).

The EHVPTLs are the main network of electric power, so the security and reliability of the power grid are quite important. The equipment, which can inspect the power lines autonomously are eagerly expected to replace human from the inspection work completely or partly.The ultimate goal of the research is to solve the key techniques, develop the EHVPTLs inspection robot system with the completely proprietary intellectual property rights, carry out the laboratory and field tests, and lay the foundation for the field application of the inspection robot in theEHVPTLs.

II.LITERATURE SURVEY

The developments in mobile robotics have increasingly played an important role in the inspection and maintenance work of Power Transmission Lines (PTLs). The research and development work of the inspection robots for 500kV PTLs is carried out in Shenyang Institute of Automation, Chinese Academy of Sciences (SIACAS).
An embedded control system which can withstand the strong electromagnetic interference has been developed. A lot of field experiments have been carried out, and the experimental results have shown that the inspection robot can reliably work during the 500kV Extra High Voltage (EHV) electromagnetic environment and possess the primary ability to implement the inspection task of the 500kV PTLs.

Since 2002, supported by the National High Technology Research and Development Plan (863 Plan) and the Science and Technology Project of the State Grid Corporation of China, SIACAS, cooperated with the Northeast China Grid Company Limited, has been engaged in the development of mobile robots for inspecting the 500kV EHVPTLs

In 2006, HiBot Corp. started to develop technologies to address these issues in collaboration with The Kansai Electric Power Company(abbreviated KEPCO), J- Power Systems Corporation and Tokyo Institute of Technology has developed Expliner - a robot for checking damages on overhead high-voltage transmission lines.

A balance control mechanism using counterweights that HiBot Corp. has uniquely developed enables Expliner to overcome obstacles on overhead transmission lines such as suspension clamps, allowing operators to inspect multiconductor transmission lines in parallel.

In 2010, the commercial version of Explainer left the HiBot assembly line with several improvements in manufacture, ease of transportation and assembly, endurance and reliability.

In 2013, it will be used in the actual inspection of cable in Kansai Electric Power Company (KEPCO)'s operation.
In addition, HiBot is currently building a business scheme of Expliner Robot for worldwide.

III.PROPOSED METHODOLOGY AND DISCUSSION

This project deals with the monitoring and observing of an inspection robot for EHV power transmission line parameters such as extremes end pole existing, temperature and lighting or sparking. Here we have designed a microcontroller based prototype model where we are observing the above-mentioned parameters through the microcontroller. It is based on embedded technology as well as wireless technology.

Here we are monitoring parameters like temperature, lighting or sparking and extreme end pole existing. For measurement of these parameters we need sensors which respond to the changes in the parameters appropriately.

Hence, we have used LM35 as temperature sensors, PHS220 as the extreme end pole existing sensor and LDR as the lighting or sparking sensor. As the signals measured are of very low value therefore their amplification is very necessary. Hence LM324 has been used as a non-inverting amplifier. As LM324 contains 4 op-amps per IC hence it has been used.For analog to digital conversion we have used ADC0808. We are using it as 3:1 multiplexer. IC 555 has been used as a timer IC to provide a clock signal to the ADC0808. It is used as a-stable multi-vibrator with 50% duty cycle for 220 K-Hz frequency.

The heart of the project i.e. the microcontroller is P89V51RDXX or IC 89s52. It is used because of its larger memory.The display is done through 16×2-line LCD. We can also use 4 lines LCD. MAX232 has been used for the interfacing purpose. With the help of this IC we can display the data on the computer also. For storing the data for the future use, we used EEPROM IC 24C16. The power module consists of IC7805 for 5V supply and IC7812 for 12V supply.For the observing action we have used sugar cube relays or IC L293d with which we can connect the robot vehicle motor etc. BC557 transistors have been used for gain purpose.

The main objectives of this project are to use radio frequency (RF) bands to observe and monitoring of the transmission. This prototype shows a Robotis observing and monitoring the transmission with the help of RF signals. RF signal propagate through air. The RF Receiver senses these signals from the air and gives command to the controller. This project makes use of the transmitter and receiver at 433MHz that is available at low cost.

The Radio Frequency based control proves to be more advantageous compared to the Infrared Red based control that limits the operating range to only a few meters of distance.

We have also included IP Camera is a new generation product with the combination of analog camera & IP video technology. Despite all functions which analog cameras have, IP camera can compress and encrypt video and audio signal then send it to remote terminals through internet with its built-in processor and web server. With its IP address, users can use standard PC browser to visit IP camera, real time monitor targets, manage, and store video or image, PTZ control also is available through network. As a new member in camera family, IP camera shares the same operation

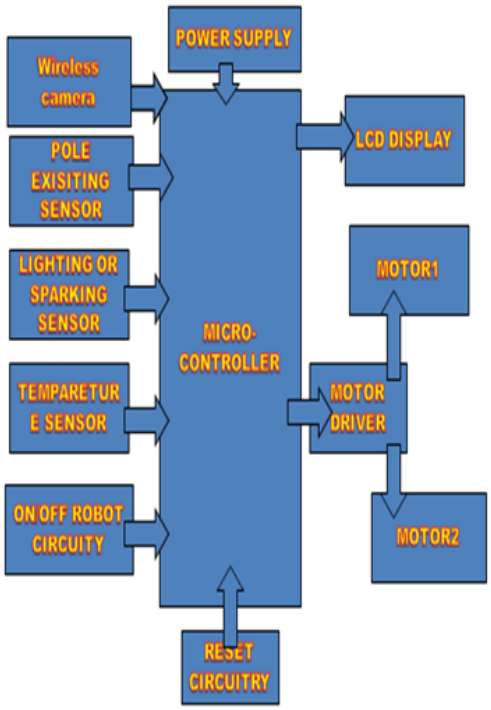
function with the analog camera, such as, auto white balance, auto shutter speed, auto backlight compensation etc. On the other hand, IP camera supports remote access through internet, and support multi-user visit, some IP cameras can extend to both analog and digital signal

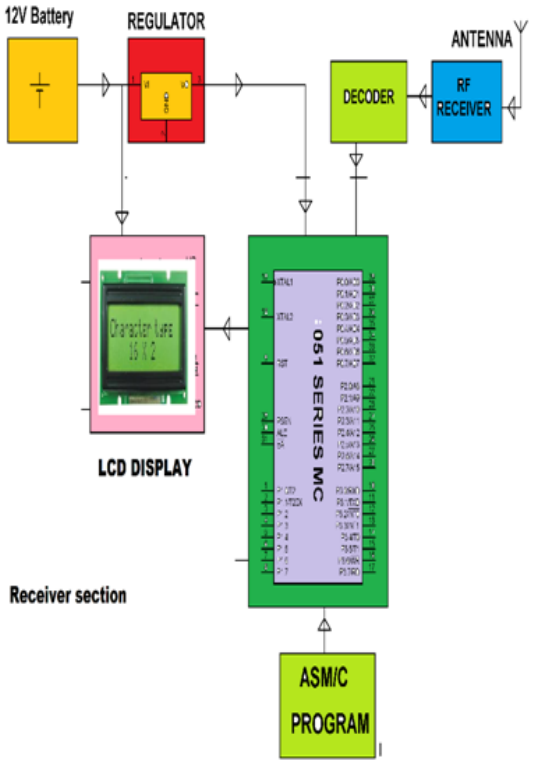
IV.EXPERIMENTAL RESULTS WITH TABLES/GRAPHS/FIGURES

The inspection robot is keep on moving across transmission line back and forth. And at same time monitors the parameters, continue sends the signals to the receiver end. It has two sections: **Transmission Sector**and **Receiver section.**Working is explained with the help of basic block diagram as follows:

Basic block Diagram:

Transmission section **Receiver section**





Explanation of Block diagram

The block diagram consists of six main parts. These are:

1) The sensors

2) ADC

3) Microcontroller

4) The controllers and display

5) Camera Section

6) RF Transmitter and Receiver

1). THE SENSORS

a) Temperature sensor and amplifier: -

Temperature sensor is the sensor that measures the amount of heat that it observes. As the output signal of sensor is smaller in amplitude the signal power is also low therefore amplifiers are used. The weak signals are amplified using amplifiers.

b)Lighting or sparking sensor and amplifier: -

Lighting or sparking sensor is the sensor that measures the amount of the lighting or sparking that it sees. The output of the lighting or sparking sensor is in the form of current. As the output signal of sensor is smaller in amplitude the signal power is also low therefore amplifiers are used. The weak signals are amplified using amplifiers.

c)Extreme end pole existing sensor and amplifier:

Extreme end pole existing sensor is the sensor that sense the POLE POSITION i.e. the extreme end pole existing in the air. There are 3 types of extreme end pole existing sensors: open air extreme end pole existing sensor, duct extreme end pole existing sensor and room extreme end pole existing sensor. The sensing element is the impedance type extreme end pole existing sensor. The output of the extreme end pole existing sensor is in the form of IR SENSOR.

2) ANALOG TO DIGITAL CONVERTER (ADC): -

ADC is used as a signal conditioner, which is given as an input to the micro controller.Most of the information carrying signals such as voltage, current, temperature, pressure and time are available in analog form. However, for processing, transmission, and storage purpose, it is often more convenient to express such signals in digital form. When expressed in digital form, they provide better accuracy and reduce noise. The A to D conversion is a quantizing process whereby an analog signal is converted into equivalent binary word.ADCs are classified into two general groups based on the conversion techniques. One involves comparing a given analog signal with the internally generated reference voltages. This group includes successive approximation, dual slope technique and flash A to D type converters. Another technique involves changing an analog signal into time or frequency and comparing these new parameters against known values. This group includes integrator converter and V to F converter.

3)MICRO-CONTROLLER (8051): -

It is the major part of the system. It maintains the temperature, extreme end pole existing and lighting or sparking intensity to the desired value. The 8051 has one serial port that receives and transmits data. Transmission and reception can take place simultaneously. The four communication modes possible with 8051 present the system designer and programmer with opportunities to conduct very sophisticated data communication network. It is the heart of the system which controls all the inputs and the observing action to be taken at the output. Microcontroller used here is the AT89S52.

4) THE CONTROLLER AND DISPLAY: -

a) Display: -

It is used to display the current values of the measuring quantities. It can be used to display the various options and all the readings that are stored. LCD or 7 segment LED display can be used. Here the LCD used is the 16×2-line LCD. We can also use 16×4-line LCD. Liquid Crystal Display which is commonly known as LCD is an Alphanumeric Display it means that it can display Alphabets, Numbers as well as special symbols thus LCD is a user-friendly display device which can be used for displaying various messages unlike seven segment display which can display only numbers and some of the alphabets. The only disadvantage of LCD over seven segments is that seven segment is robust display and be visualized from a longer distance as compared to LCD. Here I have used 16 x 2 Alphanumeric Display which means on this display I can display two lines with maximum of 16 characters in one line.

b) TemperatureController: -

The error between the reference and present value is given to the temperature controller, which responds correspondingly to the error and gives the feedback to the sensors. The temperature observing depends on whether the temperature needs to be increased or decreased. The temperature observing can be done through robot vehicle motor.

c) Extreme End PoleExistingController: -

The error between the reference and present value is given to the extreme end pole existing controller, which responds correspondingly to the error and gives the feedback to the sensors. The extreme end pole existing depends on the OBSTRACTION. Hence for observing the extreme end pole existing robot vehicle motor are used.

5) CAMERA SECTION:-

This section sends videos continuously to control section of electricity.

IP Camera is a new generation product with the combination of analog camera & IP video technology. Despite all functions which analog cameras have, IP camera can compress and encrypt video and audio signal then send it to remote terminals through internet with its built-in processor and web server. With its IP address, users can use standard PC browser to visit IP camera, real time monitor targets, manage, and store video or image, PTZ control also is available through network. As a new member in camera family, IP camera shares the same operation function with the analog camera, such as, auto white balance, auto shutter speed, AGC, auto backlight compensation etc.

6) RF TRANSMITTER AND RECEIVER:

In many projects we use RF modules for transmit and receive the data because it has high volume of applications than IR. RF signals travel in the transmitter and receiver even when there is an obstruction. It operates at a specific frequency of 433MHz.RF transmitter receives serial data and transmits to the receiver through an antenna which is connected to the 4^{th} pin of the transmitter. When logic 0 applied to transmitter then there is no power supply in transmitter. When logic 1 is applied to transmitter then transmitter is ON and there is a high-power supply in the range of 4.5mA with 3V voltage supply.

Working of RF Transmitter Module:

From the circuit, the power supply +5V is connected to the 40 pin of microcontroller and ground is connected to 20th pin. Here, we got two switches which are duly connected to microcontroller with pulled up to 5V and these two switches form the input command to the microcontroller. We also got an LCD display for displaying the data to be transmitted. We also have an arrangement for a computer key board to be connected for positive and negative part from clock and data pin which is connected as input to the microcontroller from the output of key board and that data is ultimately displayed in the LCD. We also have one RF transmitter. It has VCC supply, GND. Data pin which goes to microcontroller.

RF Receiver Module:

At receiver end we have similar connections for power supply as microcontroller needs +5V. Similarly, to transmitter, hear also we are using two push buttons with 10k pull up resistors through 5V supply for RF Module. We are using pin 3.0 to connect data pin of RF module and 1 and 2 pins of RF module is used for GND and VCC.We also have two buttons for selection of code and for receiving the data. Once the data is received by the receiver module that data is demodulated and goes to the receiver pin 10 of microcontroller as per the program. It then displays the message on LCD display.

V.CONCLUSION

We conclude that the various parameters of an inspection robot for EHV power transmission line such as temperature, lighting or sparking, and extremes end pole existing play a great role in the electricity power growth and should remain within the required area such as mountain, hills, valley.
Here in this project we have successfully monitored the parameters through various sensors.The proper maintenance of High-voltage transmission lines is of vital importance, since any problem may result in the interruption of electricity, with many above mentioned parameters through the microcontroller, avoid negative impacts to health, sanitation, transportation, and safety are maintained. Preventive maintenance is the best way to avoid problems with transmission line, by robot detecting them in an early stage and responding accordingly with action plans for repairs or improvements.
Here we have designed a microcontroller based prototype model where we are observing above parameter.

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