Track Vehicle Project

Project Proposal

ECE 445 Senior Design

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Team: #25

Content

I. Introduction

1. Title

Track Vehicle Project

This project will help The Federal Railroad Administration (FRA) to detect the defects on railway automatically, thus saving human resources and money.

2. Objective

This whole system is aimed at detecting the defects on the railroad by analyzing the picture of the railroad. Our project goal is to design and build a camera triggering module which will take consecutive images of the railroad. Specifically, the camera will take a picture every time after the vehicle traveled a certain distance. Finally, all the pictures should be able to cover all the area that the vehicle passed through, which will then be send to image analyzing system for defects detection.

For the camera triggering module, the triggering should be matched with the travel distance of the vehicle in order to cover every area of the railroad passed through by the vehicle. Additionally, each picture will be associated with a GPS coordinate, which will be given by a GPS receiver. Those GPS coordinates are intended for the workers to locate those pictures on the railroad once a defect has been found.

Functions:

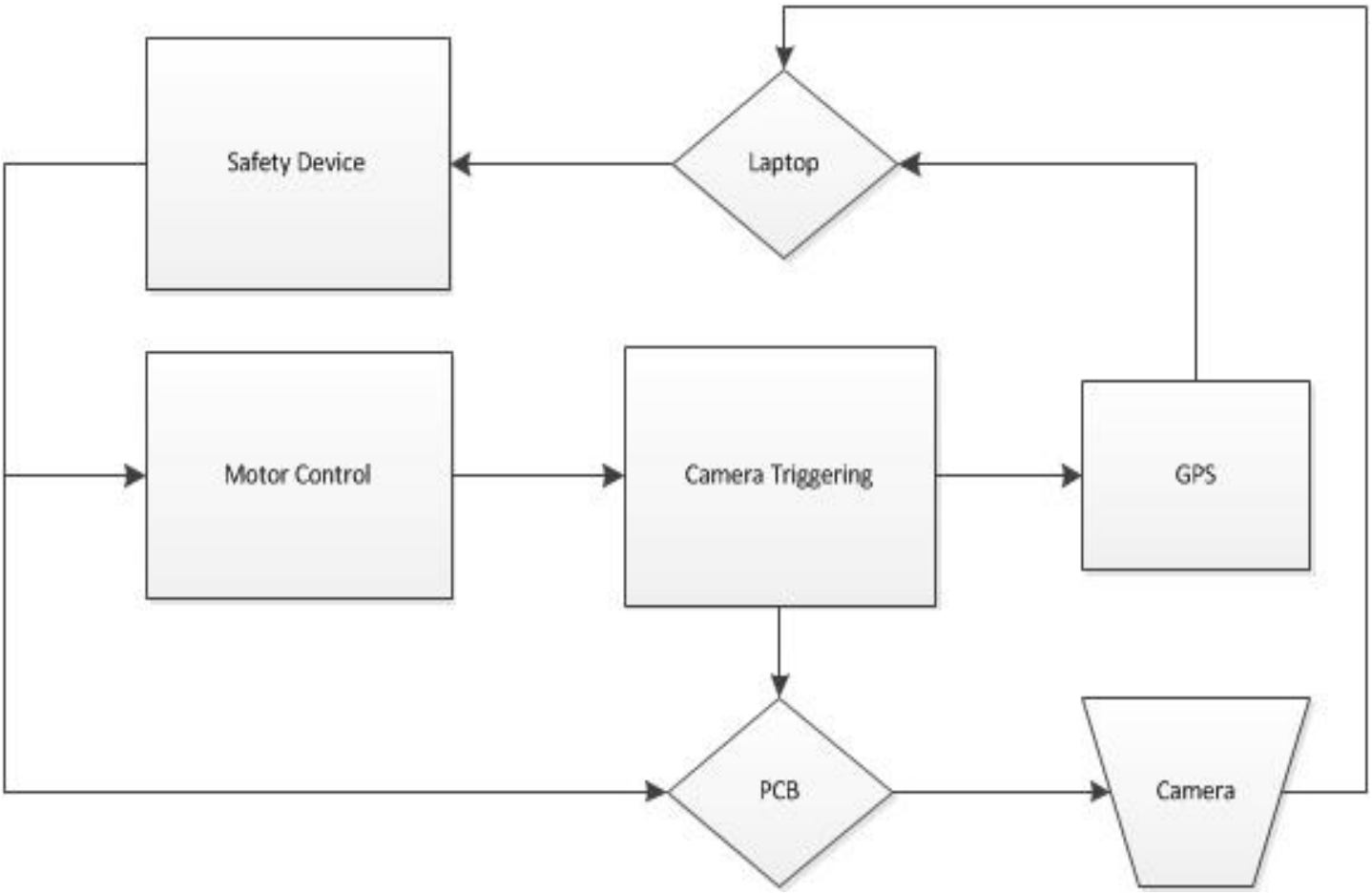
- Taking pictures as the vehicle travels through the railroad
- Record the GPS coordinate for each picture
- Control the travelling speed of the vehicle
- A safety button is included, which will shut down the system and stop the vehicle when pressed.

Features:

- Whole system mounted on a railroad vehicle
- Powered by Lead-acid battery
- Vehicle driven by a ??? motor
- Semi-hemisphere camera capable of taking a full-view picture
- Laptop mounted to the vehicle for controlling
- Only one picture for each location, no duplicated pictures
- Safety button to ensure the control over the vehicle

II. Design

1. Block Diagram



2. Block Description

- Safety Device

This module is intended to keep the vehicle under control. If the vehicle is moving too fast or being too far away from the operators, this safety device will kick in and force the vehicle to slow down or stop it.

- Motor Control

  This module controls the behavior of the motor that drives the vehicle. It will control the start and stop of the motor and control the motor speed. Another important function of this unit is to keep the motor operate at a constant speed. We will also try to modify this unit so that the motor can operate in both way, such that the vehicle can go forward and backward.

- Laptop

  The laptop will collect all the data we need for this project, including pictures taking by the mobile camera, GPS position and the corresponding direction of each picture. It will also send feedback signals to the safety devices. It is worthy to mention that direction will be used for camera triggering verification when the train is going backward.

- Camera Triggering

  The triggering module collects data from both motor control and computer. This module will calculate the distance that the vehicle has traveled by using the data from motor control or sensors on the wheel. Specifically, this module will monitor how many rounds the motor (or wheel) has rotated and convert it to the displacement of the vehicle. When the displacement reaches a set value, this module will send out a triggering signal and at the same time, reset its counter for the next round.

- PCB

  This is the hardware that powers up and controls the camera. This PCB will take triggering signal from the Camera Triggering module and let the camera take pictures.

- GPS

  The GPS module will collect positioning information once the camera is triggered so that each picture will be assigned a GPS coordinate. The data will be sent to the laptop for further use.

- Camera

This is the image acquiring device of the system. It will be controlled by the PCB module and take pictures and transmit it back to laptop for storage. In the completed system, there will be multiple cameras mounted to the vehicle in order to take pictures from different angles. In our project, we will temporarily use one camera.

III. Requirements and Verifications

(The requirements and verifications involving in connection between two modules is only described once.)

- Laptop

The laptop serves as the control kernel and the storage for data collection.

Requirements:

* It is connected to the camera and GPS and hence stored the pictures for future image analysis in order to find the defect in the railway.

* Each time it receives a camera image, the laptop knows how much distance is traveled in the time interval, hence deriving the speed of the vehicle and send it to the safety device.

* It receives the location data from the GPS module and assigns them to the photos taken by the camera.

Verification:

* Check if the laptop works stably on the railway (anti-shock/battery issues).

* Check the data from the camera can be successfully uploaded to the computer. Take down photos.

* Check the data from the GPS can be uploaded smoothly and continuously to the computer and the corresponding time can be synchronized with the camera image. Take down the list of the GPS location and the corresponding time.

* Check if the speed can be calculated within computer and the speed warning can be sent to the safety device to slow down the vehicle. Use an oscilloscope to show the data.

- Safety Device

The safety device detects a possible speed warning signal from laptop and informs the motor control system to slow down or shutdown if necessary.

Requirements

* Receive speed signal data and operate corresponding process to ensure a limited speed.

Verification:

* Check if a warning signal sent by laptop can be passed into the motor control system and interrupt the current traveling to slow it down. Also try to make sure the warning signal ceases as the motor decelerate to designated speed range. Test out on a railway and push it over the setting value to see the feedback.

➢ Motor Control

The motor and its control unit is the muscle of the system. It should make sure the vehicle can navigate smoothly on the railway to accomplish mission.

Requirements:

* Make sure the acceleration and deceleration functions work well.

* Make sure all four wheels have same rotation speed so that the car has the constant speed. This can be done by similar algorithm used in ECE110 (duty cycle configuration)

* Have a “brake” system to decelerate or stop the vehicle. An electrical part is to stop the power supplying the battery and a physical part is to install a brake which brings friction to stop the vehicle while.

* Implement a mechanism for a sensor to detect the traveling distance by counting the rotation of the wheel and send signal to the camera triggering system.

Verification:

* Check if battery can provide reasonable power to drive the vehicle effectively and endurably. Note down the time of endurance.

* Make sure the car can start/stop according to commands. Test out on field.

* Configure the wheels’ duty cycle and check if it moves in a constant speed. Test out on filed and measure the speed by noting down the travel distance and time taken.

* Test out the emergent brake system by sending warning signal. See “safety device” part.

* Configure the sensor to make sure the rotation of wheels is correctly transformed to the distance the car has traveled and this signal can be sent to camera triggering system. Take the data from the sensor and use a graph to show the relation between cycles and distance and then measure the radii of a wheel to verify it.

➢ Camera Triggering

This unit receives the navigation signal from the sensor in motor control system and decides when to take photos and when to note down the GPS location (simultaneously).

Requirement:

* A circuit which can analyze the data sent by the sensor in motor control part and find the time which corresponds to a next photography and GPS taken time.

Verification:

* Test if the signal of rotation can be successfully extracted for the triggering system to recognize reasonable action time. Show the signal in computer and decide the corresponding triggering time in the graph/table.

* Check if signal for above action time can be sent to GPS and PCB for the two devices to work. Make the connection to a oscilloscope first to check the signal is successfully sent.

➢ PCB

This system receives the triggering system and transmitted to the camera to let it take photos. It also power up the camera.

Requirement:

* Power up the camera.

* Send triggering signal to the camera to let it take photos

Verification:

* Test if the connection is stable enough for the camera to keep working without an outage of power.

* Test if the signal can be sent to the camera to let it take photos correspondingly. Record te timing to see the delay.

➢ Camera

This part takes photos according to the triggering time and sent it to the laptop for analysis afterward.

Requirements:

* The camera is fixed firmly on the vehicle and a shield is necessary to keep it from physical worn. Also, the image taken should be clear enough for image data analysis.

* See “Laptop” and “Camera Triggering” part.

Verification:

* Test the system in field to check the mechanical stability and analyze the photos taken to decide if its solution is good enough.

* See “Laptop” and “Camera Triggering” part.

➢ GPS

This part receives the satellite signal and deicide location of the car, whose output for location information is sent to the laptop to show the location of possible damages of railway.

Requirements:

* Obtain satellite signal correctly and the precision should be within tolerance range (see tolerance part). The signal should be synchronized with the photo-taking.

* See “Laptop” part.

Verification:

* Test out the location inquisition function and use a commercialized GPS to verify its accuracy. Use a chart to record.

* Extract the GPS’s time with the camera’s time to see if the data extraction is synchronized.

* See “Laptop” part.

IV. Cost and Schedule

1. Cost Analysis

Labor

Name	(Rate/Hour)*2.5*(Total Hours)	Total Price
Jilin Jiang	(30$/Hour)*2.5*(120 Hours)	$ 9000.0
Kuangxiao Gu	(30$/Hour)*2.5*(120 Hours)	$ 9000.0
Jialun Liu	(30$/Hour)*2.5*(120 Hours)	$ 9000.0
Labor Total		$ 27000.0

Parts

Name	Model	Single Price	Quantity	Price
Micro Controller	PIC18F1220	$ 2.5	2	$ 5
GPS with increased accuracy	Crescent Vector II OEM Board	$ 350 (approximately)	1	$ 350
Parts Total				$ 355

2. Schedule

Week	Date	Task
1	8/27 – 9/2	Post project ideas
2	9/3 – 9/9	Pick up projects and find group member
3	9/10 – 9/16	Submit RFA
4	9/17 – 9/23	1. Talk with Prof. Hart 2. Submit Proposal 3. Set weekly meeting time with Prof. and TA

5	9/24 – 9/30	Sign up for design review Read the report of previous group (all member) Hook up the system to check its functions and figure out what still needs to be done (all member) Work on design review: 1. Detailed design of camera triggering module (Kuangxiao Gu, Jialun Liu) 2. Check the camera and GPS unit and find out how to trigger it, the power and data transmission (Jilin Jiang, Jialun Liu) 3. Understand the motor control unit designed by previous group (Kuangxiao Gu) 4. Find out anymore parts needed 5. Write the Design Review (Jilin Jiang, Jialun Liu)
6	10/1 – 10/7	1. Design Review 2. Check with TA and Prof. to make sure we are on the right track 3. Ordering parts (Kuangxiao Gu) 4. Camera triggering module complete
7	10/8 – 10/14	1. Connecting the camera triggering unit and the motor control unit. (Kuangxiao Gu, Jialun Liu) 2. Continue on GPS unit (Jilin Jiang) Camera PCB designed and simulated (Jilin Jiang, Jialun Liu)
8	10/15 – 10/21	1. Continue implementing blocks 2. Ordering PCB (Jilin Jiang)
9	10/22 – 10/28	1. Continue implementing blocks 2. GPS unit complete (Jilin Jiang) 3. Individual progress report

10	10/29 – 11/4	1. All Blocks implemented 2. Start synthesizing (all member)
11	11/5 – 11/11	1. Mock-up demo 2. Synthesize the whole system (all member) 3. Implementing Data transmission protocol (Kuanxiao Gu, Jilin Jiang)
12	11/12 – 11/18	1. First field test on real railroad (all member) 2. Mock-up presentation
13	11/19 – 11/25	Thanks giving break
14	11/26 – 12/2	1. Sign up for demo and presentation 2. Trouble shooting (all member) 3. Second field test (if necessary)
15	12/3 – 12/9	Write the Final Paper (all member)
16	12/10 – 12/16	Final Paper due & Check out