UNMANNED AERIAL VEHICLE FOR ELECTRICAL APPLICATION

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ABSTRACT

In India, we have a very large network of electrical transmission lines. In order to plan its maintenance, the lines should be inspected. Currently we are using a large manpower to inspect the transmission lines which is costly and ineffective and in safety point of view it is very risky.Systems already developed for inspection purposes do not meet the specifications as determined for transmission line inspection.

A solution is proposed by the design and construction of a monitoring system consisting of a kk2.1 flight controller, wireless video camera and a live line indicator. In order to collect data of transmission lines, the whole system is mounted on a quad copter that flies along transmission line.The developed system is used to stream the video data to a monitoring station.

INTRODUCTION

All transmission lines should be inspected after construction is completed before energizing the line. Linemen should climb each structure and check the following: Conductor condition, conductor sag and clearance to ground, trees and structures, insulator conditions, line hardware for roughness and tightness, structure vibration and alignment, guys for anchors that are pulling out, guy wire conditions, and missing guy guards, ground-wire connections and conditions, structure footings for washouts or damage, obstruction light operations for aircraft warning. For current inspecting methods India is spending a lot of money. As well, the methods used to inspect the lines are not so effective and are risky. Also these methods are time consuming.

In this paper, we have presented a monitoring system which aims at providing a system that provides same level of functionality as current methods used.In order to plan proper maintenance activities, high quality inspection data must be acquired and which is possible with the system presented in this paper.

The paper is structured as follows:

Firstly, we have presented a brief background of current inspection methods and existing technologies. Then, the system analysis, functional analysis, monitoring system design, monitoring system operation, live line indicator design, operation of live line indicator, results and future work are discussed. Finally a conclusion is drawn.

BACKGROUND

Following are common methods used for existing monitoring system and inspection of the overhead transmission lines:

- Current methods of inspection:

In present situation two types of inspections are there, first one is air inspections using chopper and another is ground inspection by inspector. There are two types of air inspection: detailed air inspection, fast air inspection.In every three years we have to conduct a detailed air inspection. In this inspection we have to evaluate condition of tower structures, insulator, conductor, line hardware, conductor spacers and earth wire. We have to inspect all these parameters as close as possible using a chopper (Helicopter). The fast air inspection is done annually in order to check general condition of transmission line and for servicing.

Ground inspections are conducted once per year. Ground inspections are done to identify obvious defects on the line. All findings for an inspection must be recorded and supported with photos and video. When crews are conducting an aerial inspection, defects with regards to the following aspects needs to be inspected and noted

- Damaged or broken insulators,
- Pollution that negatively impacts theperformance of the transmission line. Types ofpollution to be noted include industrial,mine/dust, marine or bird pollution.
- Birds' nests on structures and damaged ormissing bird guards.
- Moved or missing vibration dampers.
- Broken or missing spacer.
- Trees, reeds, grass or other natural productsimpairing servitude.
- Defect regarding general hardware includinganti-climb devices, tower members, towerlabels, stays and other general hardwareconcerns.
- Damaged conductors.
- Damaged shield wire.

- **Existing monitoring solutions**

Hydro Québec have invented new system for the purpose of transmission line inspection.System is known as Line Scout. Line Scout is a robot developed for inspection of live transmission line. It has a three axis robotic arm.It runs on the top of live line by using its two wheels. A camera is fitted on the arm and has ability to hold various tools & various sensors to be used for inspection of transmission line.

HiBot has invented a robot "The Expliner", which is used for inspection of HV line. It consists of four wheels which are mounted on two axles. The Expliner include four sets of laser sensors in order to take measurement of transmission line conductor. A high definition,high zoom camera is mounted on the robots which gives the detailed visual inspection of the line.

The both robots are attached to transmission lines with the help of rollers and wheels. The robots have difficulty for moving along with transmission line.

SYSTEM ANALYSIS

This section contains the system analysis of the unmanned aerial vehicle (UAV) droneas well as monitoring system.

- **Project Objective:**

Following are the some main objectives of the project:
To use unmanned aerial vehicle (UAV) for electrical application.
To indicate whether the line is live or not by using a live line indicator.

- **Requirements Analysis:**

The design of the system presented in this paper was done according to a set of specifications in order to satisfy the design problem. These specifications are:
Live video streaming must be achieved toprovide real-time monitoring capabilities.

The system must be equipped with a mobilenetwork connection. The system will bemounted on a quadcopter and a wirelessnetwork connection is thus needed. It must been sured that the wireless network connectionhas sufficient bandwidth to enable livestreaming of data from the monitoring system.
The system must be lightweight as it must bemounted to a quad copter. Excess weight willimpact negatively on the flight characteristics of the quadcopter.
The system will run from battery power and must thus have low power consumption. Low power consumption will mean longer flight times.
The system must be compact as limited space is available on the quad copter.
The system must be reliable.
The system must be designed with future improvement in mind.

- Operation of the system and UAV

1. **UAV**:

The quad copter which is mentioned in the paper is the simplest type of multicopter, with each motor/propeller spinning in the opposite direction from the two motors on either side of it (i.e. motors on opposite corners of the frame spin in the same direction).A quadcopter can control its roll and pitch rotation by speeding up two motors on one side and slowing down the other two. So for example if the quadcopter wanted to roll left it would speed up motors on the right side of the frame and slow down the two on the left. Similarly if it wants to rotate forward it speeds up the back two motors and slows down the front two.
The copter can turn (aka “yaw”) left or right by speeding up two motors that are diagonally across from each other, and slowing down the other two.
Horizontal motion is accomplished by temporarily speeding up/slowing down some motors so that the vehicle is leaning in the direction of desired travel and increasing the overall thrust of all motors so the vehicle shoots forward. Generally the more the vehicle leans, the faster it travels.Altitude is controlled by speeding up or slowing down all motors at the same time

2. **Wireless Camera:**

The choice of video system is one of the most crucial decisions for the project. The camera needs to be light enough so that the UAV can fly unabated and compact enough so that it does not interfere with the landing gear and rotors. The video system must also be able to transmit a suitable distance over open space without interference or losing signal. For our prototype design we will consider 100m to be a suitable range, though many of the products we researched can transmit up to 1000m.
There are many different options for the camera. One of the first solutions was to mount an IP camera to the fuselage of the quadcopter which would be able to produce a high resolution image with its own transmitter. The downside to using such a camera is the necessity to be connected to a network; the system would not be able to function without an internet connection and would not be useful in wilderness areas. CCTV cameras were also considered but were quickly discarded as they are generally too large and heavy for our application.
Digital cameras and helmet cameras with Wi-Fi connectivity like the Samsung SMART and Go Pro series were investigated. The cameras were designed to have a separate device, such as a smartphone, act as a viewfinder for the camera. Potentially, our viewfinder could display the live video to the operator while the camera records. One detriment to this method is not being able to easily transmit the video to a computer for post analysis. Another detriment is the transmission distance of the Wi-Fi signal, though it is not documented on the products website, the transmission distance is likely not adequate for our purposes.
CCD cameras were researched and found to be a viable candidate. The cameras operate by having an image projected onto a capacitor array. The intensity of light the capacitors are exposed to determines the electric charge accumulated on the capacitor. This technology is a key factor in digital imagingand allows for very small camera units.
There are two methods to transmit video wirelessly: using analog transmission or digital transmission. Analog wireless is an older technology than digital and has its benefits in being cost effective with transmitters and receivers costing as low as Rs. 1000 each. Analog transmitters are able to accommodate multiple receivers while digital transmitters can only be paired to a single receiver. Having multiple

receivers could be useful to separate the quadcopter controller screen from the video analysis performed by our computer. The disadvantage of analog transmission is that it is more susceptive to interference from common household technologies such as wireless routers, cordless land lines, and microwave ovens which cause static on the video feed. Digital wireless is a much more robust system that does not suffer from interference induced static. Higher quality video can be transmitted using a digital signal and can transmit over farther distances than analog, but such systems are much more expensive; as low as Rs. 6000 per piece. The digital systems are also larger and heavier than their analog counterparts, making them less ideal for mounting on a quadcopter.

3. Live line indicator:

For live line indicator we are using IC CD4017. To understand how this circuit is going to work we have to understand the purpose and action of the IC CD 4017. In simple word Pin 14 is the input clock pin for this IC, when it gets a clock it starts counting which means it will give output to its 10 decoded output pins one by one. So a 100Hz clock will result in each output pins giving a 10Hz output. Pin 3 is one of its output pins, you can use any other output pin.Pin 16 is for supplying positive voltage and Pin 8 is for negative or ground reference.Pin 15 is the RESET pin, we are keeping it low so that the counter keeps on counting.Pin 13 is for clock inhibit, we want to advance the count one step at the positive clock signal transition. For that we have to keep this pin at low. So we hook it up to the ground reference point.If the probe is brought closer to a live wire, capacitive coupling between the live wire and the probe clocks the counter. It causes the LED to flash, and as I said earlier the any of the output pins will get only 1/10th portion of it(as it has 10 output pins so yes that's logical) so the LED will flash 5 times in the 50Hz 220V line and 6 times in the 60Hz 110V line.Keeping it away from the Live wire will eventually lower or breaks the capacitive coupling and thus the counter will stop and the LED will turn off.5-20cm long and stiff insulated piece of wire can be used. Usually those used in high current applications such as powering up an air-conditioner. Sensitivity of this circuit can be varied with the length of this probe.This circuit can run from 3V only, two AA sized battery can do this. And because of using3V supply no need to use current limiting resistor with the LED.It can work with up to 18V supply but going over 3.5/4V will require a current limitingresistor with the LED.

RESULTS

We took some tests with the designed monitoring system, and as stated before, the system proved to be very reliable for the inspection of transmission lines. As well, the live line indicator which is fitted to the quadcopter, indicates either the line is live or dead. If the conductor is carrying any current then it glows the LED connected to the circuit. We also observed that, live line indicator can indicate the live line even though it is insulated. The live line can be identified from a distance.

FUTURE WORK

This section will detail work that will be done in the future. The system as designed is aimed at proving the concept of a monitoring system attached to a quadcopter to perform transmission line inspection. Further work needs to be done to improve the quality of inspection data or add other types of sensors to the monitoring system. High quality thermal imaging will be added to the system. This will enable the system to accurately gauge the temperature of the transmission line to detect failing hardware. Lidar sensors will be added with which the system can form a 3D map of the surroundings. Servo operated camera gimbals will be added to enable smoother operation of the cameras.

Further work also needs to be done on the networking capabilities of the system. This system used a local Wifi network to prove the concept. Adjustments to the system will be made to incorporate technologies such as cellular networks for long range communication and data streaming.

CONCLUSION

In this paper, a monitoring system was designed for transmission line inspection. The monitoring system attaches to a quad copter that flies along the transmission line. The monitoring system is capable of real-time video streaming to a remote control station from where the system is operated. Fault logging capabilities are provided. High quality inspection results were obtained that can successfully be used as a cost effective alternative to current methods of inspection.

REFERENCES

I. Raquel Remington, Ramon Cordero, "Warrant Requirement and Suspicionless Drone Searches," in The Domestic Use of Unmanned Aerial Vehicles, USA, Oxford University Press, 2014, p. 228.
II. Larry March, Daniel Villanueva, "Report of the Defense Science Board Task Force on the Investment Strategy for DARPA," DARPA, Washington, D.C., July 1999.
III. Jakob Julian Engel G., "Quadcopter," Colorado State University, Fort Collins, Colorado 80523, 2012.
IV. https://hobbyking.com/
V. http://www.redcircuits.com/Page35.html
VI. http://www.next.gr/circuits/index4.html
VII. http://www.circuit-finder.com/