TRANSMISSION LINE MONITORING SYSTEM

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Abstract : In the field of Electrical Engineering, the transmission line plays an important role. During the transmission of electricity some faults occur in it. The main problems faced by transmission lines are damage of insulators, conductor corrosion, vibration damage, arching damage of conductors and leakage of current . Many lines are located in remote and rugged environments. Usually the workers who inspect these lines conduct the helicopter surveys or must climb the tower to check the line close proximity. In connection with the shortcomings of the current power transmission line inspection Transmission Line Monitoring System(TLMS) or Robot technology, a new electric power inspection leading to significant cost benefits in contrast to the conventional systems(Helicopters, industrial climbers etc.) is developed to improve the monitoring and control. The images of the line defects and potential problems are located and collected with the aerial views of the cameras. Combined with the GPS to receive the information, an autonomous inspection and airborne image real-time display is presented according to the default track points. It can be used to conduct inspection on ground, relatively small mountain ranges, plains region of daily patrol and large area electric power line disaster monitoring word. The additional features of this paper include current sensor, temperature sensor, camera and GPS tracking for various purposes to monitor the line.

Index Terms **– Transmission line monitoring system, robot technology, Temperature sensor, GPS tracking.**

I INTRODUCTION

The power generating capacity of our country is very low but conversely the consumption rate is very high as a result of which the demand for power has increased. So it has become necessary to reduce the losses in order to obtain efficient power transmission[1]. In order to achieve this, transmission lines have to be monitored in real time. The simplest form of power lines consists of one conductor per phase hung on insulator string which can be of either suspension or strain type. However in bundled power lines there is more than one conductor per phase. The inspection of power lines are difficult and dangerous for a human to perform due to the nature of their location and also due to the complexity of the power system. In order to rectify this problem, we propose a robot whose purpose is to monitor the transmission lines which would act as an alternative to a human technician. The robot is suspended from the conductor through a roller wheel mechanism and travels along the conductor. In doing so it has to cross the obstacles along the power line that requires complex robotic controls such as conductor grasping, obstacle detection, image processing and pattern recognition which require appropriate sensors, measuring devices, power supply and actuators. By using such an automated system the level of human involvement can be minimized. The robot consists of a current coil (insulation detector), RC servomotors, carbon, rotating shaft, micro-wheel assembly, transmitter, receiver, GPS and a microcontroller unit such as the Arduino. Current coil is used to determine the flow of current through the live transmission lines and the variation in the current coil reading gives the quality of insulation. It is also used to determine the transmission voltage level. Thermal imaging camera is used to measure the temperature of components and this data is used to identify the components that are defective due to normal wear & tear, chemical contamination, corrosion, fatigue and faulty assembly in transmission systems. Over heating can occur in virtually all electrical components including generators, transformers, pole top connections, insulators, jumpers, shoe connections, fuse connections, switch gears and starters. RC servo motors are used for mechanical action of the robot and thus are responsible for the locomotion of the robot. Carbon composite frames which are of low weight, forms the body of the robot. They are of high mechanical & insulating strength. Solar panels provide power to the robot by converting the solar energy into electrical energy. Vibration sensors are used to detect the hissing noise which can occur due to corona effect. In the rotating shaft ultrasonic sensors are used to detect the obstacles of the surroundings and another static sensors on the robot is used to detect the ground clearance to measure the sag in the transmission line. Micro-wheels for the robot movement are fixed over the live conductors. These micro- wheels are connected to the RC servomotors which provide mechanical energy required for the rotating the wheel. GPS assembly and Trans-receiver assembly is used for communicating the position of the robot to the control room and the monitored data. The micro-controller unit integrates all these elements in to a single system [2].

Unlike underground cables, overhead lines are vulnerable to external environmental attacks, such as adverse weather, high humidity, pollution, ground stability, vegetation, and flying objects etc. To ensure high reliability and availability of the overhead lines for bulk electricity transmission, cost effective maintenance strategies including the application of specific accessories and materials, such as lightning arrestor and high voltage insulation coating (HVIC) as well as tower refurbishment to mitigate the risks caused by lightning, pollution and typhoon are essential. Power Corporation has adopted both preventive and condition-based strategies for Transmission overhead line (TOHL) maintenance for many years and has accumulated a lot of valuable experience and knowledge on the implementation of various maintenance and refurbishment practices. These practices have led to the achievement of world class service performance and contributed in the long term economic growth[33.

Existing system deals with monitoring of transmission lines by using hot line maintenance. Its main purpose is to inspect transmission lines including conductors, insulators earth wires and poles [4]. This process is done manually by checking each conductors at great height. The inspecting person is placed on the transmission lines by using helicopter. The person on the transmission line have a faraday's suite over him which acts as an insulation between line and person.

The sensors with the inspecting person will transmit key information to utility personnel using a global positioning system to accurately identify its location and speed. Another system will collect data from remote sensors deployed along the line, and an electromagnetic interference detector will identify the location of discharge activity (i.e., corona or arcing). Where discharges are identified, field personnel may do further inspections using daytime discharge cameras. The robot is also designed to collect data from the range of EPRI[5].

Fig 1: Hot line inspection of transmission lines

The transmission line robot traverses structures and obstacles using bypass systems that are permanently installed on the transmission line. The robot automatically disconnects itself from the shield wire and connects itself to the bypass system. Once it is has bypassed the obstacle or structure it then returns to the shield wire. These bypass systems could be installed during construction or be made integral to the line hardware. It is envisioned that the robot's mobility could be developed to remove the need for bypass systems, enabling its deployment on existing transmission lines.

II PROPOSED TRANSMISSION LINE MONITORING SYSTEM(TLMS)

The robot uses high-definition visual and infra-red spectrum cameras with advanced image processing to inspect the right-of-way and component conditions. It will be able to determine clearances between conductors, trees, and other objects in the right-of-way. The cameras also will be able to compare current and past images of specific components to identify high-risk conditions or degradation. It has an added features such as temperature detection, current sensing and human machine interference for easy servilegency and information receiving at even remote location.[2]

The automated motor control wheels are added advantage of this system. If the transmission towers are knocked down or damaged , the whole sections of country can go dark. But conducting routine maintenance on these transmission towers can be costly ,time –consuming and even more dangerous for workers. It would be wonderful and cost efficient to use a rover to maintain it. Rover inspection involves the use of autonomous or remotely controlled machines that incorporate imaging ,sensing and other technologies to assess the condition and status of transmission system components. Rover inspection system is developed by EPRI’s office of technology innovation promises to reduce costs, enhance safety and expand coverage while improving reliability. An unmanned aerial vehicle(UAV), also known as ROBOT, is an automated motor device without direct human interaction . Operated either under remote control by a human operator or autonomously by onboard computers**.** The sudden emergence of the mobile robot walks on overhead power towers. Its ultimate Purpose is to automate to inspect the defect of power transmission line [3].

Fig 2: Transmission Line Monitoring System(TLMS)

III CONTROL STRATEGY

3.1RF CONTROLLER

L293D Drives the motors, but to control the motors remotely it needs a mode of communication. it can be possible through “Radio frequency” controlling. All radio controlled robots have four main parts, the transmitter is held in hands to control the robot. It sends Radio waves to the receiver. The receiver consisting an antenna and circuit board inside the robot receives signals from the transmitter and activates motors inside the robot as commanded by the transmitter. The motors can turn wheels, steer the vehicle, operate propellers, and the power source. The transmitter sends a control signal to the receiver using radio waves which then drives a motor, causing a specific action to occur. The motor may cause the wheels to turn, while the motor in a plane may adjust the flaps. The power source is typically a rechargeable battery pack, but sometimes it consists normal batteries. In many of the robots, the radio controlled motor provides guidance while another source of power provides the locomotion.

3.2FIREBASE SETUP

- The first step for us is to setup the Firebase database in the cloud. The instructions are:
- Visit https://console.firebase.google.com/ and login with your Google account.
- Click on Create New Project button.
- This will bring up the Create a project screen as shown below, where you will need to provide a project name. Note that you will need to provide a unique name for your project. Select a Country/region where you would like your database to be hosted. Click on Create Project.
- we are only going to look at the Database feature of Firebase and not other services for now. Click on the Database link on the left. This will show up some details about your database as shown in fig. 3.
- Note down your database URL this is the unique database url that is available to the outside world for integration. In our case, the Android application that we shall be writing in App Inventor will be using this unique URL as our backend database.
- Another point to note here is that it shows the database name and a null next to it. This means that currently there is no data in the database. Keep this screen handy, you will be coming back to it and can see the database live here as it comes in. Even if not live, you can see what the data currently is in the database over here.
- Click on the Rules tab. You will notice that it has the rules.
- Firebase supports multiple authentication mechanisms, but we will keep it simple for now and not use any authentication.
- We are going to do is open up access to this Firebase database to allow anyone (everyone) to both read and write.
- That’s it. We have a Firebase database in the cloud, all ready for read and write. Now, all we need is to write this to our Android application.
- Enter Mit App Inventor 2 now for completing our Android application.
- Writing our Android Application
- Go ahead and login to Mit App Inventor 2 now. Once logged in with your Google account, do the following:
- Click on Projects → Start New Project. This will bring up a screen where you can give a name to your project. Choose any name. We choose “moveit” . Click on OK and you will be navigated to the Project Design window.
- The next step is for us to design our Application.
- Formation of lables.
- Place the lables on the screen step by step and enter the text in them which we would like to see in the APP. Now arrange the blocks according to the code
- The Firebase DB component is available under the Experimental section of the Palette
- The important thing to configure next is our FirebaseDB1 component that we added to the screen. Click on the FirebaseDB1 component and see the properties. App Inventor hosts a service in the backend where you can use their hosted (Default) version of Firebase, but we will be using our database that we created in the earlier section. So to do that, we will need to give the value in the Firebase URL property as the one that you noted down earlier. Set that value in the Firebase URL property and deselect the Default value (Set it to not selected)
- This will have an impact on how your database values are finally stored, which shall be seen below.
- The entire blocks arrangement is shown in the figure below.
- Now try running the code for the first time
- Fall is well, you will see an entry in the database
- Now go ahead and do that for all the bus stops and even try to update a Bus Route with multiple stops, it will overwrite correctly the last value.
- It is important that you see the almost real-time capabilities of Firebase here[5]. While trying out the functions, keep your Firebase database console open and notice the values coming in. It makes for great viewing!

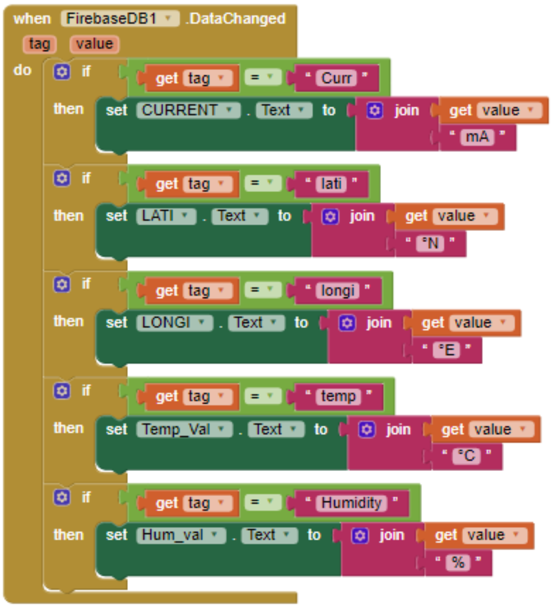

Fig. 3 Arrangements of blocks

IV EXPERIMENTAL RESULTS

The Proto type model of TLMS including pole structures, transmission lines is shown in the figure 2. The sensed values of temperature sensor(DHT22),current sensor(ACS712) and GPS module (Ublox-neo 6m) are practically displayed in the designed app "MOVIT.NEC" on LCD as shown in Figures 4. The fig. 5 gives experimental results on the app.

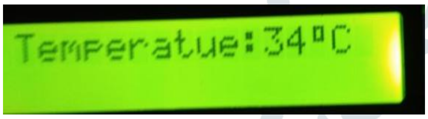

Fig. 4.1 Temperature reading on LCD

Fig:4.2 Current reading on LCD

Fig. 4 Temperature, current, latitude and longitude location of TLMS

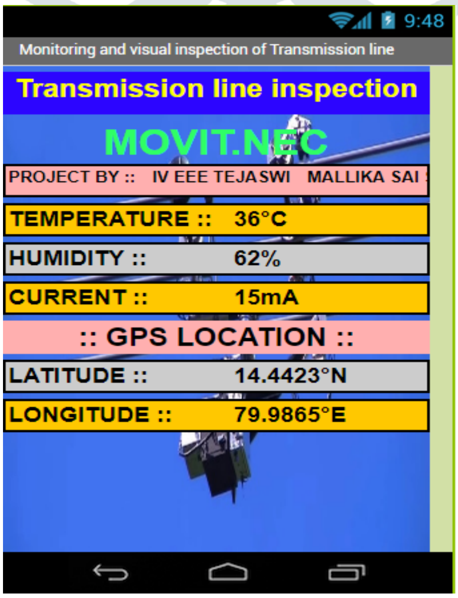

Fig. 5. Experimental results of TLMS

This app can be placed in the Google play store for the open access, where anyone can see the results. The results are varying since the robot is moving from one place to another place. The varying experimental results can be seen in the mentioned figure. In this way, the sensed values of sensors at various conditions can be displayed in the app screen. This app can be used in any type of temperature and altitude conditions.

5. CONCLUSION

- TLMSs are dedicated to completely autonomous inspection of electrical power line, are still an emerging technology. Rolling on wires TLMSs are more recent technologies but slowly are proving to be a very practical and valuable means to become part of the inspection standard working methods. The state-of-the-art in fact shows that many goal as, a compact, reliable remotely operated locomotion system capable to cross most of the obstacles present on the lines, a significant payload, a sufficient autonomy, and the capability to work without de-energizing the lines are reached. Being, in fact, able to detect the status of the cable from close distances and allowing also contact measurements achieve a higher level of inspection data completeness, made possible. Many concrete results are reached but however further improvements are still necessary. In particular the specific constraints for a completely autonomous live line inspection can be done in the following areas:
  - Visual serving for power line tracking is to be improved
  - Robust control algorithms for flight dynamics, ensuring a very high stability and positioning capability for close and precise inspections in particular in case of adverse weather conditions like strong lateral wind
  - A completely autonomous navigation system capable to detect, identify and cross obstacles must be added. Particular attention must be paid for broken strands.
  - A battery recharging system from the live line that can extend the autonomy up to several days combined with a more versatile mechanical concept capable to cross all types of obstacles (like jumper cable) .
  - A good compromise to optimize the economic impact could be to extend properly the autonomy and maybe to design an energy management system that during the night (dark) hours can recharge the robots being so ready to work with the first lights of the day.

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