Department of Computer Science & Engineering
The University of Texas at Arlington

Project Charter
CSE 4316: Senior Design I
Summer 2019

Team Rocket
Rocket Board

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Revision History

Revision	Date	Author(s)	Description
0.1	06.22.2019	AP	Document creation
0.2	07.01.2019	AP	Vision, mission, and succes criteria

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1 Vision

In today's increasingly complex world, it is important to get more and more people interested in pursuing STEM education. The complex nature of these topics can make it difficult to grab young peoples interest. To this end we believe it is important to use hands on and interactive projects that demonstrate these fields are not as out of reach as young people may think. Further more we seek to show the importance of interdisciplinary work to make very complex projects and ideas come to life.

2 Mission

Rocket Board is an on board sensor package for model rockets. During a flight the sensors will collect data on things such as altitude, speed, and atmospheric conditions. Furthermore Rocket Board will include a GPS module for tracking and recovery. Rocket Board will be supported by an android application to track the rocket , as well as visualize some of the data provided by Rocket Board .

3 Success Criteria

Upon completion of the prototype system, we expect the following success indicators to be observed in regards to flights of the rocket itself.

- A 95% reduction in rocket loss due to not being able to locate it after landing.
- Visualization of the rockets flight trajectory.
- Introduction into classrooms and other STEM education programs.

Within 6 months after the prototype delivery date, we expect the following success indicators to be observed:

- Improvements to quality and accuracy of data visualization
- A 20% increase in the number of classrooms and STEM education programs using the product.
- The appearance of user made improvements to the electronics and application.

Within 12 months after the prototype delivery date, we expect the following success indicators to be observed:

- Translation of the application and documentation into other languages.
- An additional 20% increase in the use of the product in classrooms and STEM education programs.

4 Background

Flying model rockets is safe and easy hobby that has been used to drive interest toward the STEM field in young people. However, gathering data about the rocket's flight, tracking the rocket's final location, and visualization of the data currently have either expensive or technical solutions behind them. This prevents people that are interested in model rockets from fully immersing themselves into the hobby, and largely keeps it to diehard fans that will spend the money or time to acquire the necessary parts or skills. This problem can be mitigated by developing an on board sensor package for model rockets that will be supported by an Android application. Thus, allowing for a simpler solution to the mentioned problems, and allowing for more people to appreciate the hobby and the STEM field. Currently, the rockets need a separate receiver, a ham radio, or a standalone GPS to track the rocket. Instead, the application would have Google maps integration to allow for a convenient way to pinpoint the location of the rocket without a separate device as most people carry smart phones. Model rocket telemetry tends to require the hobbyist to put electronics into their model rocket and know micro-controller programming. By developing a prebuilt unit people will only have to deal with installing the product into their rocket which would save the user both time and money.

This product is not currently being sponsored by anyone; however, it has a clear market of newer hobbyist and educators. Hobbyist that are newer or without that much time to dedicate would benefit from the product as it would allow them to achieve a fuller experience in the beginning phases. Educators would benefit from having a low cost and low effort product, such that it would be easy to incorporate into a curriculum and engage more children into the STEM fields.

5 Related Work

The field of model rocket telemetry and tracking is full of methods from amateur to professional approaches. On the amateur side of the field, online forums like The Rocketry Forum contain numerous discussions about the different electronics and how to properly utilize them [2]. However, these solutions and discussions primarily involve which parts are best to buy and how to properly setup and install them. This would satisfy our targeted customer base as it does not simply the process and is more in the realm of diehard hobbyist. Another example of an amateur solution is found the website hackster.io which gives schematics and code that someone would be able to follow and implement themselves [3]. This makes it easier for someone without the technical knowledge to recreate the process; however, the task can be daunting to some. Therefore, even a more well developed amateur solution would not fit the needs of the targeted customers. Products like the TeleMetrum contain a GPS and other sensors to allow for data collection [4]. However, these types of products require a HAM license to properly utilize them and do not provide interfaces like an application to manage the data; therefore, they would not fit all need of simplicity. The Seagull Rocket System from Eagle Tree Systems contains many of the features that the product will contain and fits into the payload bay of a decent sized rocket [5]. The main problems with this device is the almost five hundred dollar price tag is too high for the targeted customers and it does not have an application to help manage all of the data. The Featherweight GPS Tracker is cheaper than the previous product at three hundred and fifty dollars, and has an iPhone application that is in the testing phases [1]. This does not have the flight path visualization, and is still on the higher end of cost for the target customers so it does not fully fit the their needs.

6 System Overview

Rocket Board will allow users to collect flight data and track a model rocket.Tracking and flight data visualization will be done by the user on a companion application for Android smart phones. The Android application will allow the user to have detailed history of the rockets previous flights. During flight, Rocket Board will collect data on the rockets flight and transmit it back to the companion app for display and. After the flight the rocket will begin sending its location to the android application to allow for tracking and recovery of the rocket.Inside the rocket many sensors will be taking readings. For example, the barometer will be reading the atomic pressure and altitude.

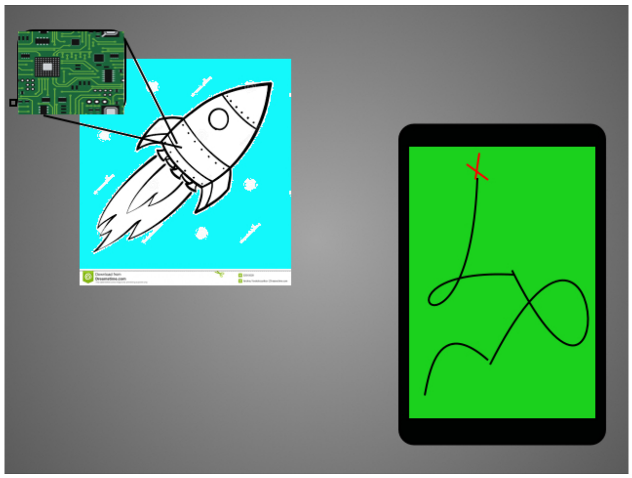

Figure 1: The system's GPS tracking feature

Rocket Board will also include an Inertial Measurement Unit (IMU) which is a device that contains an accelerometer and and gyroscope. This device will calculate measurements such as the angular rate, force and more. Rocket Board will retrieve these measurements continuously during the flight. These numbers will be filtered and transformed using various Gaussian and kinematic equations to perform further analytics. The application will save all of the data for further analysis by the user. Tracking the rockets progress will be possible with sensors that will keep to up to date with the relative geographical coordinates. These coordinates will be used in connection with Google maps to accurately portray the flight course on the application. Rocket Board will transmit data to the application through the flight until recovery when the user will turn the electronics off. Once all of the data has been collected and the rocket has landed, it will then utilize the SPI method to exchange the data with FM transmission. The data will be sent in packets at a frequency above 2000Hz, in order to stay out of the spectrum utilized by normal radio stations. Each packet will send all of the sensory reading for the allotted time frame. Finally, the application will receive all of the information and display the updated analytical data. The user should be able to track the flight and all of its data collected by the sensors. It is our hope that the user can to obtain all of information, interpret it, and adjust methods for more efficient lights in the future.

7 Roles & Responsibilities

The stakeholders of the project are Dr. Chris Conly, Darion Adams, Rahasya Chandan, Alexander Pavlak, Nathan Reagan and Brianca Washington. Our point of contact with Dr. Conly is currently Brianca Washington. The current Scrum Master is Alexander Pavlak. Should the current Scrum Master like to step down, a team meeting will be held and new Scrum Master will be chosen.

Project Sponsor - Dr. Chris Conly

- Oversee project progress and quality
- Provide feedback
- Grade deliverable

Team Member 1 - Darion Adams

- Software Developer: Design and implement software, Test and maintain software
- Planner: Track deliverables, Create schedule and project time line
- Quality Assurance: Test quality of project and manage risks

Team Member 2 - Rahasya Chandan

- Hardware/Software Developer: Design, implement and development of hardware and software
- Researcher: Research, collect and analysis areas important to the project
- Quality Assurance: Test quality of project and manage risks

Team Member 3 - Alexander Pavlak

- Project Manager: Support and direct team, Help define project scope, goals and deliverables
- Software Developer: Design and implement software, Test and maintain software
- Document Editor: Format and keep document updated
- Quality Assurance: Test quality of project and manage risks

Team Member 4 - Nathan Reagan

- Hardware/Software Developer: Design, implement and development of hardware and software
- Budget Holder: Maintains and ensures the budget of the project
- Quality Assurance: Test quality of project and manage risks

Team Member 5 - Brianca Washington

- Hardware/Software Developer: Design, implement and development of hardware and software
- Researcher: Research, collect and analysis areas important to the project
- Quality Assurance: Test quality of project and manage risks

8 Cost Proposal

A functional rocket with the capacity to house the device will be used for testing, and will consume the bulk of the cost. Various sensors (outlined below) are used to collect the necessary data for mapping in the final application. The measurements are recorded to later be transmitted using a central microcontroller. The packet of data is then sent to the end program using an FM transmitter.

Item	Source	Quantity	Cost
YPAT25 Rocket Kit	LOC Precision	1	$65
TM4C123GH6PMI Microcontroller	Mouser	1	$10.64
EK-TM4C123GXL Evaluation Kit	Mouser	1	$13.45
MPL3115A2R1 Barometer	Mouser	1	$4.87
Sparkfun MPU-9250 IMU	Mouser	1	$10.57

Table 1: Budget Table

8.1 Preliminary Budget

8.2 Current & Pending Support

Funding is provided solely by the UTA CSE department, with a budget of $800.00.

9 Facilities & Equipment

The project will need to occupy a lab space that contains everything that one could need to solder parts to a circuitry board. These tools include things like solder irons, solder, any removal tools, exchangeable soldering tips, clamps, stands, or anything else that could be helpful with solder smaller boards. A scale will also be useful when making these systems, because weight will affect the performance of the rocket itself. Connectivity and transmission techniques can also be tested in a lab first, but should be tested in open area/field in later stages. In the beginning stages, an oscilloscope will be essential to following the SPI methods for transmission to ensure timing and readings are valid data. When building the sensory subsystem, again a lab is needed for tools like the oscilloscope, voltmeter, and a multimeter. In this case, the oscilloscope will be used for more ensuring current flow and testing the accuracy of the data. In later stages, the system will be soldered together and added to the rocket for actual flight testing. During this time, it will need to be held in an open field or area. Also, a phone will be used to use the application to track the data, while another phone is tracking the path on Google Maps. This will ensure accuracy.

10 Assumptions

- We assume that there are methods to interface the various hardware and software components necessarily to successfully complete the project.
- A suitable outdoor testing location will be available to launch the rocket
- All the hardware implementation will fit in the chosen model rocket
- The implementation of Log GPS, Altimeter, IMU, etc sensor data is successful
- All software being used for implementation and testing is free of charge

11 Constraints

The following list contains key constraints related to the implementation and testing of the project. Most of the constraints listed are to keep the complexity of the project at a manageable level.

- Final prototype demonstration must be completed by November 3rd, 2019.

- The target operating system for the companion app shall be Android.
- Rocket Board shall communicate via FM radio.
- Total development costs must not exceed $800
- The demo rocket shall weigh no more than 1 pound and fly on less than 4oz of propellant. This is to ensure compliance with FAA regulations for test flights.

12 Risks

The following high-level risk census contains identified project risks with the highest exposure. Mitigation strategies will be discussed in future planning sessions.

Risk description	Probability	Loss (days)	Exposure (days)
Device breaking due to physical launching stress	0.50	20	10.0
Outdoor launching grounds are not available	0.10	14	1.4
Internet access not available at installation site	0.20	3	0.6
Delays in shipping from overseas vendors	0.15	20	3.0
Launching malfunction	0.05	15	0.8

Table 2: Overview of highest exposure project risks

13 Documentation & Reporting

13.1 Major Documentation Deliverables

13.1.1 Project Charter

Over the course of the project development, this document will be modified on an as needed basis. Any modifications will be brought up and discussed during sprint review before being added. The initial draft of the project charter shall be delivered no later than 11:59 P.M. July 7th, 2019. The final draft will be delivered upon project completion.

13.1.2 System Requirements Specification

The system requirements specification will be reviewed during sprint review. During this time decisions as to additions, removals, and modifications will be made prior the start of the next sprint. The initial document will be delivered no later than 11:59 P.M. July 23rd, 2019.

13.1.3 Architectural Design Specification

The architectural design specification will be reviewed during sprint review. During this time decisions as to additions, removals, and modifications will be made prior the start of the next sprint. The initial document will be delivered no later than 11:59 P.M. August 8th, 2019.

13.1.4 Detailed Design Specification

The detailed design specification will be reviewed during sprint review. During this time decisions as to additions, removals, and modifications will be made prior the start of the next sprint. The time of delivery of the initial draft will be determined later in the design process.

13.2 Recurring Sprint Items

13.2.1 Product Backlog

As new requirements are added to the system, new items will be added to the product backlog. This will be done during the sprint review and planning week at the time the new requirements are added to the SRS document. The product backlog will be maintained using an online spreadsheet that all team members have access too.

13.2.2 Sprint Planning

Each sprint will be planned during the review week of the previous sprint. All team members and the product owner will take part in sprint planning. A total of 9 sprints are planned for the project.

13.2.3 Sprint Goal

Who decides the sprint goal? How will you involve your customer in this process? The sprint goal will be discussed and decided by the team during the sprint review week of the previous sprint.

13.2.4 Sprint Backlog

Who decides which product backlog items make their way into the sprint backlog? How will the backlog be maintained (collaboration software, a "scrum board", etc.)? During the sprint review and planning period The team will discuss and decide which items from product backlog will be added into the upcoming sprints backlog. The product owner will be consulted during each sprint review to ensure they are aware of exactly what is being developed at all times. The backlog will be maintained in an online spreadsheet that all team members have access too.

13.2.5 Task Breakdown

Individual tasks will be picked by the team members themselves. In the event that no member picks a particular task the product manager will assign the task to a team member. Tasks will be tracked using an online spreadsheet that all team members have access too.

13.2.6 Sprint Burn Down Charts

Burn down charts will be generated at the end of each sprint to track progress and help with planning the next sprint. Each team member will record their effort on an online spreadsheet which will also be used to generate the burn down chart. An example burndown chart is provided below.

13.2.7 Sprint Retrospective

A sprint retrospective will be held for one week following the completion of a sprint. Each member will discuss issues faced, any shortcomings in completion, and speculative ideas for later implementation. Discussions regarding ideas and expectations for the future will be documented for later reference.

13.2.8 Individual Status Reports

Status reported by each member will consist of their individual work for their specific aspect of the project. This will be reported weekly to ensure sprint cohesion. Key items include time required for current progress, estimated time remaining, and discussion of integration within the overall device.

13.2.9 Engineering Notebooks

Engineering notebooks will be updated weekly. Each interval will take one page, with an interval being one month. Team members will keep each other accountable by distributing the work and requiring that each part be completed. The TA will sign as witness to each page.

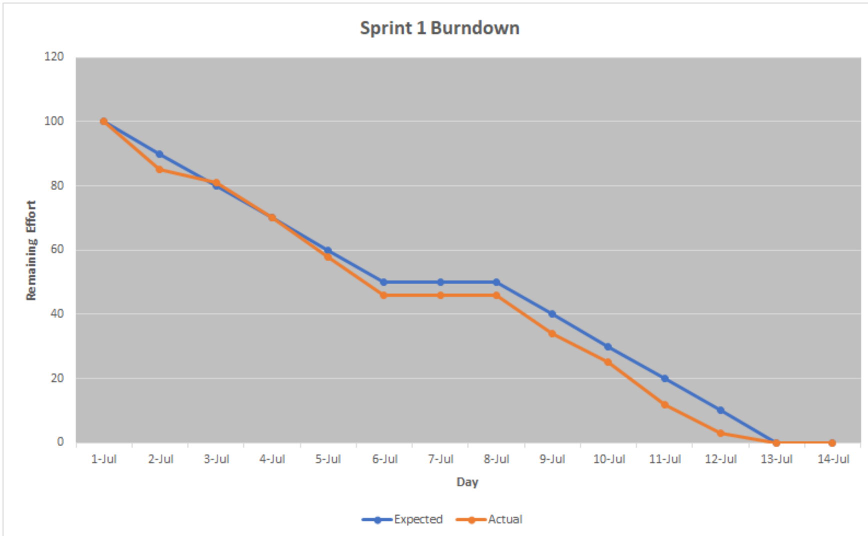

Figure 2: Example sprint burn down chart

13.3 Closeout Materials

13.3.1 System Prototype

A system prototype will be created using the EK-TM4C123GXL evaluation board with a breadboard to ensure basic sensor/transmission functionality. This will be demonstrated using the debug functionality found in Code Composer Studio prior to the soldering of the final SMD TM4C123GH6PM microcontroller.

13.3.2 Project Poster

The project poster will contain pictures of the rocket launch and complete application, in addition to the schematic files and explanations of the parts chosen. The project poster will be a white 36" x 48" tri-fold corrugate display board delivered on the day of presentation in December 2019.

13.3.3 Web Page

The web page will contain the project documentation and demonstration of the finished product. It will be updated as the documentation is updated.

13.3.4 Demo Video

The demo video will show the launch of the rocket and a video screen capture of the Android application in use.

13.3.5 Source Code

Source code will be open-source and maintained using the git version control system. The code will be regularly updated on a public GitHub repository following the GNU General Public License. Each source file will have the necessary copyright documentation outlined in the header, and a copy of the license itself will be provided as a separate file in the final project repository.

13.3.6 Source Code Documentation

Doxygen will be used to generate the documentation. The final source code documentation will be provided as a PDF file. Documentation regarding the physical device will be provided as a separate PDF file.

13.3.7 Hardware Schematics

A PCB will be created to connect the microcontroller and sensor peripherals. EagleCAD will be used to create the necessary schematic file (.sch) and PCB file (.brd).

13.3.8 CAD files

Will the project involve any mechanical design, such as 3D printed or laser-cut parts? If so, what software will you use to generate the files and what file formats will you provide in your closeout materials (STL, STEP, OBJ, etc.). If your project is purely software, omit this section.

13.3.9 Installation Scripts

Updates will be deployed for the Android application via the Google Play app store.

13.3.10 User Manual

A digital user manual will be provided with a guide on mounting the device and a link to download the application. The application will have a built-in instruction guide to pair the device with the application.

References

[1] Featherweight Altimeters. Featherweight gps tracker, 2018.

[2] The Rocketry Forum. Rocketry electronics and software, 2019.

[3] Ish Ot Jr. Smrt: Sensor-based model rocket telemetry, 2017.

[4] Altus Metrum. Telemetrum, 2017.

[5] Eagle Tree Systems. Seagull rocket system, 2019.