Experimental Validation of a Solar-Powered Reconfigurable Intelligent Surface

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BACKGROUND

Reconfigurable Intelligent Surfaces (RIS) are a promising technology for improving 5G and 6G wireless communication by enhancing signal strength, coverage, and efficiency. However, for RIS to be used widely, they must have a reliable and low-cost power source that can work independently of the electrical grid. Solar energy is a strong option because it is sustainable and can operate in remote areas, but its performance depends on sunlight and weather conditions.

RESEARCH QUESTION

Can a solar-powered system reliably sustain the continuous operation of a Reconfigurable Intelligent Surface (RIS) without connection to an external power grid?

TESTING MODEL

- Tested via Arduino setup along with 40W solar panels, 12.8 V $LiFePO_4$ battery, and 20Ω load resistor to emulate RIS.
- Performed 3 outdoor tests on the Engineering Research Center (ERC) rooftop
- Used current and voltage sensors to monitor charging and discharging.
- Logged data via SD card for each test (10-15 hours).

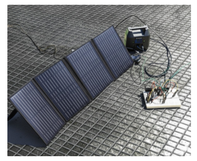


Figure 3: Picture of Arduino setup on roof

Figure 4: Picture of Engineering Research Center rooftop

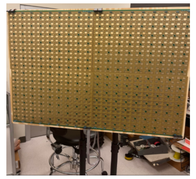


Figure 5 : Current RIS prototype with 1024 radiating elements

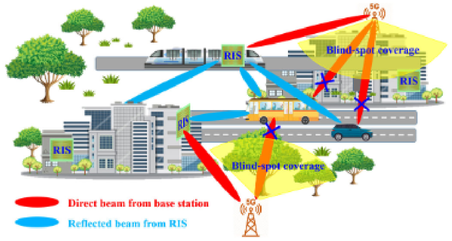
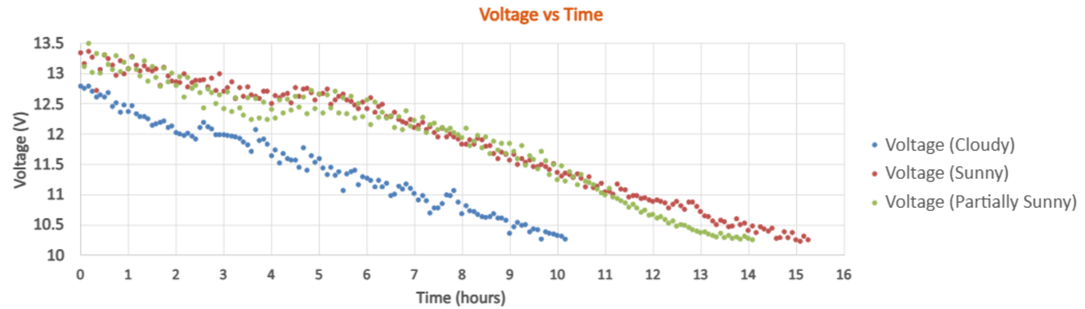
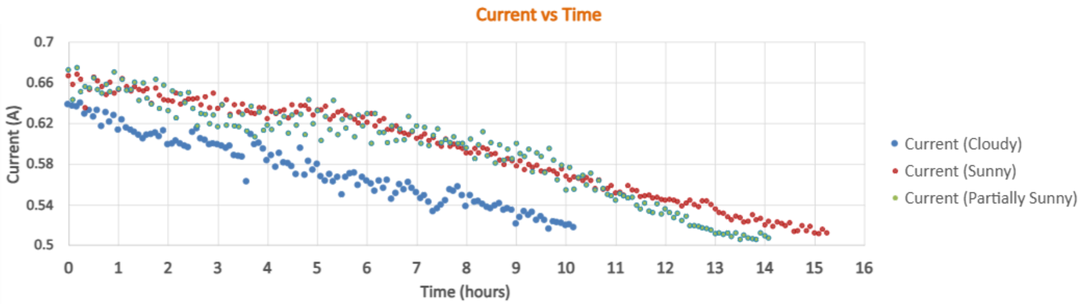


Figure 1: Picture of how an RIS functions in real world application

Figure 2: Picture of testing schematic for data collection

DATA COLLECTION





RESULTS & OBSERVATIONS

The battery voltage dropped from about 13.3 V to 10.3 V during the test, showing that it gradually discharged over time. The system worked as expected, but the test used a higher load than what the RIS would normally draw, and not all the solar panel's power was being used. With a lower load and full use of the solar panel, the battery would likely maintain a more stable charge.

FUTURE WORK

Future testing will be conducted using a Teensy microcontroller with more accurate current and voltage sensors to reduce noise and improve measurement precision. Additional experiments will be performed under different weather conditions to better understand how sunlight variations affect the system's performance and long-term reliability.

FURI

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