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Power Line Inspection Robot

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1. Abstract

This paper presents about prototype of a power line inspection robot. It would inspect the line by recording temperature, distance, and sending back video feed to visually inspect for flaws in the conductor, insulators and other components along the line. Design parameters were set to measure distance within15% accuracy. A camera was for visual inspection and an encoder is used to measure the length of conductor between the fixed poles. Advanced goals for this project would be to further refine the initial design parameters and allow control of the robot wirelessly from the ground at a distance of 40 feet, or the height of a pole. These specifications included distance measurement within 5% accuracy.

Keywords: Power line, inspection, robot, camera, visual inspection.

2. Introduction

As power lines are relied on more and more to power schools, hospitals, and places of business, catching the problem areas before failure becomes much more important. One way to find these problem areas is by conducting a thorough inspection of a given transmission line. A big driving factor of power line inspection is government policy. This inspection not only includes the physical conductor but also the vegetation growing nearby. The utilities are expected to provide a more reliable distribution of power, in an attempt to prevent another blackout from occurring. This reliability is created through redundancies and inspecting crucial lines.

This project came about from an article read in the IEEE Spectrum Automation Blog on Hydro Quebec's robotic device called the LineScout. (13, Guizzo, 2011) Their robot was a project started after the '98 ice storm, originally an ice breaking robot, that lead to an inspection and maintenance robot. This article sparked the idea of creating an inexpensive inspection robot to ride on the conductors which my senior project partner, Jesse Sawin, and we began to develop. Several designs and papers were found on the subject including other companies that have worked on similar devices to the LineScout.

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3. Design of power line inspection Robot.

A block diagram of the electrical system was drawn up and initial project specifications were agreed upon. After reviewing several of the designs detailed, initial sketches were drawn in attempts to create a simple robot capable of obstacle avoidance.

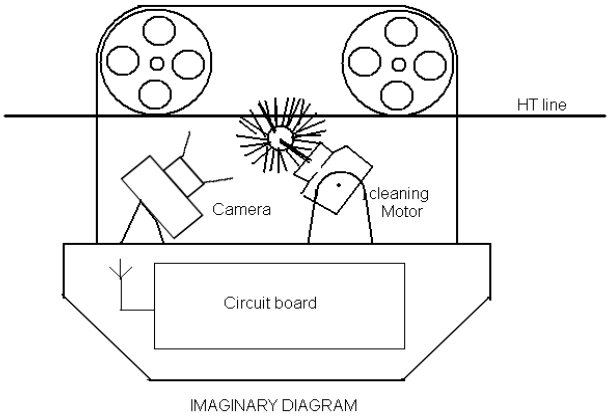

Fig. 3.1 Block diagram of inspection robot.

The design was refined as manufacturing possibilities were assessed. The conceptual design below was created as a platform that could be modified for obstacle avoidance capabilities later on. The rack and pinion for mobility of the arms was kept through these modifications although it was later found to be of little use.

3.1. Requirement specification for the prototype.

At most two operators shall be able to deploy the robot in less than 40 minutes. This time is to be counted from when the robot is packed in the transportation container to when it is properly placed and ready to start inspection on the power line. The time it takes to set mission parameters will not be included in the deployment time. There shall be a convenient interface available for defining the operation of the robot during the inspection. After deployment, the robot shall autonomously travel along the power line in a programmed direction.

3.2. Obstacle passing.

The robot shall autonomously pass the following obstacles:

- Insulator(s)
- Vibration damper(s)

The robot may autonomously pass the following obstacles:

- Tension clamp
- Spacer of twin or triple bundle conductors
- Transposition

When the robot encounters an obstacle that it cannot classify into one of the above categories, it shall not attempt to pass it but rather halt and alert an operator.

Hardware used in the robot shall be designed for electromagnetic compatibility (EMC), to ensure proper operation at the extreme conditions close to live power lines. Tests shall be performed to confirm EMC conclusions.

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The robot is equipped with one video camera. This camera(s) shall supply moving or still images of at least:

- Conductors
- Towers
- Insulators
- Vegetation
- Obstacles

Fig. 3.2 wireless cam

This Robot is equipped with audio, positioning, environmental sensors, and magnetometers to tackle the problems.

4. Power line inspection Prototype.

The completion of this project showed the robot's ability to meet three out of four of the scope's advanced specifications, and subsequently all of the basic specifications. The robot, seen below, was able to record distance to the nearest inch, temperature within 2 °C, and run for 1 hour and 45 minutes.

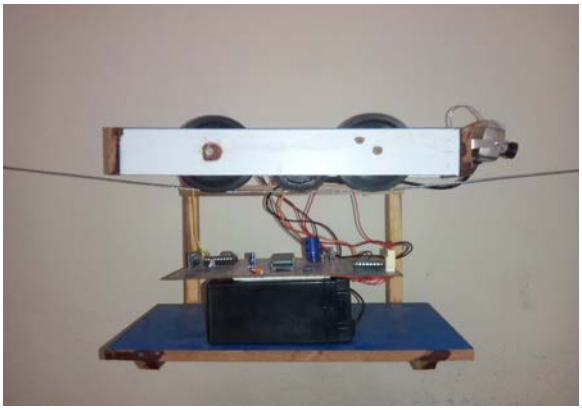

Fig 4.1 Final design prototype

The only advanced item that was not accomplished was wireless control; instead a tethered control box was used for robot operation. Wireless communication remains as one of the future improvements to this project. Final touches done on the project include the manufacturing of printed circuit boards for the robot and control circuitry.

5. Conclusion

This pre-study report has described the power line inspection problem. The report has also presented and analyzed a novel solution to power line inspection.

If the line inspection robot is to work, it needs to master five key technologies:

- Climb on Energized Line
- Pass Obstacles
- Inspect Equipment
- Autonomous operation
- Gather power from line

These five technologies are all vital to the completed line inspection robot. The

technologies were analyzed for relevance in a first, simplified prototype. The decision was made to focus on the second item; passing obstacles. The reasoning behind this decision is that climbing past obstacles is the most difficult to achieve and at the same time the only really novel technology.

The report presented previous solutions to the problem, and then went on to describe the solution developed for the new line inspection robot. Focus was placed on mechanical design and many details were given on individual design choices and their motivation.

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