Microgrid Variable Voltage Emulator (MVVE)

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Introduction

- Across Alaska, remote villages and communities rely on small, independent, and often unstable power systems known as microgrids.
- Unstable power is dangerous to critical infrastructure such as Federal Aviation Administration (FAA) equipment.
- To test FAA infrastructure before it is implemented in the field, our team is constructing a Microgrid Variable Voltage Emulator (MVVE).
- The MVVE will automate adjusting a variac in synchrony with pre-programmed voltage-time series, providing a controlled test environment to directly evaluate equipment performance without constant human input and oversight.

Concept

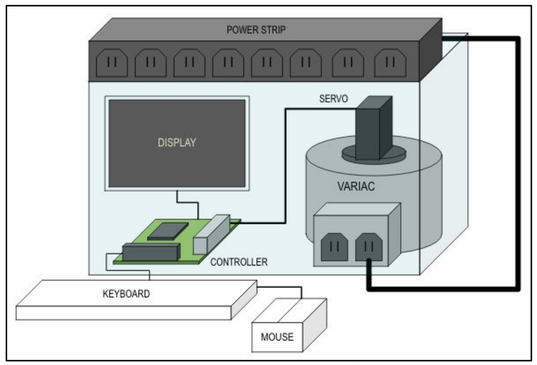

Figure 1. Initial Concept Image of the MVVE

- Variable power delivery
- Servo motor
- Simple user interface
- Controller

Work Completed

- Assembled Raspberry Pi System with Raspberry Pi OS
- Developed UI system that displayed simulated voltage level on input
- Feedback circuit has undergone redesign

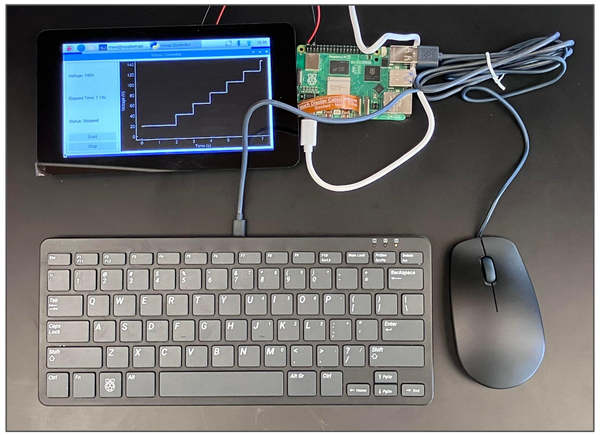

Figure 2. Current progress of the MVVE; showing Raspberry Pi connected to peripherals and running the test program

Future Work

- Loan a temporary variac to test before our variac order arrives.
- Finalize feedback circuit design, determine analog conversion ratio from the output voltage.
- 3D print the required gears/framing for the UI/servo structure.
- Construct the housing structure and securely mount the devices, minimizing any weaknesses.
- Verify the automated action of the MVVE aligns with preprogrammed voltage schedules.

Technical Design

- The user can select and start a preprogrammed voltage schedule, which can run independently and monitor its own output
- The Raspberry Pi controls a servo-motor via a gear train, where the gear ratio and the feedback circuit are used to determine the necessary rotation.
- The motor is fitted inside a 3D-printed gear which drives a chain connected to another gear around the dial of a variac.
- The angle of the variac dial controls the tap-setting of the variac, dictating the transformer-ratio.
- Changing the transformer turns-ratio (by turning the variac dial) varies the voltage level from 0-110% of the input voltage (0-140V)

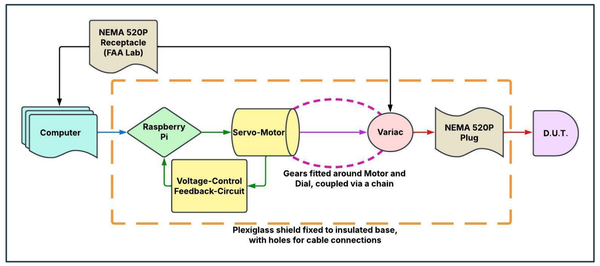

Figure 3. Modified Simple Block Diagram of the MVVE

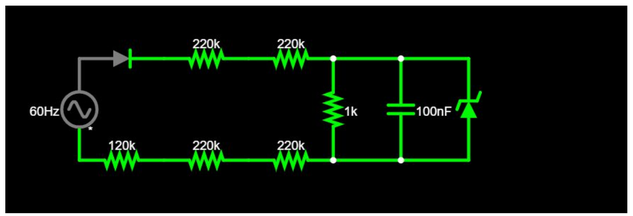

Figure 4. Circuit Diagram of the MVVE Voltage Feedback Circuit

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