Train Trax: Train Monitor for Positive Train Control Test Beds

Project Management Workbook

# Revision History

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| --- | --- | --- | --- |
| Version | Date | Description | Author |
| 1.0 | 10/20/2015 | Initial Version. | Stephen Jalbert  Rashad Madyun  Corey Sanders |
| 1.1 | 11/2/2015 | Renamed Document form “Project Management Document” to “Project Management Workbook” | Corey Sanders |
| 1.2 | 11/3/2015 | Added Additional Risks Identified for the Project | Corey Sanders |
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Figure 1. Team Roles

|  |  |
| --- | --- |
| **Role** | **Team Member** |
| Project Manager | Corey Sanders |
| Developer | All |
| Reviewer | All |
| Moderator | Corey Sanders |
| Configuration Manager | Rashad Madyun |
| Backup Configuration Manager | Stephen Jalbert |
| Scribe | All |
| Test Manager / Quality Assurance | Stephen Jalbert |

# Purpose

The purpose of this document is to provide information about the work being done to manage the Train Trax project. It is intended to assist the project manager with facilitating the team to create the Train Trax project on time and on budget.

# Risks

This section keeps track of risks according to the risk management strategy described in the Team Operation Document[1].

## Identified Risks

* Scope
  + Our estimates has it so that our project is larger than 5000 LOC. A concern is that the work necessary to complete the project may take longer than the time available for the team to complete implementing within a single term.
* Domain Experience
  + The team has some experience with using IMUs, however the accuracy necessary for the project may require advanced methods of filtering and configuration to accomplish reliably.
  + The team has not worked with RFID tags to determine the location of any object before. Time is likely to be spent figuring out how to incorporate the RFID tags within the design.
  + The team is responsible for RFID tags and it is unknown what is the best strategy to place them to achieve the accuracy desired.
* Track Geometry
  + The team is unsure what will be the best method to obtain the geometry of the track. Although it is hoped, the use the system itself to determine the track's geometry, there is the risk that the system may not be accurate or reliable enough to provide this.
  + Resolution Ideas
    - One idea for mitigating this is if we can get our system to be accurate enough to determine geometry for a fixed distance or length of time and then use it to map the geometry in segments. (This would prove a bit challenging, but multiple samples will likely resolving the issue.
    - Another is to divide data collection into phases. Where we only collection information on a portion of the table at any one time. This gives us the opportunity to identify any problems with our data collection procedure before we have to redo collection of the entire table. This also gives us the opportunity to test off of a section of the test bed while geometry collection is still in progress. Lastly, it reduces the amount of time necessary at any one time to collect geometry data to reduce the risk of availability of personnel to collect geometry data.
* Bandwidth
  + One concern is that our plan to have the majority of the work performed 'off train' means that we need to have a high amount of bandwidth to ensure that we can collect and report all of the needed raw sensor data in a timely manner. Depending on the sampling rate necessary to accomplish our goals, this may amount to several kiloBytes to be delivered within a second.  
    - Current worst case estimate for 1 kHZ sampling of accelerometer and gyroscope data is 70 kBps (560 kbps).
    - Selecting Bluetooth 4.0 (25 Mbps) or Wifi Direct (250 Mbps) to ensure that there is enough bandwidth if we need to increase sampling beyond 1 kHz (Predicting only 100 Hz is needed).
    - Also want ensure that there is enough bandwidth for us to report data from multiple IMUs / additional sensors.
* Acceleration Measurement Accuracy
  + One concern is most IMUs that are available for use on the market seem to be for designed for 16 g applications. Though there is a 2 g mode, a concern is that the level of sensitivity of the hardware will introduce a lot of noise with the degree of movement observed by the train. This is something that was reported by Dr. Kulick that the team that developed the previous IMU system encountered. It is uncertain, however, what mode the IMU was used in as well as actual data samples to understand exactly what that meant in practice.
* Testing
  + The team is still unsure how we are going to conduct testing. Ideas have been gathered in general on how the testing will be made, however, there is the risk that our methods for testing will not adequately verify that the system is working correctly.
    - One suggestion to address this is to have test descriptions in place to use to verify the behavior of our prototype. i.e. we prototype our testing as we prototype our product.
* Motion Detection Unit Code Coverage
  + There is a risk of how we are going to accomplish our code coverage requirement for the Arduino software. It is preferred by the customer to have the tests conducted natively from the device, however, Remotely executing the code on the platform is problematic.
  + Resolution Ideas
    - Designing the methods so that the majority can be run on any platform so that we can run unit testing on the development machine.
    - Designing the software so that all of our code for processing can be streamed real-time to the development machine where it is processed when in test mode.
      * Introduces more complexity to our development. It adds another risk of test software interfering with performance of the rest of the software. (Unless we have a completely different test image to differ from the development image)
    - Researching into using a simulation for our target board to verify its behavior
    - Researching into using GDB for remote debugging and obtaining coverage information from that remote link.
* Estimation of Position from RFID Tag Detection
* RFID Tags are intended to be used by the project to correct position estimates calculated by acceleration and orientation changes measured from IMUs. There is, however, an unknown amount of latency between when the test rail car cross a RFID tag and when the RFID tag reader reports the identity of the tag that was crossed. As a result the precise time that the test rail car crosses the tag, cannot be determined from the RFID reader alone.
* Interfacing with Optical Sensor to Determine Time that RFID Tags Are Detected
* The current plan for addressing the risk of resolving latency between RFID tag readings and when the test rail car actually crosses the tag involves adding a new peripheral to the test rail car. It will be an optical sensor that detects when tag is crossed. Using this sensor, adds to the scope of work necessary to get the system to work, and adds to the concern of having enough time to complete the project. The sensor also represents another point of failure for the system that needs to be accounted for in test and design.
* Accuracy of Laser Tape Measurers
* The current plan for collecting track geometry data involves using multiple laser tape measurers to triangulate each position of interest on the train track. The tape measurers have been reported to measure within an sixteenth of an inch for over 90 feet. It is however, uncertain, about how accurately we can measure in practice the position of object on the track with them.

## Risk Management Plan

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Title | Likelihood | Impact | Severity | Status | Date Identified | Date Resolved | Resolution Description | Notes |
| Scope | Medium | High | High | Monitored | 10/20/15 |  | MITIGATION: Create our requirements so that the only items share are ‘shalls’ are the minimum necessary to report the position of the train on the track.  Create as much reusable code as possible for the prototyping and research efforts. |  |
| Domain Experience | High | High | High | Monitored | 10/20/15 |  | MITIGATION: Create a proof-of-concept prototype to report the dead-reckoning position of a Nexus 7 or other equipment. |  |
| Track Geometry | High | High | High | Monitored | 10/20/15 |  | MITIGATION: Divide collection of track geometry into phases. Create Geometry Collection Procedure as early as possible. Perform track data collection as early as possible. |  |
| Bandwidth | Medium | High | High | Monitored | 10/20/15 |  | AVOIDANCE: Select a hardware module capable of sending data at least an order of magnitude greater than we predict we need. |  |
| Testing | Medium | Medium | Medium | Monitored | 10/20/15 |  | MITIGATION: Practice some of the testing described in the Test Plan with our prototype. |  |
| Motion Detection Unit Coverage | Medium | Medium | Medium | Monitored | 10/20/15 |  | AVOIDANCE: Create sample unit tests with ArduinoUnit and evaluate. |  |
| Acceleration Measurement Accuracy | Medium | High | High | Monitored | 9/2/2015 |  | MITIGATION: Collect raw data from the IMUs as early as possible, and analyze how usable it is. Verify the degree of accuracy expected from selected IMU. |  |
| RFID Tag Detection Timing | High | High | High | Monitored | 9/2/2015 |  | AVOIDANCE: We are equipping an optical sensor to detect when the test rail car crosses a RFID tag. |  |
| Optical Sensor Interop | High | Medium | High | Monitored | 10/26/2015 |  | MITIGATION: Interfaceing with the optical sensor is being included n the initial design. The test rail car is being constructed this semester so that the team can start testing with it this term. Scripts will be created to evaluate raw measurements from the rail car, including optical sensor measurements. Evaluation involves trying different algorithms to estimate position with the available data. |  |
| Laser Measurer Accuracy | Low | High | Medium | Monitored | 9/2/2015 |  | MITIGATION: We are conducting track geometry data collection as early as possible so that we can evaluate the quality of the data. A normal tape measurer will be used to compare the calculated values against. |  |

# References

1. Train Trax Team Operation Document