E2.01 Integrated Camera and Lighting System

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Project Overview

Our project involves designing an integrated camera and lighting system for a lunar surface rover aimed at capturing high-quality images in dynamic environments.The static lighting array, controlled by a microprocessor, includes independently adjustable spotlights and floodlights for optimal illumination at varying distances. A lighting analysis camera captures snapshots, allowing the microprocessor to identify dark and bright areas for real-time lighting adjustments. Our high dynamic range camera captures and records high quality video for a mission specific purpose. Our design objectives were:

- Develop an integrated camera and lighting system for a lunar surface rover, capable of capturing high-quality images in various lighting conditions.
- Utilize programmable spotlights and floodlights to dynamically adjust illumination based on environmental needs.
- Integrate an HDR camera to capture detailed images, accommodating high-contrast scenarios and reflective surfaces.
- Design the system to operate effectively under extreme lunar conditions, including total darkness and direct sunlight.
- Ensure the system can produce clear imagery across a variety of material textures and reflective surfaces.

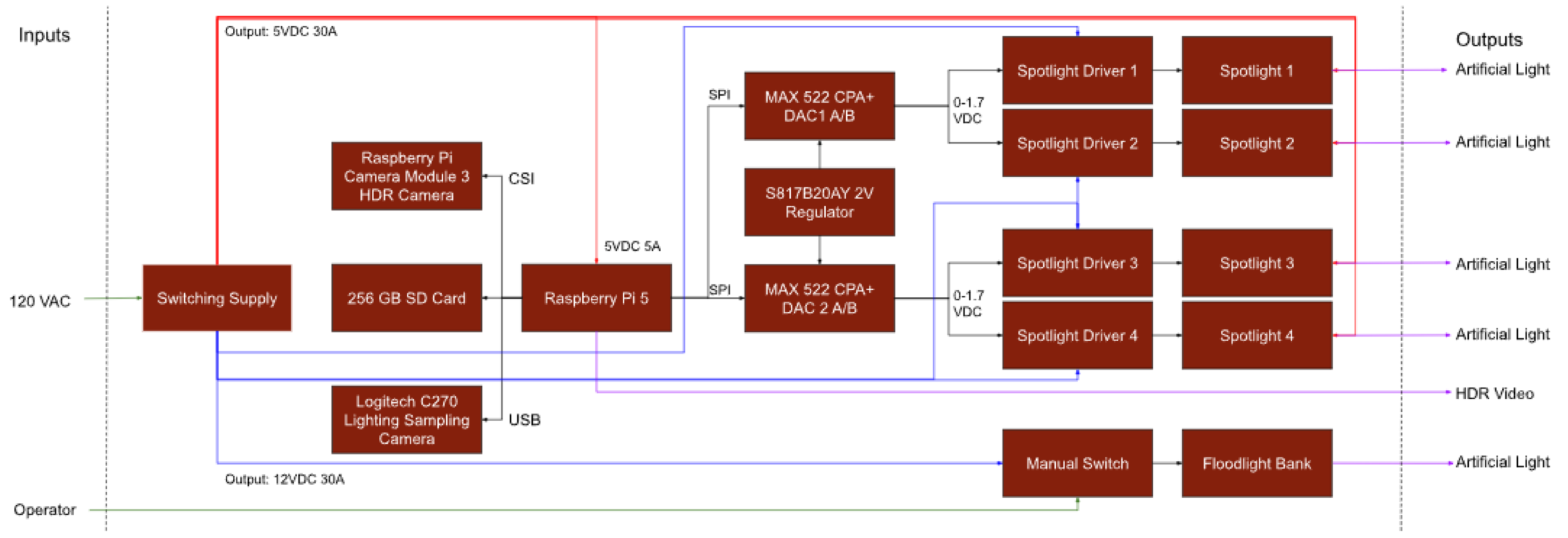

Fig. 1: Block Diagram

HDR and Lighting Sampling Camera

Our system utilizes an HDR camera in order to capture high quality imagery and a lighting sampling camera to identify regions in front of the rover that need artificial lighting. The video captured by our HDR camera is stored on a 256GB SD card on the microprocessor with a max recording time of approximatley 84.6 hours. The image data captured by the lighting sampling camera is used in our image processing algorithm and deleted after it is used to adjust the lighting array to improve the lighting environment of the scene.

Team Accomplishments and Acknowledgments

Over the course of the last two semesters our team has overcome many challenges and accomplished a great deal together. We would like to give a special thanks to our NASA Sponsor, Mrs.Toni Clark, who's assistance has been invaluable in the completion of this project. Additionally, we would like to thank Dr. Tim Urban and the rest of TSGC for facilitating the design challenge. We would also like to thank all of our Texas State Faculty, Mr. Mark Welker, Dr. Rich Compeau, and Dr. Jeff Stevens for there many contributions. Finally, we would like to thank our mentor team, Phonons and Photons, and our first semester team, Effectively Grounded.

Image Processing Algorithm

Fig. 2: Original Image (Apollo 15 Moon Landing)

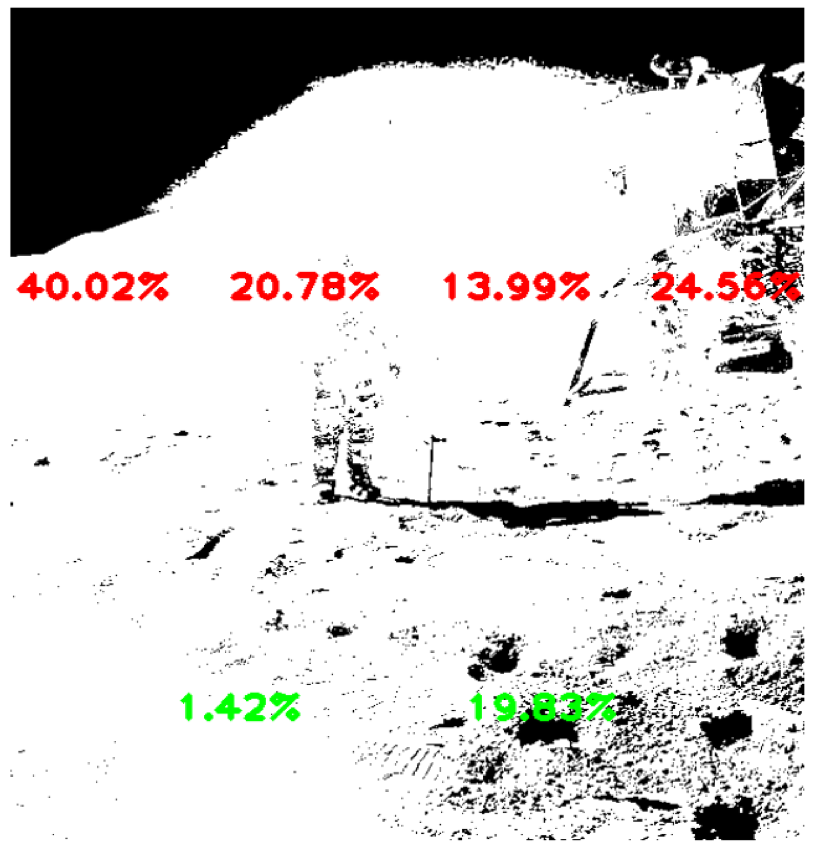

Fig. 3: Processed Image With Darkness Detection

Our image processing algorithm first converts a sample image to the HSV color space, where information relating to the brightness of each pixel can be extracted. Following this, calculations are preformed on each quadrant of the image to determine its level of relative brightness. The output of the lighting array is then adjusted to reflect the needs of the environment.

Lighting Array and Spotlight Drivers

Our lighting array is statically mounted in order to combat the lunar dust problem. This array is comprised of four spotlights to illuminate areas further away from the rover and four floodlights that provide illumination for near the front of the rover. During testing, we identified that our spotlights alone provide more illumination than the headlights of a car. Our PCB design is a voltage controlled current source that allows brightness variation in our spotlights.

Fig. 4: Car Headlights

Fig. 5: Spotlights

Fig. 6: Lighting Array

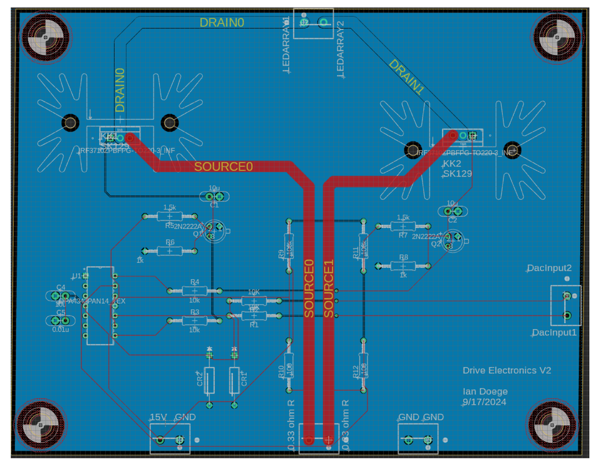

Fig. 7: Spotlight Driver PCB

Test Data

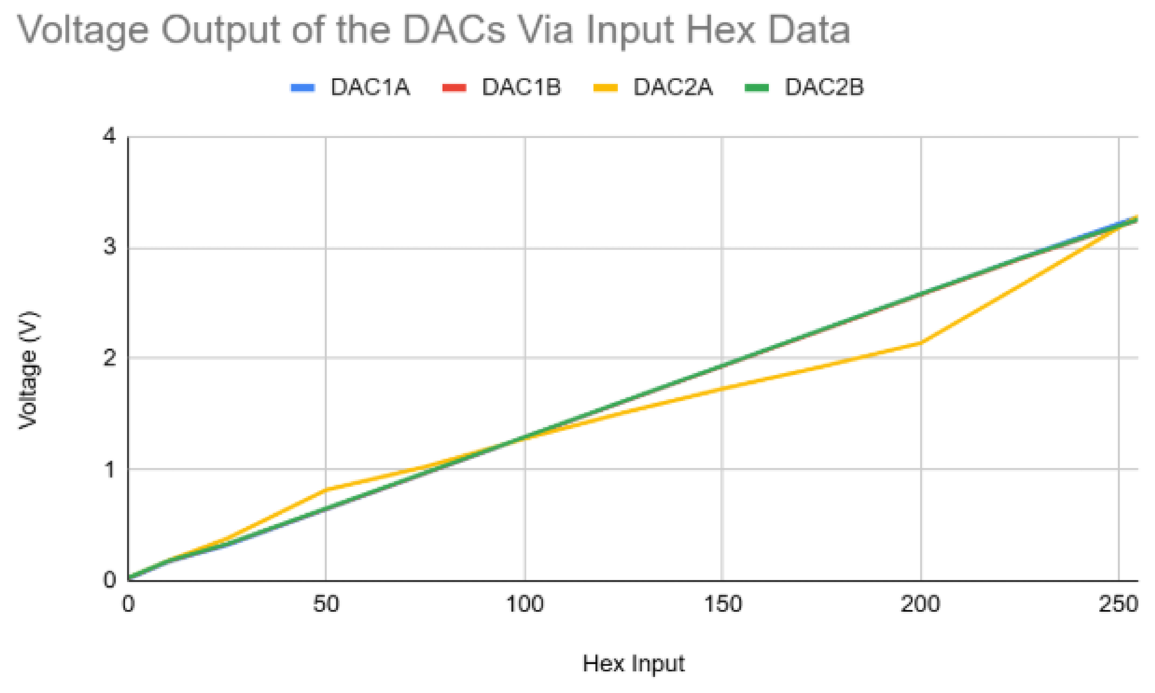

Fig. 8: DAC Output Per Hex Input From Image Processing

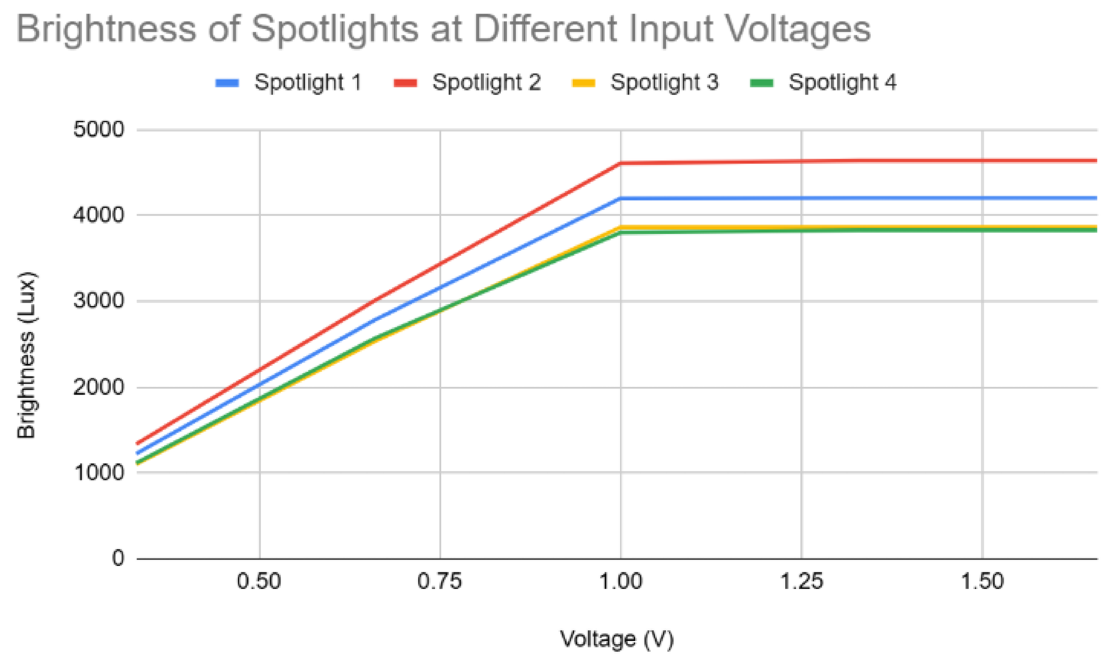

Fig. 9: Spotlight Lux Per Input Voltage

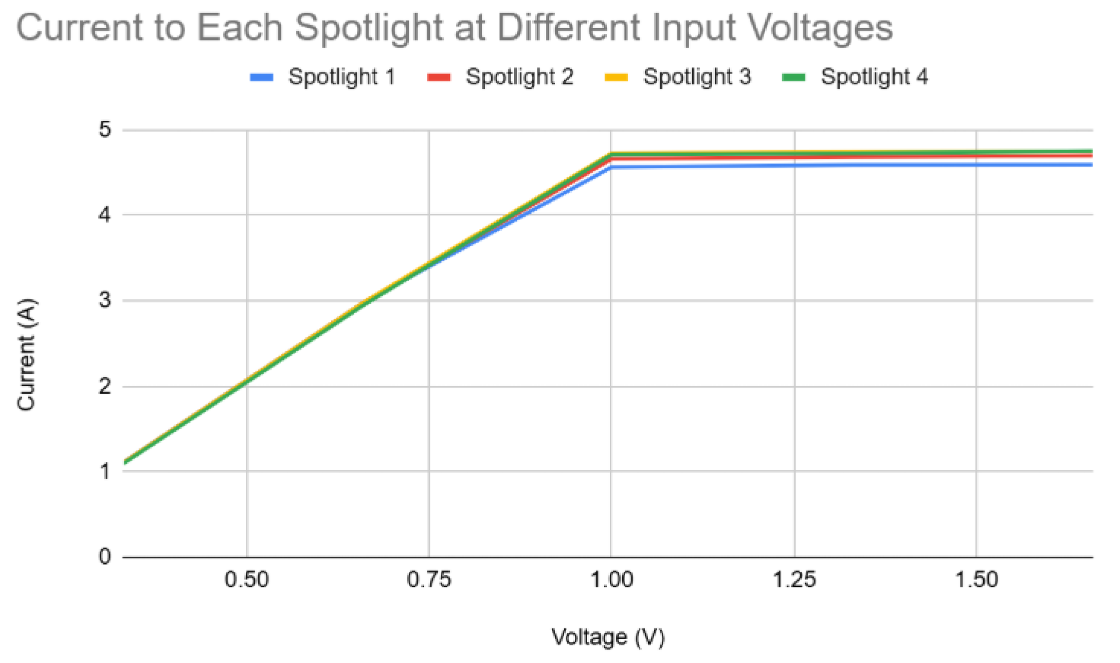

Fig. 10: Spotlight Current Per Input Voltage

Recording Length (s)	Recording Size (MB)
60	51.6948
180	153.0921
300	254.3845
418	351.9021
600	506.2525

Fig. 11: HDR Camera Video Size Per Video Length