Group 21
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Initial Project Document

Aerojet Remotely Radio Controlled Rover

University of Central Florida
Department of Electrical Engineering and Computer Science

Dr. Lei Wei
Senior Design I

Group 21

Christopher Keefer - Mechanical Engineering
Joel Marquez - Computer Engineering
Anjali Padmanaban - Electrical Engineering
Chase Walker - Computer Engineering

Project Sponsor - Aerojet Rocketdyne Coleman Aerospace
Faculty Advisor - Dr. Felix A. Soto Toro

Project Narrative

Aerojet Rocketdyne Coleman Aerospace - our customer - developed this project idea with the intention of challenging students with educational experience that they will encounter in the real world. They created a project requiring two disciplines of MAE/AE and ECECS to make a rocket and a payload for the rocket respectively. The payload is intended to serve as a reconnaissance vehicle for it's landing location. This team chose the remotely controlled radio rover project with motivation stemming from the interest in implementing wireless communication with the rover and it's controller, as well as the interest of having control over it's movements compared to the autonomous option. The RC rover was also chosen due to the team's division of skills in robotics, mechanics, electrical engineering, and programming.

The main goal of this project is to create a deployable rover payload for an IREC spec rocket that has remote control and wireless video transmission available upon touchdown from rocket deployment. These goals were specified by Aerojet Rocketdyne to drive the final product of this project. The team's objective is to create a rover that is light-weight, compact, responsive, and has a reliable battery lifetime while meeting the main goals of the client. The team will create a rover chassis that contains the rover's traversal systems, main PCB, and a secondary controller and video receiver PCB. The team may also be responsible for payload deployment which is discussed later.

The rover chassis will be a light frame that mounts the PCB, video camera, motors, tracks, and the power supply. The team intends to create a tank track movement system to allow the rover to avoid terrain hazards that could severely limit the movement of the rover. The frame will be made of a light and sturdy material to leave as much free weight as possible for the electrical and moving mechanical hardware, while still being able to handle the stresses of operation and touchdown. The power supply for the rover chassis will power the PCB, camera, and motors. A rechargeable battery cell will be used to avoid recurring costs and keep vehicle weight down.

The main PCB mounted to the rover will control all of the moving operations, the video camera, and signal transmission and reception. Wireless signals from the controller will be received by the PCB, and the microcontroller will take the incoming data and use it to control the motors for the rover's movement. The video camera's output will be encoded and transmitted by the primary PCB to the secondary PCB at the location where the launch will be observed. The PCB will also have sensors to measure pressure, temperature, and altitude during the rover's active duty.

The secondary PCB - the controller and video receiver - will be free standing from the rover. It will have it's own rechargeable power source to allow it to be moved freely. It will receive and decode a wireless video signal from the rover to be displayed to a screen at the launch observation location. The board will also have a joystick controller on it that will provide the data to be transmitted to the rover for movement control.

The team members will meet and work with the FAR rocket team to determine how responsibilities for the payload deployment will be divided. Based on the results of this communication, the team will finalize the requirements related to payload deployment and update timelines, expenses, and responsibilities of team members accordingly. All requirements currently related to deployment are theoretical and tentative.

The final rover product will provide remote controlled, live video reconnaissance to launch control and it may act as a prototype for larger and more high-powered applications. The sensors, and video camera will work together to provide data about the rover's location and experience to launch control. The team will work with Coleman Aerospace and their advisor throughout the length of the project to meet their goals and the client goals.

Requirement Specifications

Requirement Number	Requirement Description
1	Payload will be detachable from the rocket
2	Payload will not exceed 1 kg (2.2 lbs) in mass
3	Payload will be designed to fit inside of the rocket fairing which will be a minimum of 7.62mm (3in) in diameter
4	Payload will descend via parachute at a maximum of 2.5 meters per second
5	Rover will automatically detach the parachute upon landing
6	The rover will establish a video feed within 5 seconds of landing
7	Rover will leave the landing site within 5 seconds of landing
8	The rover will send and the secondary PCB will receive a live video feed over a minimum of 300 meters
9	The live video will transmit at a minimum of 480p 24fps
10	The secondary PCB will be able to display the video from the rover to a display with an HDMI input

11	Secondary PCB will send and the rover will receive remote control signals over a minimum of 300 meters
12	The rover will respond to controller input within 1 second
13	The rover will be able to travel at a minimum speed of 1.35 m/s (~3mph).
14	The rover will have tank tracks that are capable of traversing most common terrains.
15	The rover will be able to turn in both directions.
16	The rover will be able to move forward and backward.
17	The rover will travel a minimum distance of 3.05 meters (10 feet) from the landing site.
18	The rover will be able to transmit video while traveling a minimum of 3.05 meters.
19	The rover will be able to sit idle for 1 hour minimum and have enough power remaining to travel 3.05 meters while transmitting video
20	The rover will have sensors that can measure pressure, temperature, and altitude

Project Constraints

Due to the nascent stage of the project, the constraints listed are currently theoretical and others may arise as our requirements are fully formed and we receive customer feedback as the project progresses. Some of the predicted constraints include:

Constraint Number	Constraint Description
1	Adhering to the 2.2 lbs weight limit
2	Creating a sturdy and light chassis
3	Traversing rocky or unpredictable terrain
4	Implementing remote control of the rover payload

5	Sourcing a power supply that can power the motors and the camera for an appropriate amount of time while adhering to the weight constraint
6	Managing battery voltage, capacity, and weight
7	Researching the wireless transmission of video data and remote control data to/from the rover

Prototype Illustration

Pictured below is the initial and tentative design for the rover chassis. Major features include accommodations for mounting and securing the PCB and battery pack within the structural frame, a cutout for a front mounted camera, and housings for each of the motors. Also included is a mounting surface for the parachute pack. The low profile design is intended to minimize overall size for transportation via rocket as well as maintaining stability when traveling over land. Future iterations of this design will give more consideration to supporting electrical and computer systems onboard the rover once the specifications of those components are known. This group also intends to incorporate a continuous track system that will appear in future versions of this design. As this is a preliminary design, little consideration was given to exact dimensions as sizing parameters have yet to be obtained from the FAR Rocket group.

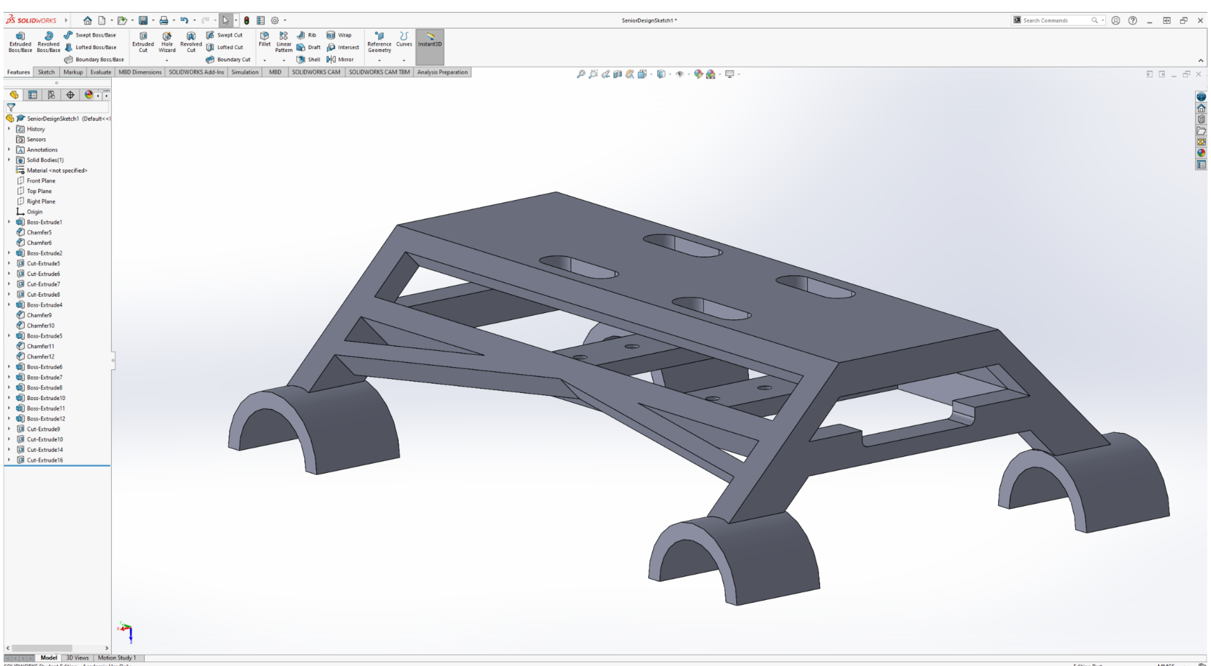

Figure 1: Initial Chassis Design Sketch

Block Diagrams

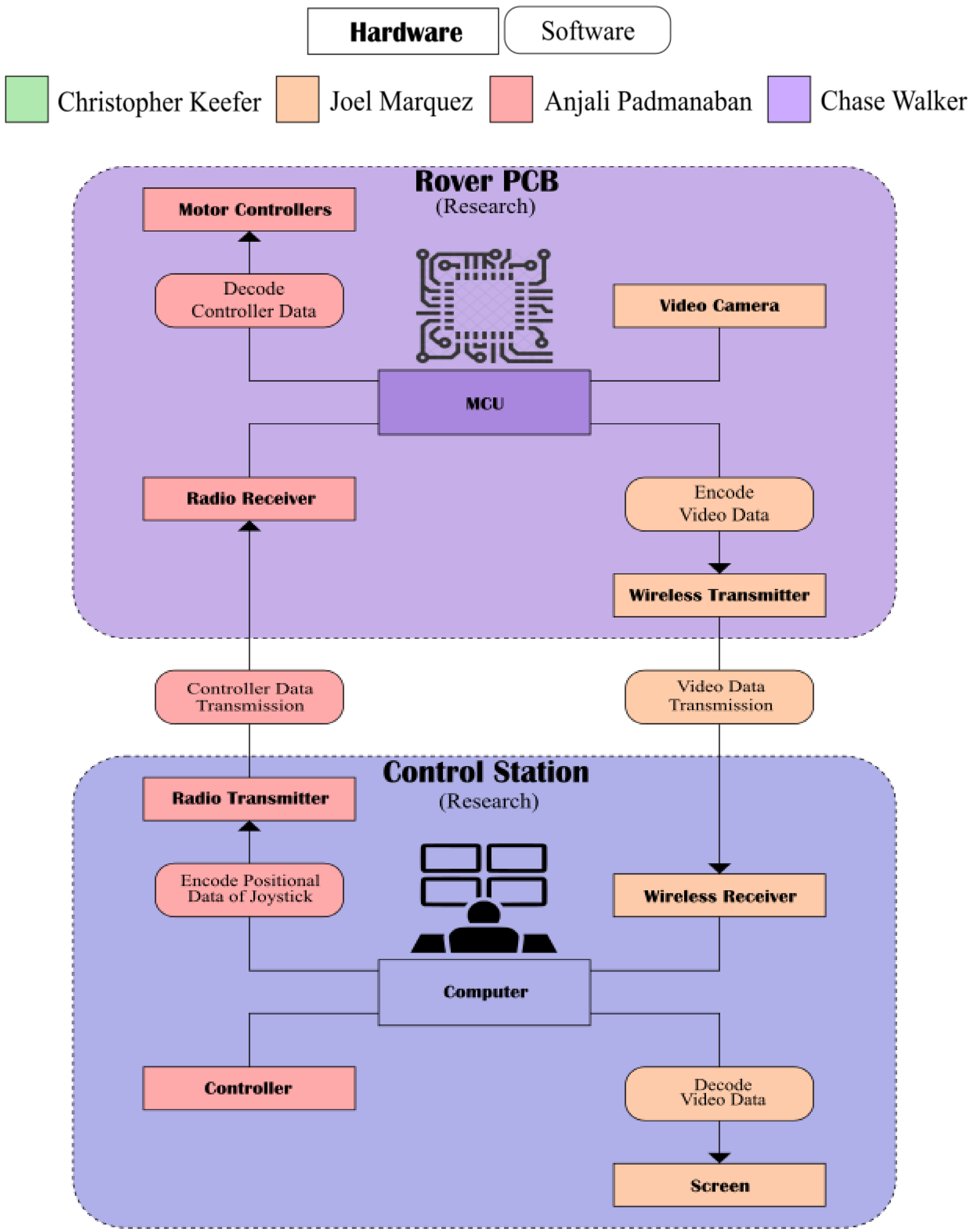

Figure 2: Block Diagram Showing Hardware and Software Components

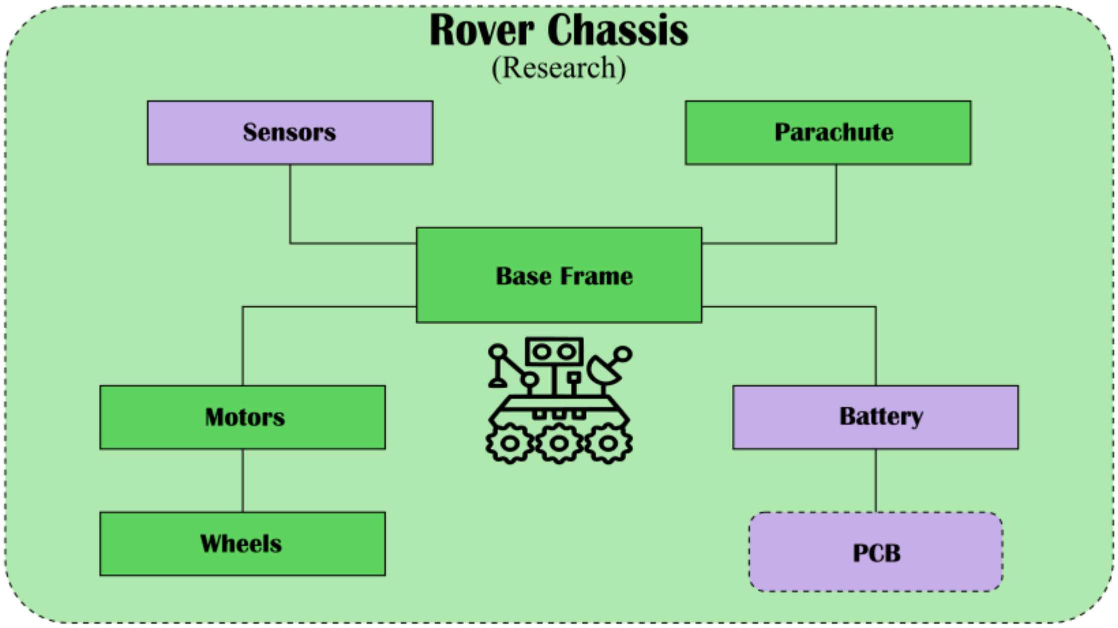

Figure 3: Block Diagram Showing Overall Rover Layout

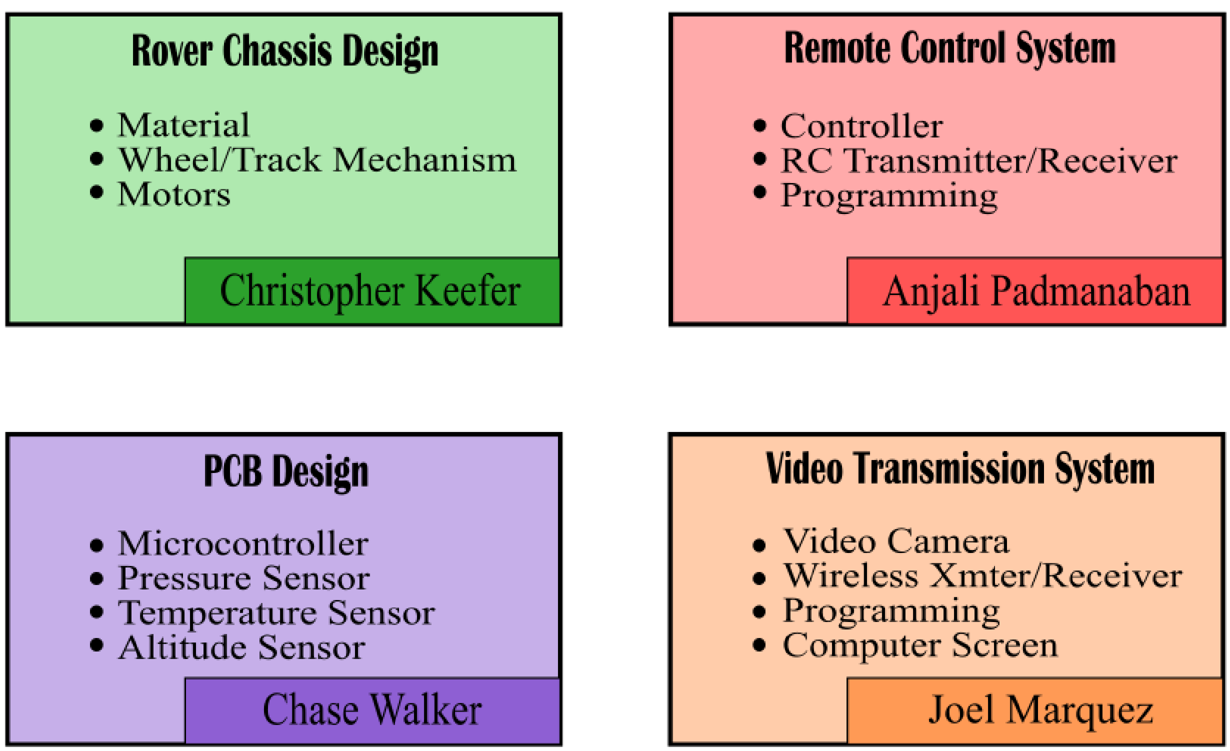

Figure 4: Group Breakdown

Budget and Funding

Our project is funded by Coleman Aerospace who are providing us with $2,000. This is a rough estimate with a materials list gathered from high-level research into the components needed to satisfy the project requirements. The components listed may increase or decrease in quantity or be replaced entirely with more efficient item selection.

Item	**Quantity**	**Estimated Price**
Microcontroller	1	$3 - $10
Pressure, temperature, and altitude sensor	1	$6
Video Camera	1	$30 - $40
Video encoder and decoder ICs	1	$30 - $50
Parachute	1	$30
Remote Controller custom PCB	1	$40 - $80
Radio transmitter and receiver	2	$10
Lithium-ion Batteries	2-5	$10 - $60
Motors	5	$75 - $100
3D-printed Rover Chassis	2	$0 - $20
Tank track assembly	2	$20 - $40
Rover custom PCB	1	$40 - $80
TOTAL (Estimated)	**X**	**$294 - $556**

Table 1: Estimated Total Materials and Costs to Implement Project

Initial Project Milestones

Number	Milestone Description	Planned Completion Week (SD1 and SD2 period)
1	Design and test proof of concept radio control communication circuitry	8
2	Design and test proof of concept live video transmission circuitry	9
3	Design and build Rover Chassis with motors, tracks, and test movement with simple prototype code and MCU launchpad	10
4	Design and test parachute system (if needed)	11
5	Design full main PCB (combine 1 and 2 and 3)	12 - 15
6	Design full secondary PCB (combine 1and 2)	12 - 15
7	Order PCBs	16-17
8	Build PBCs	18-19
9	Fully assemble rover and test	20 - 21
10	Final testing and necessary revisions	22 - END

Table 2: Breakdown of Project Milestones by Planned Week of Completion