Watchdog
Initial Problem Specification

[intentionally blank]
Initial Problem Specification

In short: verify an astronaut’s fidelity to standard operating procedure.
A combination of two approaches:

1. Computer Vision
2. Sensor-embedded tools; IoT
Computer Vision

- Real-time neural network-based object detection and localization
- Analyze the spatial relationships between objects to deduce semantics
- Static image analysis for deducing quality of astronaut-taken photographs
High Level Block Diagram

- Camera
- LCD Display
- Bluetooth Beacon
- USB
- HDMI
- Bluetooth
- GPU
- CPU
- Nvidia Jetson TX2
- IMU
- Gyroscope
- Accelerometer
- NFC
- PCB
Hardware Timeline

Fall 2018
- Parts selection
- Data collection
- PCB schematics and layout
- Sensor testing (NFC, IMU)

Winter 2019
- Sensor testing (Bluetooth beacon)
- PCB assembly, testing, and modification
- Peripheral interface (NFC, IMU, beacon)

Spring 2019
- Data fusion
- Antenna modification
Bluetooth Beacon

- Localization
- Embed in marker
- One-way transmission
- Range of transmission: 1 m (expected)
- Successfully tested on TX2
- RSSI to distance

Bluetooth Unit

- On-board Bluetooth Version 4.1
- Receive signal from a Bluetooth beacon
  - Approach a site
- Lose signal from the Bluetooth beacon
  - Leave the site
Algorithm Development

- **Three transmit power modes**
  - High power mode (-59)
  - Medium power mode (-80)
  - Low power mode (-96)

- **Data collection and processing**
  - 400 RSSIs corresponding to each distance

- **Graph comparison**
  - Find the best working mode: medium

- **Generate functions and test**
  - Quadratic function
    - $y = \frac{5.066581 + \sqrt{0.7855792 x + 72.76003}}{0.3927896}$
Near-Field Communication

- Recognize a unique tag when it is closed to the chip
- Embed NFC chip in glove, tags in tools
- Range of transmission: 10 cm
- Interface: I2C
NFC Driver

- Developed on top of Linux NFC driver.
- Functioning with TX2.

```
NFC reader: pn532_i2c:/dev/i2c-0 opened
NFC device will poll during 30000 ms (20 pollings of 300 ms for 5 modulations)
ISO/IEC 14443A (106 kbps) target:
    ATQA (SENS_RES): 00 04
    UID (NFCID1): 46 f2 7f 9a
    SAK (SEL_RES): 08
nfc_initiator_target_is_present: Target Released
Waiting for card removing...done.
```
Inertial Measurement Unit

- 9 Degree of Freedom
- Communicates via I2C
- Memory-mapped addressing to specify sensor, which allows for reading specific data
- Sensors used:
  - Accelerometer
    - ±2/±4/±6/±8/±16 g ranges.
    - Accuracy: ±60mg
    - Poll rate: 100Hz
  - Gyroscope
    - ±245/±500/±2000 degree per second ranges
    - Accuracy: ±10/±15/±75
    - Poll rate: 100Hz
IMU Driver

- Developed using fusion algorithm.
- Functioning with TX2.
Software Timeline

Fall 2018
- Overall software frame design
- UI development completed

Winter 2019
- UI revision
- Managers development completed
- Combination between UI part and Managers part completed

Spring 2019
- Hardware parts interfaces
- Data fusion
Logical Chart

**Problem Specification**

- **task manager**
  - current task: \( N \)
  - task status: \( M \)
  - information: "no error"

- **display**
  - comparison result:
    - all matched: send 1
    - not matched: send -1
    - with error information

- **procedure manager**
  - Default signals combination required by each task:
    - task 1: \([1 1 2 2]\)
    - task 2: \([2 1 2 1]\)
  - Input signals combination of each task:
    - signal[current task][0]
    - signal[current task][1]
    - signal[current task][2]
    - signal[current task][3]
    - \( \Rightarrow \) get a combination \([x \ y \ z \ n]\)

**signal from the parts**
- bluetooth signal
- NFC signal
- IMU signal
- Camera processing result
Acknowledgements

Thank you to:

Sponsors:
- Dr. Jessica Marquez (NASA)
- Dr. Richard Joyce (NASA)

UCSB:
- Dr. Yogananda Isukapalli
- Brandon Pon
- Carrie Segal

For all of your assistance with the project!