Dynamic Height Measurement

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Table of Contents

1. Introduction

1.1 Purpose

The purpose of this project is Dynamic Height Measurement of OHE. Currently, the measurement of OHE height is done manually. This project aims to measure OHE automatically. It helps the railway department in monitoring the height of overhead cables.

1.2 Intended Audience and Reading Suggestions

This project is intended for Railway maintenance department employees.

1.3 Product Scope

DHM will provide a detailed analysis of to what extent the lag of the cable is, due to the excessive run-through of the pantograph above the trains. The analysis is then converted into an Excel sheet containing relevant information regarding the distance of the cable from the roof of the train, the timestamp, and the exact location in terms of latitude and longitude. After this, the software indicates which places need manual adjustment of the cable.

1.4 References

1. https://www.tautvidas.com/blog/2012/08/distance-sensing-with-ultrasonic-sensor-and-arduino/
2. http://www.instructables.com/id/Arduino-Ultrasonic-Sensor/
3. http://www.instructables.com/id/How-to-Interface-GPS-Module-NEO-6m-With-Arduino/
4. https://blog.manash.me/serial-communication-with-an-arduino-using-c-on-windows-d08710186498
5. https://msdn.microsoft.com/en-us/library/system.io.ports.serialport(v=vs.110).aspx

2. Overall Description

2.1 Product Functions

- Dynamic Readings
- Can be used on any Train.
- Simple storage of values
- Accurate location due to GPS sensor.
- Minimal equipment
- Cost Effective

2.2 User Classes and Characteristics

Initial Step-By-Step Description

1. The administrator has a login ID which is used to log in to the system.
2. Admin clicks on the START button on the GUI page.
3. It starts taking readings dynamically from the sensor via Arduino through serial communication.
4. After the stop button is clicked the readings are stored in an Excel sheet along with their timestamp.
5. These readings can be assessed later and the location where changes are to be made can be identified.

2.3 Operating Environment

DHM works on the Arduino which is the microcontroller. We can also use C# for designing the GUI. DHM is feasible enough to work on Windows 7,8 and 10. Ultrasonic sensors and reflectors are the major components of DHM.

2.4 Design and Implementation Constraints

The GPS module of the DHM should be always placed in an open sky to maintain a strong connection with the satellite thus updating the GPS coordinates of the system.

2.5 User Documentation

Before using DHM, a small tutorial would be played on how it works and can be used with a user-friendly GUI.
The user must mention the path to the Excel sheet.

2.6 Assumptions and Dependencies

1. The overhead cable carries a very high voltage (25000V). So if this cable snaps the entire equipment could be damaged.
2. External factors like Lightning or excessive rain can harm the equipment.
3. The speed of the train plays an important factor in determining the accuracy of the reading. A constant speed should be maintained. If the train goes too fast the latency might increase.

3. External Interface Requirements

3.1 User Interfaces

GUI displays position and OHE readings. There are two buttons Start and stop. When the start button is clicked it starts taking readings from the sensor and stores them in an Excel sheet. The stop button stops taking readings and saves the data of the reading obtained from the sensor in an Excel sheet. The bottom of the screen has a timestamp.

3.2 Hardware Interfaces

Hardware used are Arduino, Ultrasonic Sensor, GPS Sensor, and Reflector Plates . Communication happens with the Serial port. Arduino interfaces with Arduino IDE to get sensor readings. The ultrasonic sensor gives a distance of the top of the bogey of the train and reflector.

3.3 Software Interfaces

Operating System: Windows 7
Other Software: Visual Studio 2017, Arduino IDE
Programming languages: Embedded C, C#
Libraries: newping.h, tinygps
Data coming into the System consists of Sensor reading which gives OHE (overhead equipment) height, location, and timestamp. This is stored on an Excel sheet. GUI is designed using C#.

3.4 Communications Interfaces

It is a wired connection.

4. System Features

4.1 Real-Time Operation

4.1.1 Dynamic Readings

This feature has high priority because as time passes the lag of the cable keeps on increasing and if readings are not real-time it could cause a lot of problems.

4.1.2 Stimulus/Response Sequences

First, the administrator has to log in. Then there are two buttons START and STOP for taking value. These values are stored in an Excel sheet. This sheet can be accessed by Railway officials and then they can go to the desired location and manually adjust the overhead cable.

4.1.3 Functional Requirements

Sometimes ultrasonic sensor can give a '0' value if the reflection is not properly received by the receiver. This is temporary and the next trigger pulse when received by the receiver gives an accurate reading.
The GPS sensor can give an inaccurate location if satellite communication stops. It takes some time to start which is called warm start.

4.2 Storage of data

The database stores all values and this is displayed in the form of an excel sheet.

4.3 Precise Location

This feature enables the workers of the maintenance department to go to the site and repair it.
Otherwise finding the location was done manually.

5. Other Nonfunctional Requirements

5.1 Performance Requirements

The ultrasonic sensor should give accurate values under all conditions. The values that are being updated in the database should be real-time values in nature. GPS sensors should give accurate longitude and latitude values.

5.2 Safety Requirements

Ultrasonic and GPS sensors should be kept inside a case as they could be damaged due to environmental factors.

5.3 Security Requirements

The controller has an assigned login for security. Only he can access the values of OHE recommend changes and update the information.

5.4 Software Quality Attributes

The sensors give dynamic readings which increases the reliability. The entire equipment is portable as it can be easily fixed on any train. It is cost effective and the materials are easily available in the market. This equipment is interoperable as it can interface with other modules as per the requirement of the railway department. Maintenance can be done easily by calibrating sensors at regular intervals.

5.5 Business Rules

The principle of live database updating and insertion would be done which is automated in nature. The database is to be later analyzed by the admin only. After analyzing, the admin then contacts the railway management department to carry on further procedures.

6. Other Requirements

The legal feasibility of this project has to be done after it has been approved by the Railway Department.

Appendix A: Glossary

DHM Dynamic Height Measurement
OHE Overhead Equipment
GPS Global Positioning System