Solar Power Supply and Environmental Control System for DIMS Experiment

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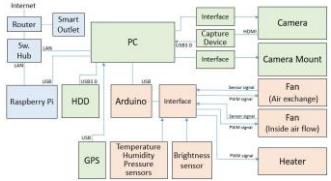
Abstract

The DIMS experiment aims to observe a candidate of a macroscopic dark matter and interstellar meteors . Four camera modules will be installed at CLF, BRM and TARA at the TA site in Utah, USA.

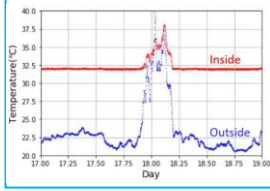
Since there is no power lines from the electric power company at the CLF site, we developed the power supply system using solar power generation.

High sensitivity CMOS cameras are housed in four camera boxes with acrylic domes. Observation will be performed automatically every night. We also developed a system to control the temperature and humidity in the boxes by acquiring environmental data for stable observation.

Environmental data acquisition and control system



Two BME280 sensors, one inside the camera box and one outside, acquire temperature, humidity, and atmospheric pressure data, which are read by an Arduino microprocessor that drives a fan that exchanges air between the inside and outside of the box and an air circulation fan inside the box.

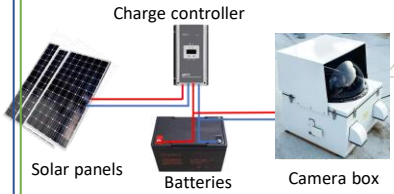


the camera box as a functioAn example of measured temperature inside and outside n of days in May, 2021. It can be seen that the temperature on these 2 nights is constant and well controlled.

Overview of the power supply system

We developed the power supply system using solar panels, batteries, and a charge controller.

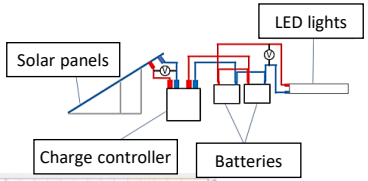
The power supply system provides two voltages, 24V and 12V.

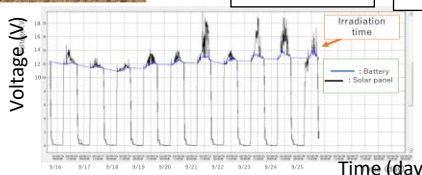


Equipment	Voltage tolerance(V)	Power consumption(W)
PC	12~24V	15W
HDD	12V	36W
Camera	11~17V	12W
Camera mount	11~15V	12W
Arduino Uno R3	6~20V	4.5W
Raspberry Pi 3 Model B	5V	2.0W
Fan	4.5~13.8V	2.5W
Router		

Operation test of the power supply system

We developed the power supply test system and measured the changes in output voltage from solar panels and batteries at the OECU university campus. We used LED lights as load resistors and measured the change in voltage with a voltage logger.





Result : When the output voltage from the solar panel increased, the output voltage of the battery also increased. Therefore, the power supply system was found to be working properly. It was also found that the output voltage of the battery was about 12V ± 2V.

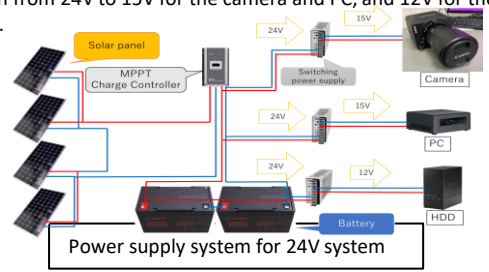
Design of the power supply system

The power supply system can operate without sunlight for three days, and the amount of power generated by the solar panels was taken into consideration so that the battery capacity can be fully charged in one day.

24 V System

Two solar panels are wired in parallel, and two more of these pairs are wired in series, and two 12V batteries are connected in series to provide 24V output.

The voltage sent to each component in the camera box is stepped down from 24V to 15V for the camera and PC, and 12V for the HDD.



12 V System

Three solar panels are connected in parallel and a single battery is used to provide a 12V output.

Raspberry Pi, Switching hub, Arduino, Fan, Camera mount are operated at 12V, and only the Raspberry Pi is operated at a step-down voltage of 5V.

Conclusion

- We decided to develop a 24V and 12V system based on the results of the power supply system operation tests.
- In the design of the power supply system, the safety factor and the amount of electricity generated by the solar panels were taken into consideration.
- In the future, we plan to observe in the U.S. using the power supply system.