ASEC 2024 Conference
The 5th International Electronic Conference on Applied Sciences
04–06 December 2024 | Online
MDPI

Designing and Testing of a Solar Charging Station for Micro-Mobility, Portable Devices and Energy Education

UTTyler THE UNIVERSITY OF TEXAS AT TYLER

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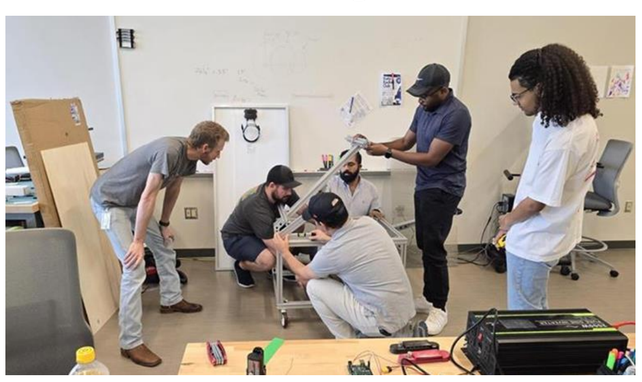
INTRODUCTION

- Solar-powered charging station for portable devices & micromobility such as e-scooters has been designed to provide a sustainable and accessible solution to promote renewable energy education and use for students at our partner Houston Community College (HCC).
- Solar charging station uses solar panels, batteries, inverter, & a data acquisition system to harness solar energy and convert it into electrical energy for charging various devices.
- The project aimed to address the educational and energy gaps in disadvantaged communities by providing clean and renewable energy solutions and enhancing educational opportunities in STEM fields.

METHOD & SETUP

- **System Interface and Requirements:** Arduino Cloud Internet of Things (IoT), Arduino IDE, Arduino Cloud Agent, moderate internet connection signal.
- **Solar Charging Station:** Uses a max 300 W solar panel and maximum of 45 degree tilt, a set of batteries of up to 1000 Wh, a solar charge controller, a power inverter, and a remote data acquisition (DAQ) system with IoT-enabled control to harness solar energy and convert it into electrical energy for charging various devices of up to 500 W.
- **System Components:** Arduino Uno R4 WiFi with ESP32 module that enables WiFi access, Terminal Blocker for unimpeded data streaming, ICM 20948 9 degree of freedom sensor, linear actuator, open channel relays for precise linear motion, current and voltage sensors to monitor various signals that are made from the stand-alone system.
- **DAQ configuration:** Components that come with integrated I2C communication ports are daisy chained, while other components occupy available ports on the Arduino Uno.
- **DAQ Setup:** To enable remote data monitoring, components are uploaded to the Arduino Uno R4 Wi-Fi via a USB-C connection using the Arduino IDE or Arduino IoT Cloud. Sketches are monitored through the Serial Monitor to verify data outputs and are then linked to the Arduino IoT Cloud Dashboard. Variables defined in the code are assigned as cloud variables, allowing for customization of data visualization on the dashboard. The Arduino device is configured for Wi-Fi connectivity through local networks, ensuring seamless integration with the cloud. To enhance functionality, secure device registration, synchronization of cloud variables, and system responsiveness are verified during setup. This methodology provides a robust framework for real-time remote data monitoring and control.

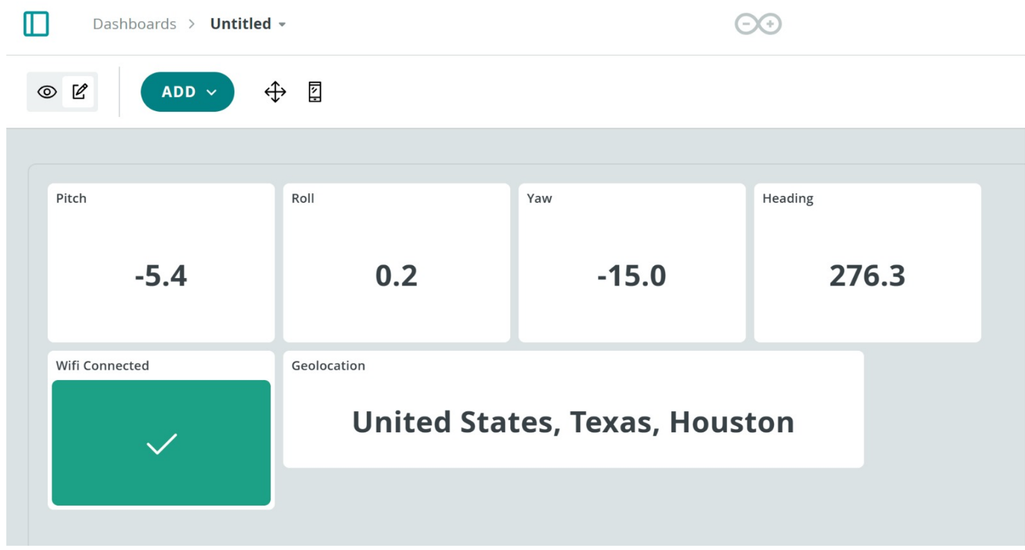


Mock focus group demonstration and interaction with participants at HCC campus in June 2024

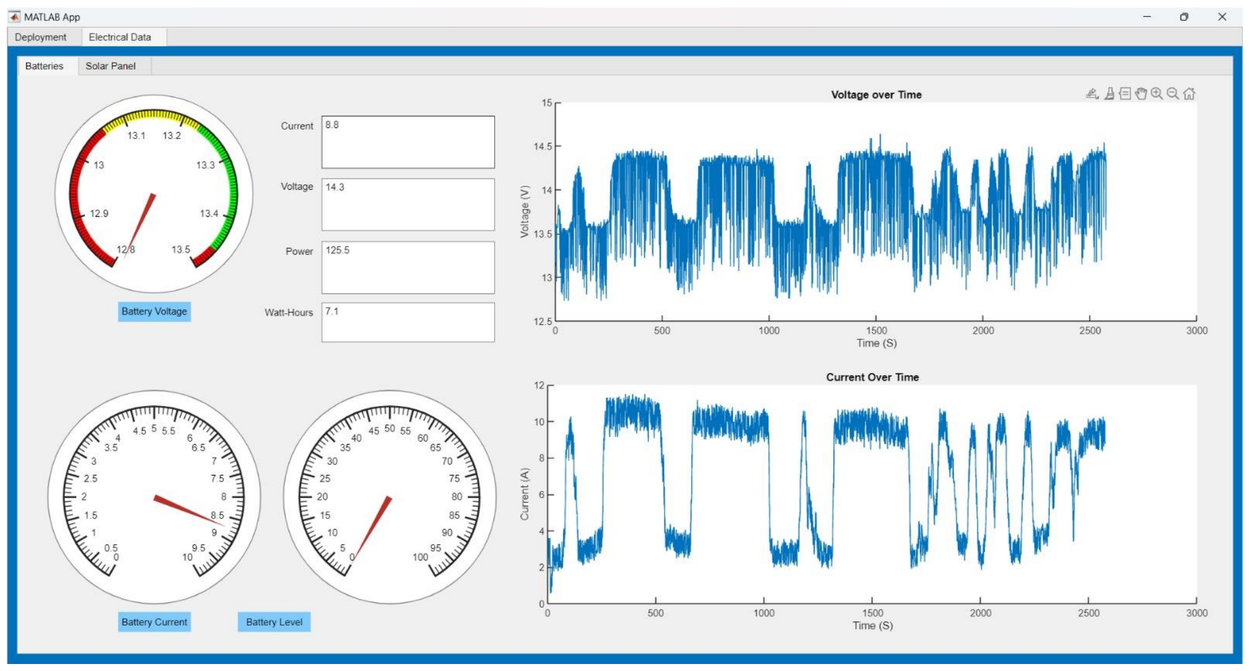
Stations deployed in outside sidewalk and in the commons area for charging demonstration

RESULTS

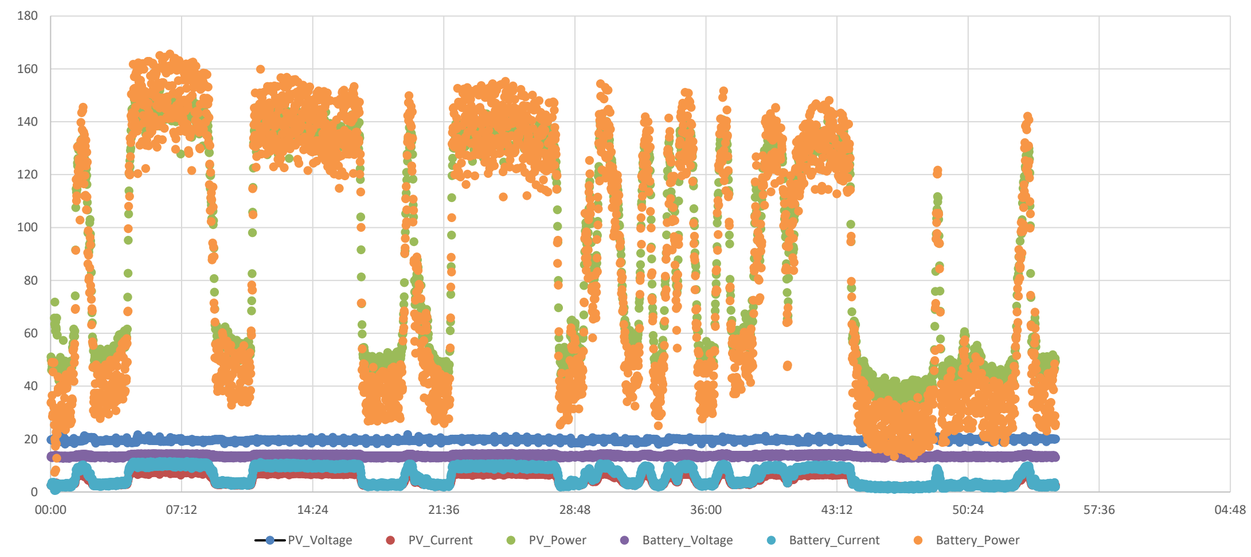
Internet of Things (IoT) Dashboard Displayed updates for DAQ of solar charging station



Deployment and monitoring of solar charged battery station using MATLAB interface



Data of successful operation shown graphically & then exported into Microsoft Excel



CONCLUSION & FUTURE WORK

- Community-Based Renewable Energy Innovation: The project pioneered a localized approach to renewable energy deployment by addressing technical challenges of integrating solar power into everyday life and the social impact of clean energy access.
- Team received positive response and feedback, and suggestions for improvement through surveys and focus groups from HCC students and faculty on prototype stations for classroom implementation.
- Team designed and tested a solar-powered system tailored for micro-mobility & education, and developing a user-friendly interface to facilitate remote access for DAQ & IoT enabled control.
- Future plan includes conducting a pilot test in HCC classrooms & incorporation of fuel cell system to evaluate usability and reliability.