In-Suit Carbon Dioxide Sensor Proposal

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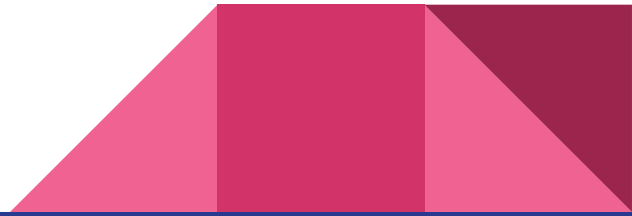

Introduction

- Goal: develop an in-suit carbon dioxide sensor
- Purposes:
  - Monitor the safety of the in-suit air environment
  - Bottleneck component in system to measure astronaut energy expenditure
- Current system is in the suit’s umbilical
  - Smaller system is needed for operations where suits are not connected via umbilical

Project Requirements

- **Purpose**: In-suit air environment monitor and component in real-time metabolic rate characterization system.
- **Inputs**: Constantly circulating mixture of O2 and CO2
- **Outputs**: Carbon Dioxide concentration reported wirelessly
- **Performance**: Accurately sample CO2 concentrate at a rate of at least 10 Hz and a pressure of 19 psia. CO2 measurement range must be at least 0% to 7%

Project Requirements

- **Safety**: Meet materials compatibility and NASA safety standards
- **Power**: Run time greater than four hours
- **Size and Weight**: Minimal footprint and able to fit inside a space-suit unobtrusively.
- **Placement**: Sensor cannot change the nominal suited operations or EVA hardware configurations.

Project Specifications

- **Outputs**: CO2 concentration will be reported wirelessly using the wireless module
- **Performance**:
  - CO2 concentration will be sampled at 20 Hz frequency.
  - Measurements will be adjusted to account for pressure of 19 psia.
  - Measurement range will be 0-20%
- **Safety**: Will design system enclosure to protect suit from any sharp components.

Project Specifications

- **Power**: Battery will have enough energy to run for at least 4 hours.
  - Lithium-Ion or Lithium-Polymer battery will be used.
  - CO_2 sensor chosen will use minimal power.
- **Size and Weight**: Will minimize footprint.

SprintIR

- NDIR CO_2 Sensor
- Measurement Range 0-20%
- Sampling Frequency: 20 Hz
- Power Consumption: 35 mW
- Input Voltage: 3.2 - 5 V (3.3 recommended)
- Interface: UART
- Configurable to correct for non-standard pressures.
- Flow-through adapter optional

MSP430F5224

- Up to 25 MHz clock
- 128 KB Flash Memory
- 8 KB RAM
- 1.8 - 3.6V operation
- Temperature range of -40 - 105 C
- Runs in Active Mode with:
  - RTC
  - Standby Mode
  - Ram retention
  - < 1 microsecond Wake up

Flow Rate Sensor

- As a stretch goal, we are considering integrating a flow rate sensor into our system, which would be used to calculate the metabolic rate of the subject.
- This system may be an in-tube pneumotach attached to a pressure transducer, or we may attempt to integrate data from a pre-existing external flow-rate sensor.
- The integration of this sensor could add additional depth to the project, but depending on the implementation, could prove to be too costly.

System Design

- MSP430 and CO2 sensor powered by battery.
- MSP430 sends configuration commands to sensor and reads sensor data.
- Data stored in flash memory until either it is transmitted or it expires.
- If possible, MSP430 will also do the wireless communications.
  - Otherwise, microcontrollers can communicate using I2C or similar.
- System connected via integration board to save space.
- System will have a smooth enclosure.

Initial Schedule