

F.I.R.E.

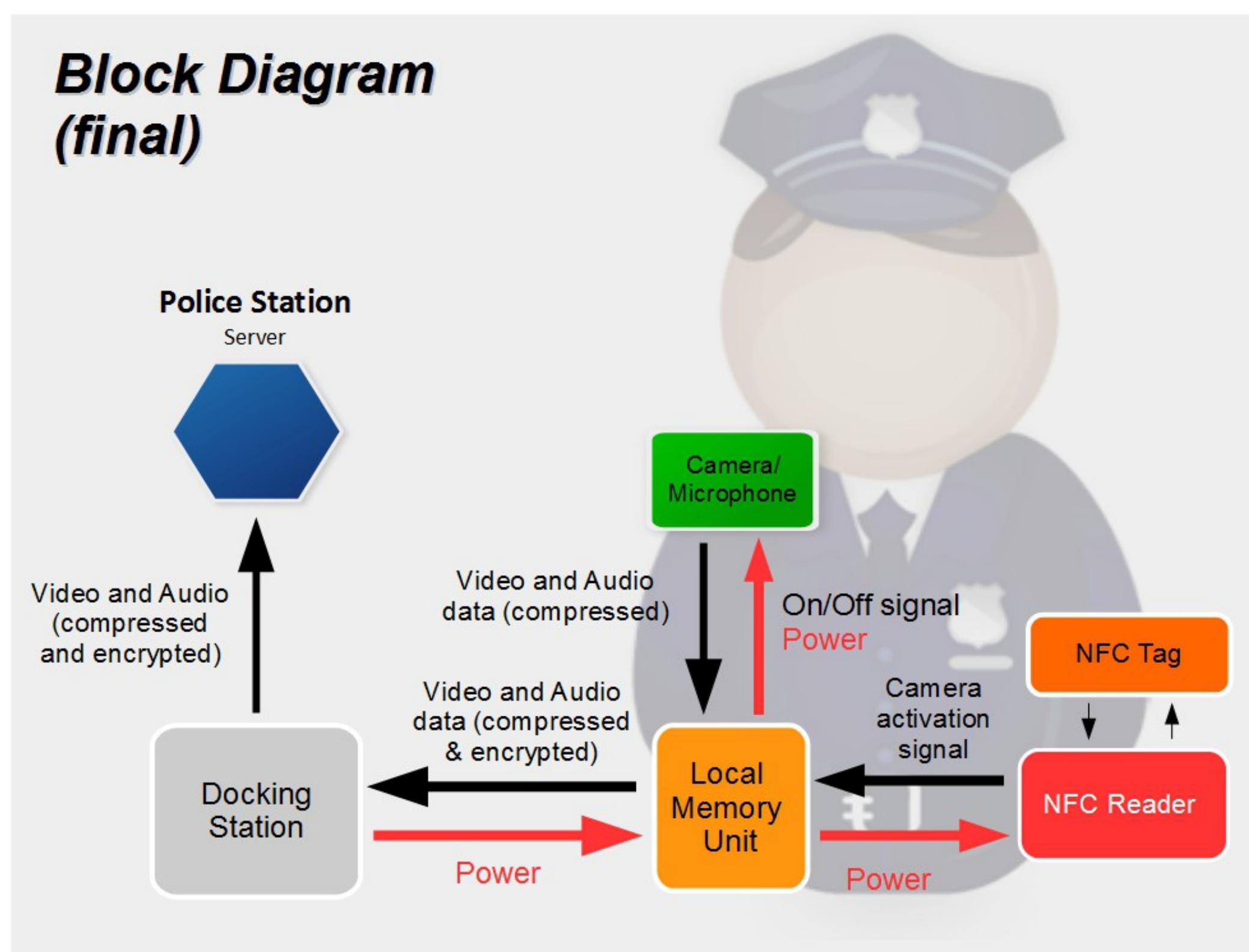
Ferguson Intervention Recording Equipment

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Faculty Advisors: Professor Wayne Burleson and Professor Daniel Holcomb

Abstract

F.I.R.E. (Ferguson Intervention Recording Equipment) is a wearable camera unit specialized for police wear. The camera is sensor activated through an NFC tagging system where when a weapon is drawn from the duty belt (firearm, handcuffs, baton, etc.) the camera unit is turned on to start recording audio and video. The data is sent from the chest mounted camera to the Local Memory Unit (LMU), where the AV data is compressed and then encrypted. In the case that an officer does not remember to turn on their wearable camera or does not turn the camera on due to malicious intent, the system automatically activates the camera unit upon removing an item from their duty belt. The camera unit will ultimately be small, easy to use and allow both veteran and rookie police officers to interact with easily.

Block Diagram



Specifications

- 3.3V rechargeable battery source
- Camera resolution up to 10 meters away
- Microphone sensitivity up to 10 meters away
- Automatically activated AV via NFC sensor on duty belt
- 2-minute pre-record of video only
- Compressed data using MPEG-4
- Encrypted data using AES
- Storage of an entire 8 hour shift on 16 GB microSD card
- Memory and power located on a waist mounted unit
- Camera accessible via USB connection
- MiniUSB connection for charging
- MicroUSB connection for data transfer
- GPS and Real Time Clock video tagging

System Overview

Camera/Microphone

- Logitech C270 Webcam
- 3D printed, chest mountable enclosure
- USB connection to LMU



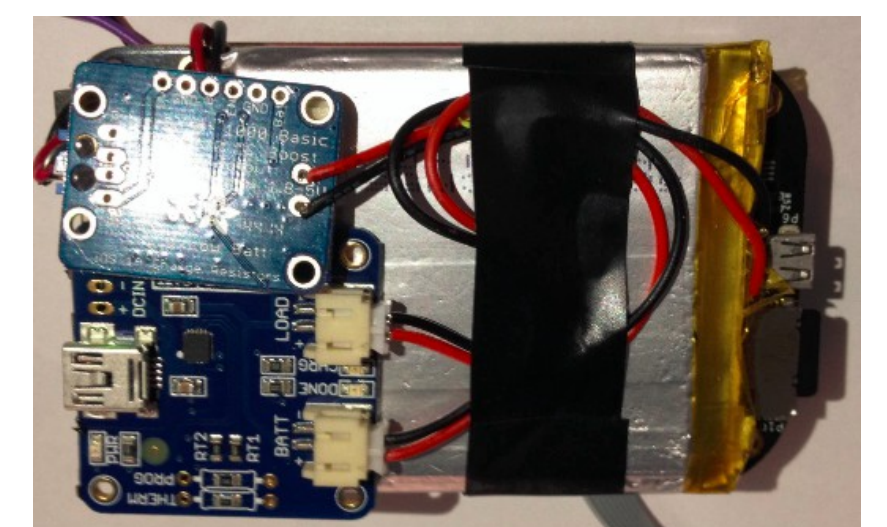
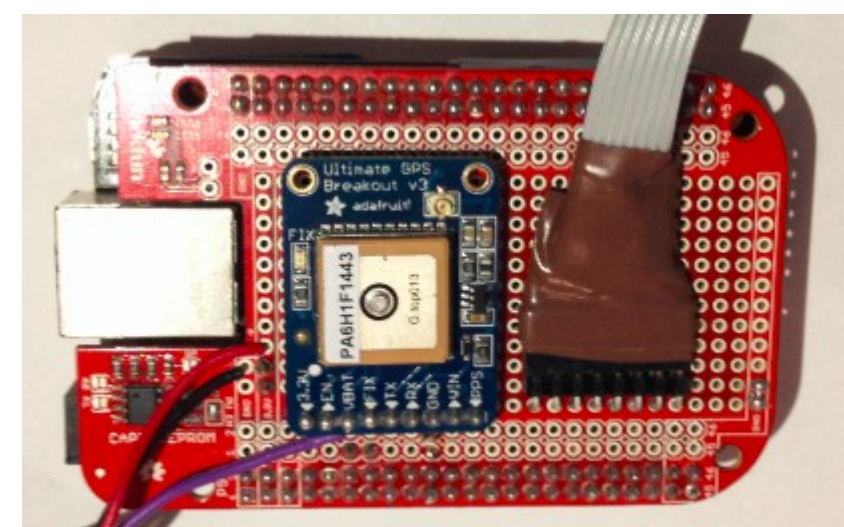
NFC Sensors

- Uses Adafruit's PM 532 Breakout Board
- Detects when tag is removed from field and activates AV
- Tags affixed to handcuffs



Local Memory Unit (LMU)

- Receives weapon pull signal via I2C on custom cape from NFC sensor
- Activates AV recording via USB
- GPS data communicated over UART
- Uses BeagleBone Black for processing
- 3.7 V battery boosted to 5V for powering USB



Software

- Angstrom distribution of Linux built on BeagleBone
- Video compressed using MJPEG
- Audio encoded using AC3_Fixed
- GPS data is NMEA encoded

Acknowledgements

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Team Members



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Motivation

Current Market Products are Inadequate

- Most products are either too large, too expensive, too intrusive, or too complex for ease of officer use



Massachusetts "two-party consent" state

- Officer must inform person that audio of interaction is being recorded
- FIRE contains an "audio activation button" which starts audio recording to go along with video recording

3D Printing

- Autodesk Inventor 2015 (free trial version)
- CAD software to develop enclosure models
- Created .stl files (STereoLithography or Standard Tessellation Language)
- Uprint SE Plus 3D printer in M5
- 3D printed material not ideal
 - 3D printed plastic too brittle; police grade plastic enclosure for LMU more realistic
- Need for waterproofing not considered
- Printed case for LMU and camera



Cost

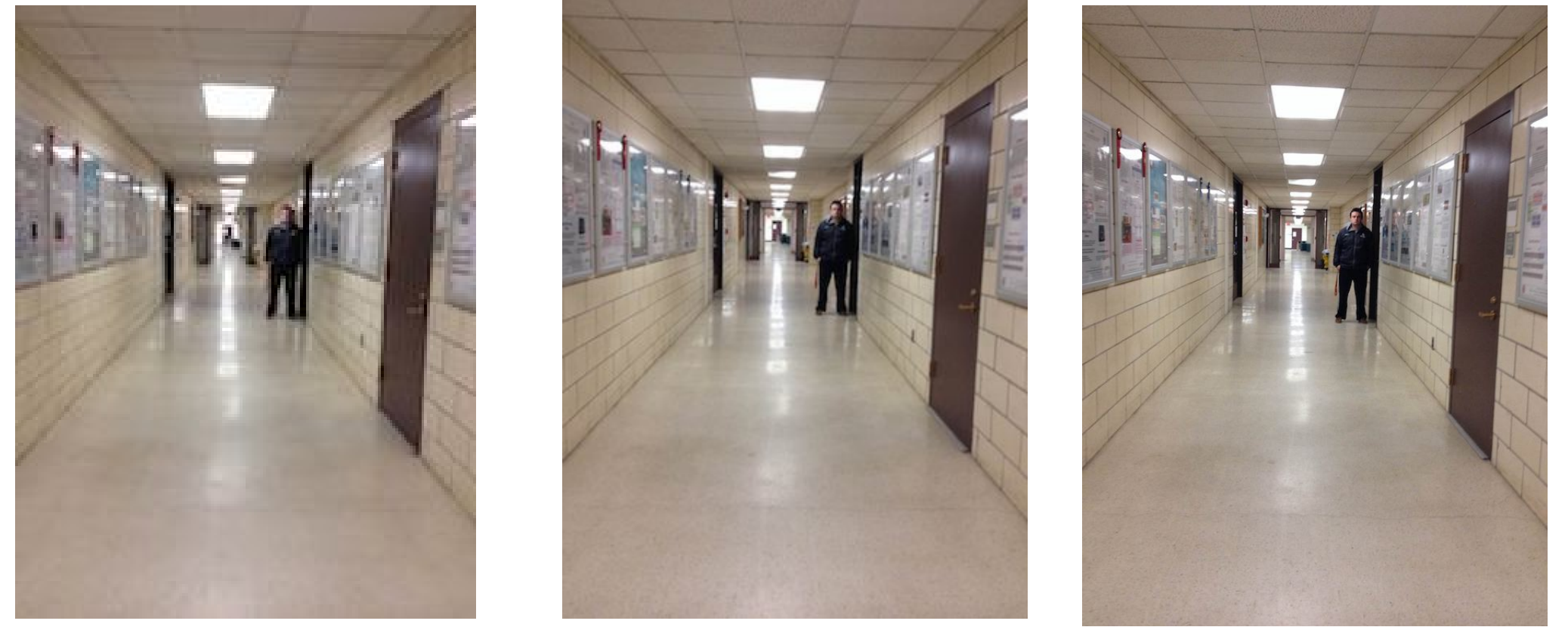
Development (per 1)

| Part | Price |
|-----------------|----------|
| GPS | \$39.95 |
| NFC | \$39.95 |
| Beaglebone | \$55 |
| PowerBoost 1000 | \$14.95 |
| USB Charger | \$12.50 |
| Battery | \$14.95 |
| ProtoBoard | \$9.95 |
| Camera | \$39.99 |
| Total | \$227.24 |

Production (per 1000)

| Part | Price |
|-----------------|----------|
| GPS | \$31.96 |
| NFC | \$31.96 |
| Beaglebone | \$55 |
| PowerBoost 1000 | \$11.96 |
| USB Charger | \$10 |
| Battery | \$14.95 |
| ProtoBoard | \$7.96 |
| Camera | \$39.99 |
| Total | \$203.78 |

Image Quality



Best (51)

Medium (30)

Worst (10)

- Opted for image quality 51 (Best)
- FFMPEG allowed for this quality compression
- Have ability to store over 8 hours of video on device at this quality
- Previous real world cases indicate a need for high resolution video for evidence purposes

GPS

GPS Data is recorded in the following format:

\$GPGGA,123519,4807.038,N,01131.000,E,1,08,0.9,545.4,M,46.9,M,,*47

Which translates to the following meaning:

| | |
|---------------|--|
| GGA | Global Positioning System Fix Data |
| 123519 | Fix time UTC |
| 4807.038, N | Latitude |
| 01131.000, E | Longitude |
| 1 | Fix Quality |
| 08 | Number of Satellites Tracked |
| 0.9 | Horizontal Dilution of position |
| 545.4,M | Altitude, Meters, above mean sea level |
| 46.9, M | Height of geoid above WGS84 ellipsoid |
| (empty field) | Time since last DGPS update |
| (empty field) | DPGS station ID |
| *47 | Checksum Data |



GPS data recorded while walking around Engineering Quad and imported to Google Earth

Security

- Data is encrypted using AES encryption algorithm
- Key generated is assigned to person who is authorized to access recordings (chief, IT personnel, etc)
- Most likely use case would involve the keys being held by ranking officers or head IT personnel
- If an officer commits a crime that is caught on camera, they will not be able to access or alter the data unless they poses the key
- Only limitation is if person who has key has malicious intent
- Key management system can fit any department ranging from large (PDNY) to small (any town around Amherst area)