NASA-MINDS Project
Structural Analysis Using Contactless Evaluation

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ABSTRACT: Structural Analysis Using Contactless Evaluation (S.A.U.C.E.) is a small hand-held and/or structure-mounted prototype designed to assess, analyze, and monitor the structural integrity of manufactured structures by utilizing remote object detection technology, thermal imaging, range finding, and vibrational monitors. The observed data is gathered is collected and stored locally for further analysis. This device is designed to be modular and compatible with other robotic systems. This promotes cross functionality of the device and allows remote monitoring of critical infrastructure by allowing use in situations inaccessible to humans

Problem Statement and Objective

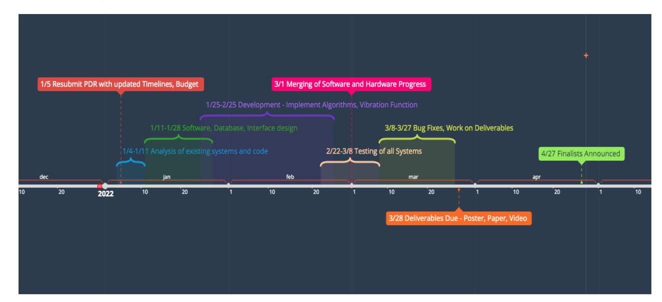
- ❑ NASA's Artemis mission to send humans to the Moon by 2025
- ❑ This prototype supports technological needs of NASA by demonstrating a real-time data collecting device that may be used in assessing the integrity of long-term man-made lunar structures
- ❑ The project developed a self-contained software and hardware device that uses AI models to detect structural-health
- ❑ Features: include real-time structural integrity detection, temperature of surfaces and distance measurement

Engineering Design Process

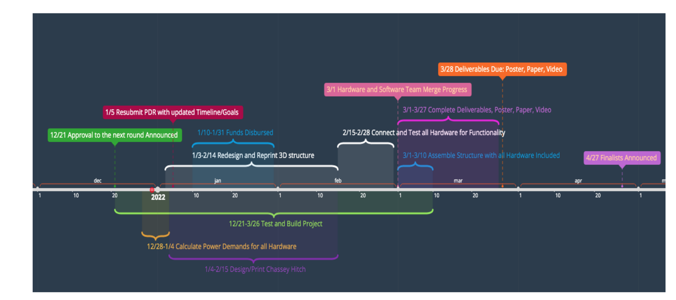
- ❑ Two student teams with non-overlapping roles,
  - ❖ Hardware team
  - ❖ Software team
- ❑ Hardware team role
  - ❖ Structural design and printed 3D parts for the chassis that houses all internal components.
  - ❖ Precise measurement of dimensions of all electronic, mechanical, and wiring components of the prototype
  - ❖ Ensure all components fit snugly inside the 3D printed structure
  - ❖ Computed the total power requirements for all hardware and software parts and designed the prototype to be self-sustainable
- ❑ Software team role
  - ❖ Identified computing device, cameras, distance, and temperature sensors that are cross-compatible
  - ❖ Software development capable of collecting, storing, and displaying the visual/thermal/distance data on an integrated screen
  - ❖ Developed a user-friendly and interactive dashboard

Project Planning

Software Team Schedule



Hardware Team Schedule



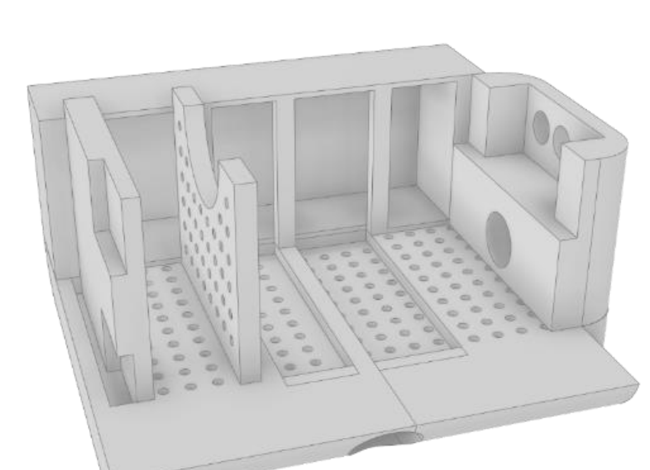
Hardware Section

- ❑ Initially, Nvidia Jetson Nano was used to design and deploy the software; unable to utilize its GPU using Python
- ❑ Switched to Raspberry Pi 4 due to improved development environment and software support
- ❑ Fusion 360 was used for 3D parts design and parts were printed using APL lab printer.
- ❑ Second design introduced
  - ❖ Ventilation holes on the chassis for airflow
  - ❖ Increased spacing between battery casing and front face to accurately accommodate Raspberry Pi 4
  - ❖ Access was included to allow for a 2.5 mm (~0.1 in) DC-to-wall plug connection, enabling recharging the batteries

Chassis Design

Sensor List

- Solar panel
- Distance sensor
- HD camera
- Temperature, humidity sensors



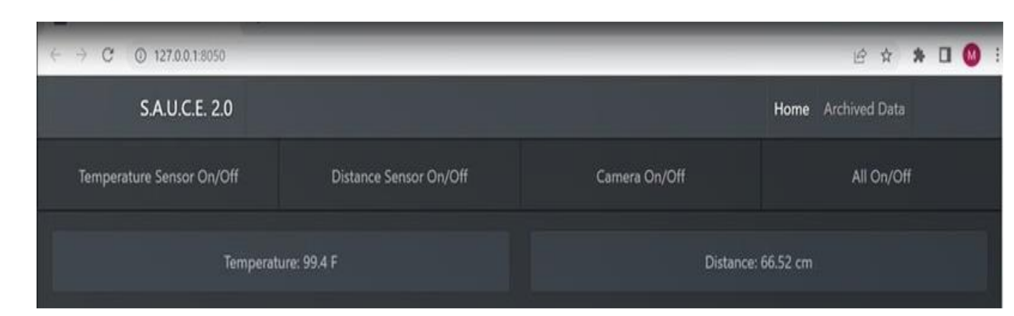
Inside view from L to R

- slot for 5-inch screen monitor
- space for Jetson Nano
- slot for LiPo battery
- slot for battery charger
- access to power source
- three camera slots

Software Section

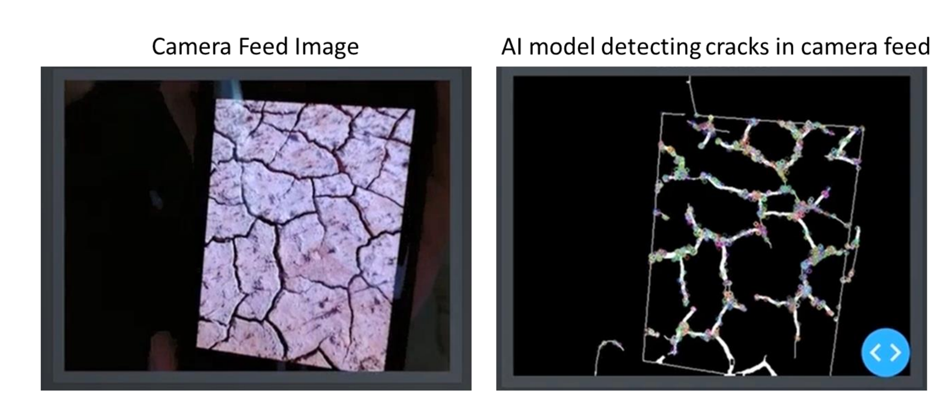
- ❑ For computing device, the factors considered were
  - ❖ Ease of use, sensor compatibility, and computing power
  - ❖ Four computing devices explored, Asus's Tinkerboard, Nvidia's Jetson Nano, and Raspberry Pi 4
  - ❖ Raspberry Pi 4 was most user-friendly, well supported
- ❑ Python software developed using Dash framework
- ❑ Github used for version control

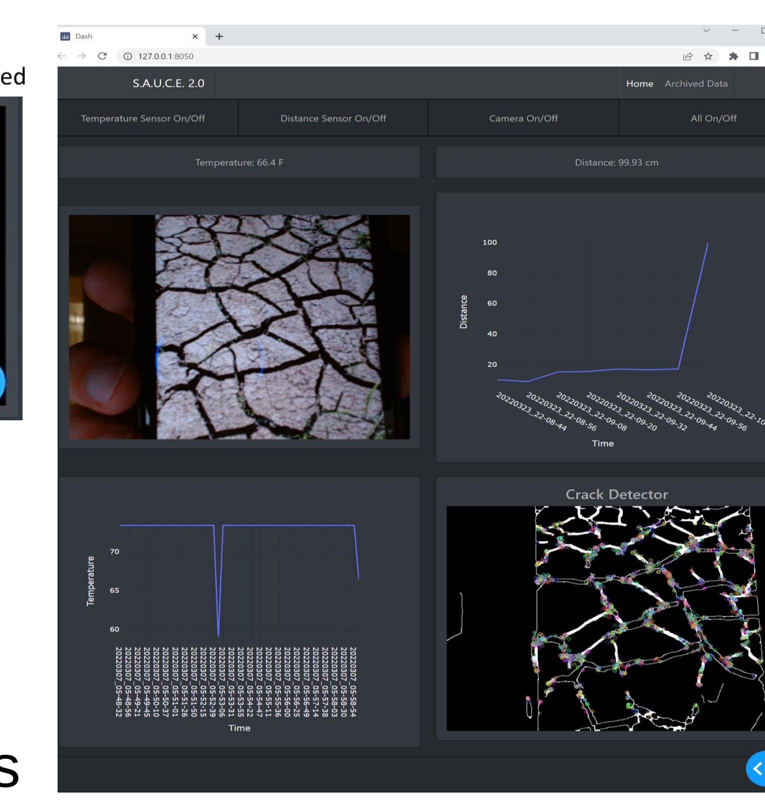
Application Screenshots



Distance and temperature displays on dashboard

Real-time temperature readings on dashboard





Right image

- ❑ Dashboard identifying cracks from a camera feed
- ❑ Real-time and interactive the temperature and distance plots

Conclusion

- ❑ Team was happy to have their proposal funded by NASA
- ❑ Great opportunity to participate in planning, budgeting, purchasing, and building the entire project starting from concept to a working prototype
- ❑ Great experience to a build a product from scratch
- ❑ Additional independent individual-work was done by Kristoffer Hendricks to deploy another AI model on Jetson Nano to estimate the probability of cracks in input images