NORTHERN ARIZONA UNIVERSITY

College of Engineering, Informatics, and Applied Sciences

Cave Climate Monitor

UGRADs Presentation

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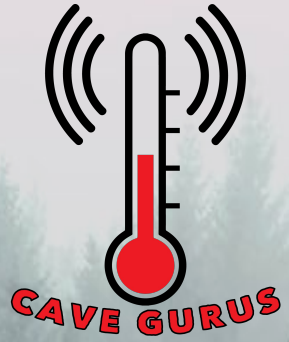
Yang Du
Jason Damp
Cheng Wang

Client: USGS - Astrogeology Branch under Dr. Tim Titus

GTA: Demetria Shepherd



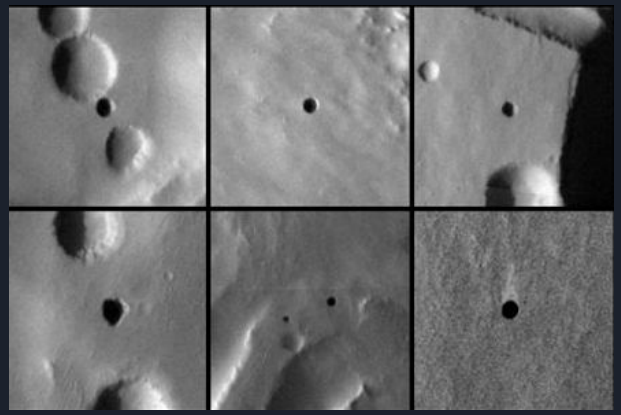
Overview

- Client’s Interest
- Purpose of Project
- Conceptual Design
- Device Module Implementation
- Cave Climate Monitor’s Product
- Conclusion
- Q&A

Client's Interest

Dr. Tim Titus - Doctor of Astrophysics

- Discovered the first caves on Mars
- Interested in terrestrial/extraterrestrial cave climates
- Cave might provide a protected niche for past or current life, or shelter for human in the future on Mars.
- Interested in wireless climate logging system to aid in extraterrestrial cave monitoring

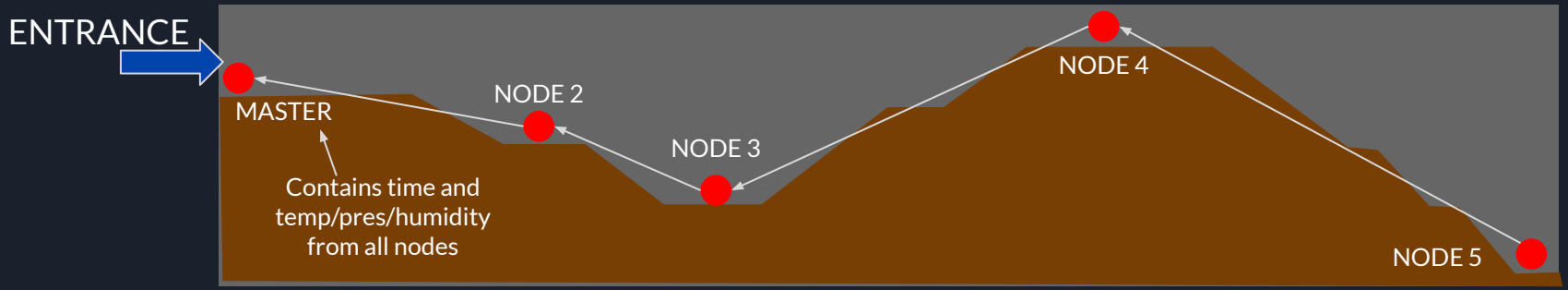


Seven Sisters

Yang Du

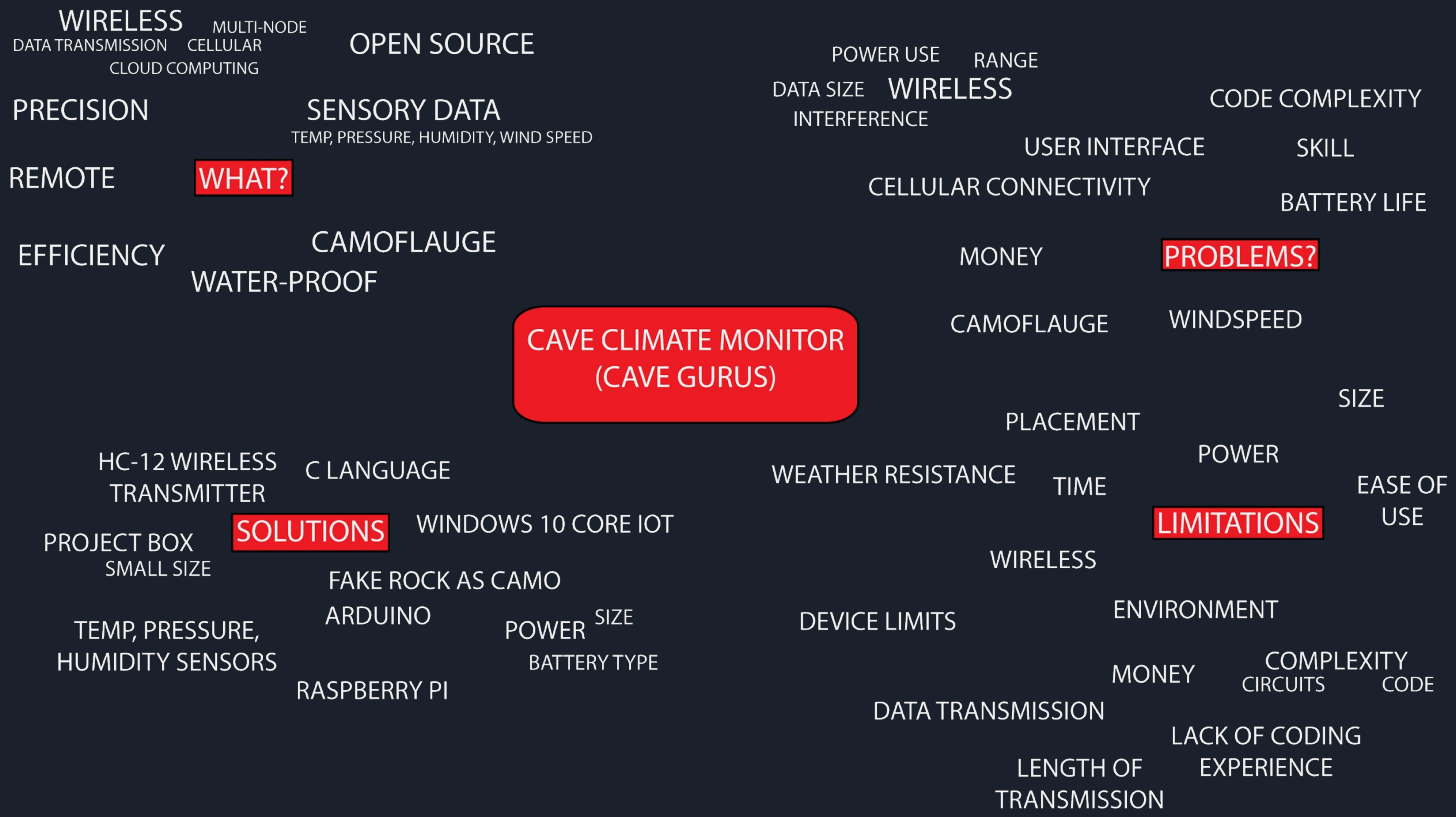
Purpose of Project

- Develop system to collect climate data (time, temperature, pressure, humidity)
- Prove that cave climate data can be recorded at multiple locations and wirelessly transmitted to the entrance of a cave for retrieval
- Ensure that the data logging system can withstand harsh weather in a cave climate
- Provide a basis for the selection of cave research bases and cave resource planning, development and construction
- Provide the basis for the exploration of caves on Mars



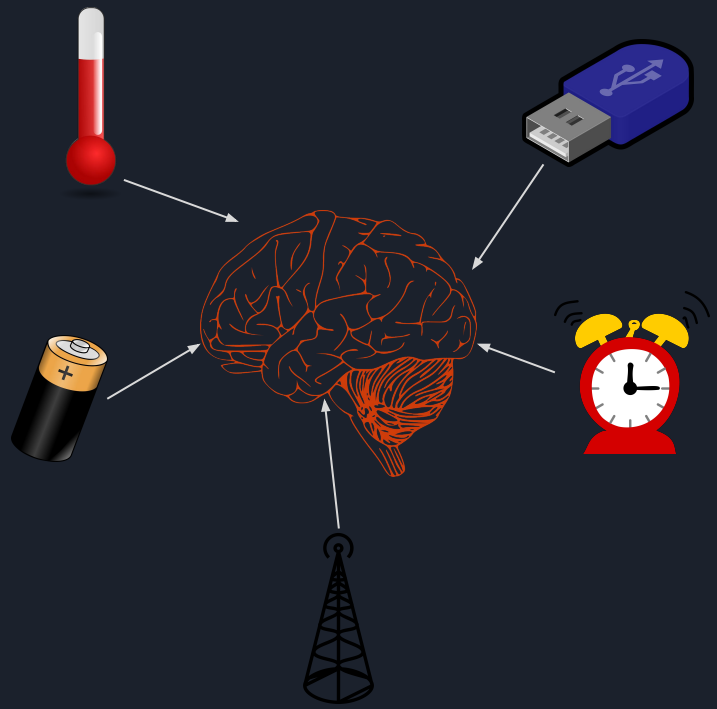
Yang Du

Original Cave Climate Monitor Mindmap



Taylor Begay

Conceptual Design



- Convert Client's Vision to Concrete Modules
  - Research various modules to best fit
    - Climate Measurements
    - Keeping track of time
    - Storing measurements and time to memory
    - Sending our measurements wirelessly
    - Managing all of our individual subsystems
    - Powering the system for extended periods of time
- Explore ideas to ensure user friendly
  - Research additional features
    - Toggle Button to Safely End Program to Extract microSD Card
    - Weatherproof Enclosure for element protection
    - 3 pole DIP switch for node assignment

Taylor Begay

Climate Measurements

- BME/BMP280 I2C temperature, pressure, humidity module
- Records all necessary weather data
- Driven by I2C for ease of integration with other modules

Taylor Begay

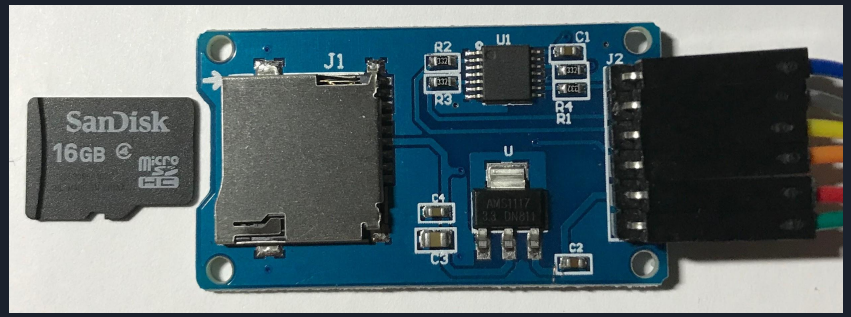
Clock

- DS3231 Real-time clock module
- Allows for a time-stamp on recorded data
- Can control power mode of microcontroller for decreased power consumption

Yang Du

Data Storage

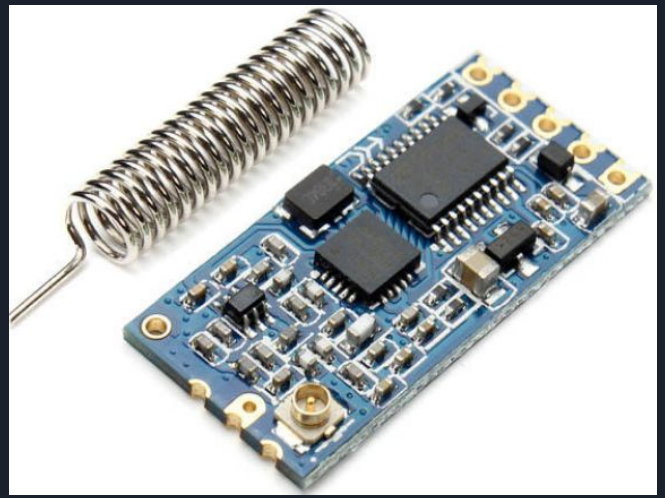
- MicroSD SPI Module
- Ability to record and store data
- Hard copy of recorded weather data for retrieval by used
- Can insert varying size of SD cards for varied amounts of data storage



Cheng Wang

Communications

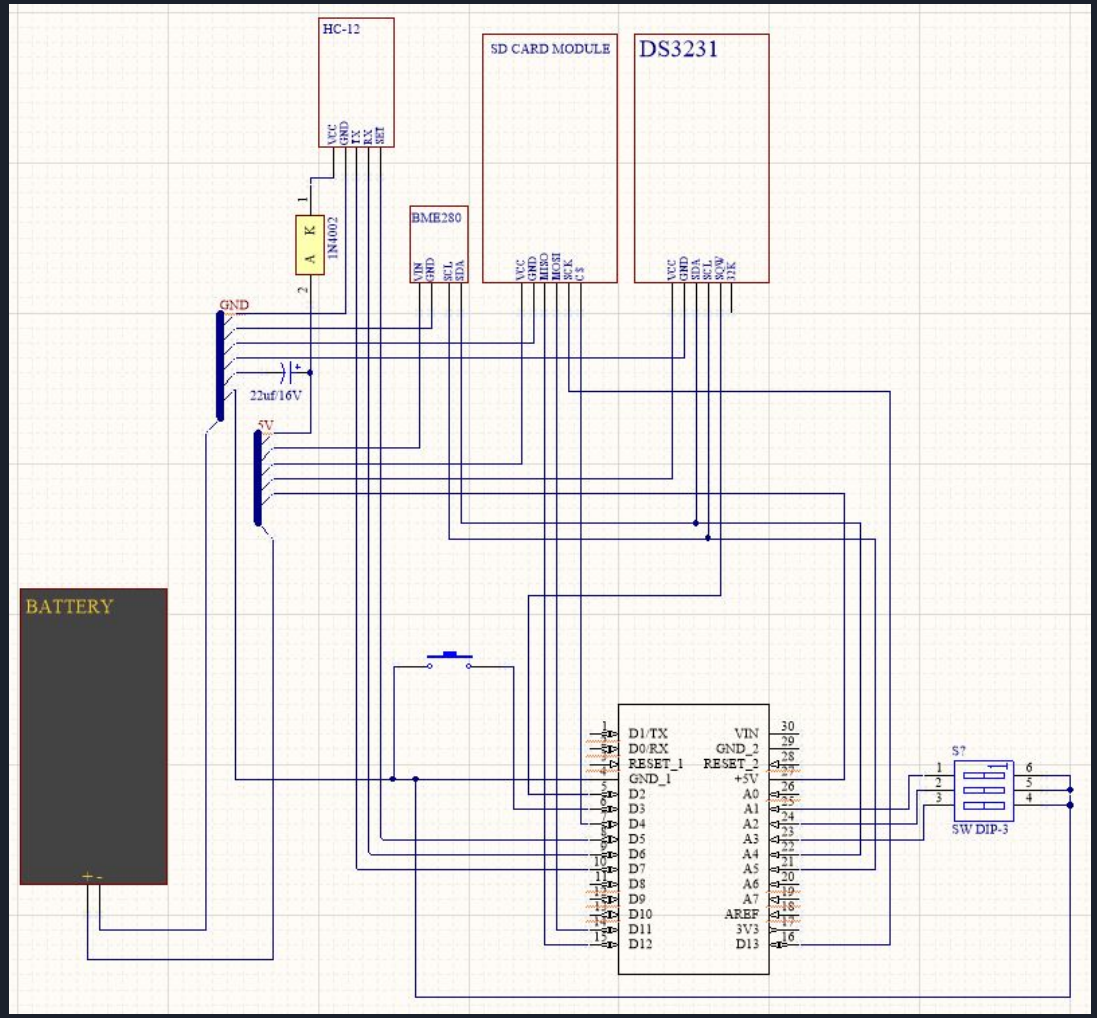
- HC-12 Wireless Communication Module
- Easy to use serial communication
- Send/pass data from node to node
- Receive data before preparing to send it out



Jason Damp

Microcontroller

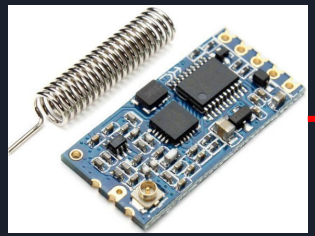
- Arduino Nano
- More than enough useable pins for our application
- Low power consumption
- Easy to use IDE and programming interface
- Ability to implement both I2C and SPI communication protocols


HC-12
VCC
GND
TX
RX
SET
SD CARD MODULE
DS3231
BME280
VIN
GND
SCL
SDA
1N4002
A
K
GND
22uf/16V
5V
BATTERY
D1/TX
D0/RX
RESET_1
GND_1
D2
D3
D4
D5
D6
D7
D8
D9
D10
D11
D12
VIN
GND_2
RESET_2
+5V
A0
A1
A2
A3
A4
A5
A6
A7
AREF
3V3
D13
S?
SW DIP-3

Device Module Implementation

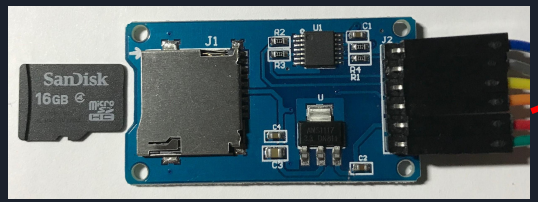
NANO

TPH

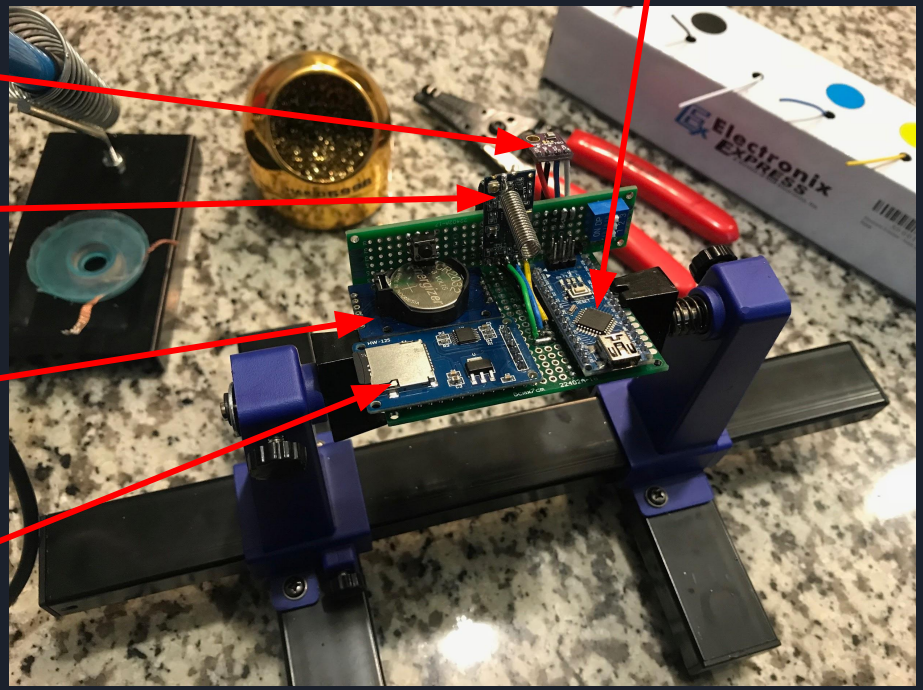


HC-12

RTC



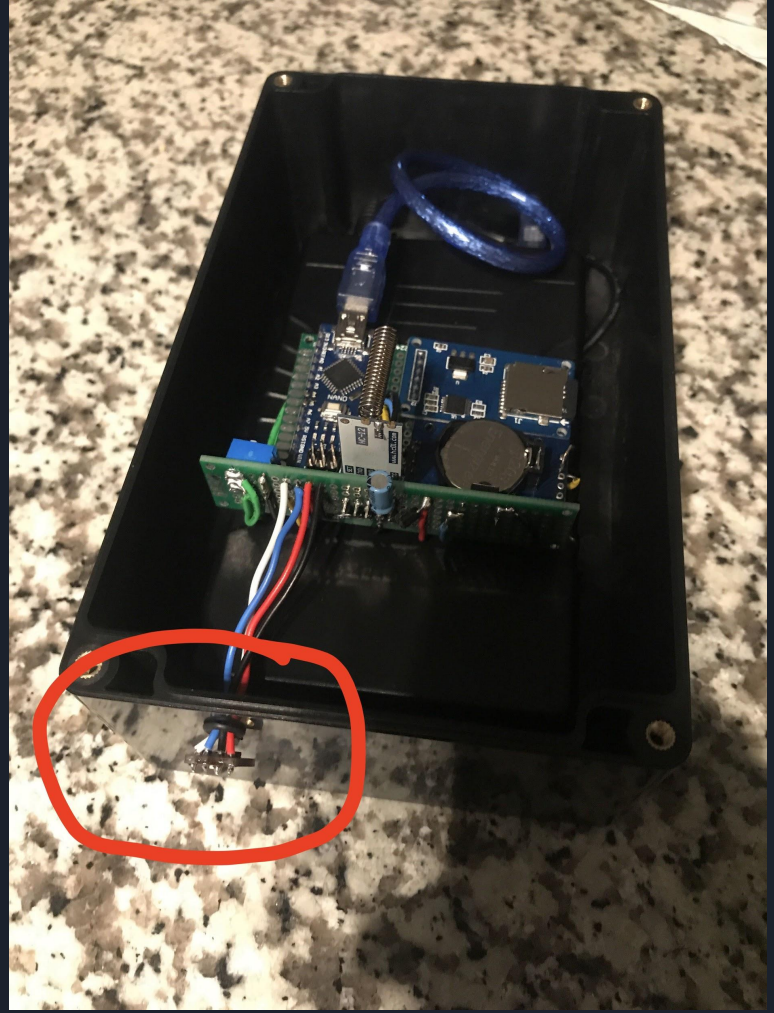
SD



Jason Damp

Final Product

- Soldered perf-board
- All modules integrated and wired to the Arduino Nano
- Long-life 12000 mAh battery
- Switch for selecting module placement
- Included stop switch
- Watertight enclosure
- Powered by 5V USB
- Ambient mounted temperature sensor



Cheng Wang

Conclusion

- We have successfully completed a model system
- All subsystem are working together to carry out their desired tasks
- Communication between 2 nodes = perfect, 3+ nodes = could use improvement
- We believe that our work is a great stepping stone for further advancement in wireless climate logging in caves

Cheng Wang

Q&A

Questions.

Comments.

Product Feedback/Discussion.