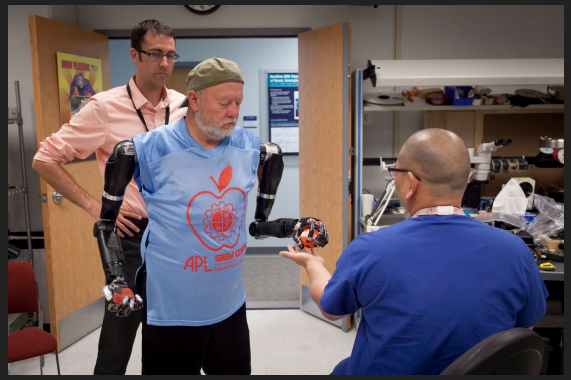
KineTrax

Team KineJax

Anthony Black, Jack Jenkins, Cherie Parsons, Grant Swanson, Christopher Whitney

Client/Mentor: Dr. Kyle Winfree

Domain Introduction



Limitations of Current Technologies

Domain Problem - Current wearable devices:

- Unable to interface with other devices
- No synchronization across a distributed network
- Doesn't yield the resolution of measurements as other capturing systems

Project Specific Problem:

- There is no software framework for the device

	Fitbit	ActiGraph	Vicon
Interface w/ devices			
Sync			
Resolution	1 min	30-100 Hz	100+ Hz
Cost	Low	Expensive	Expensive

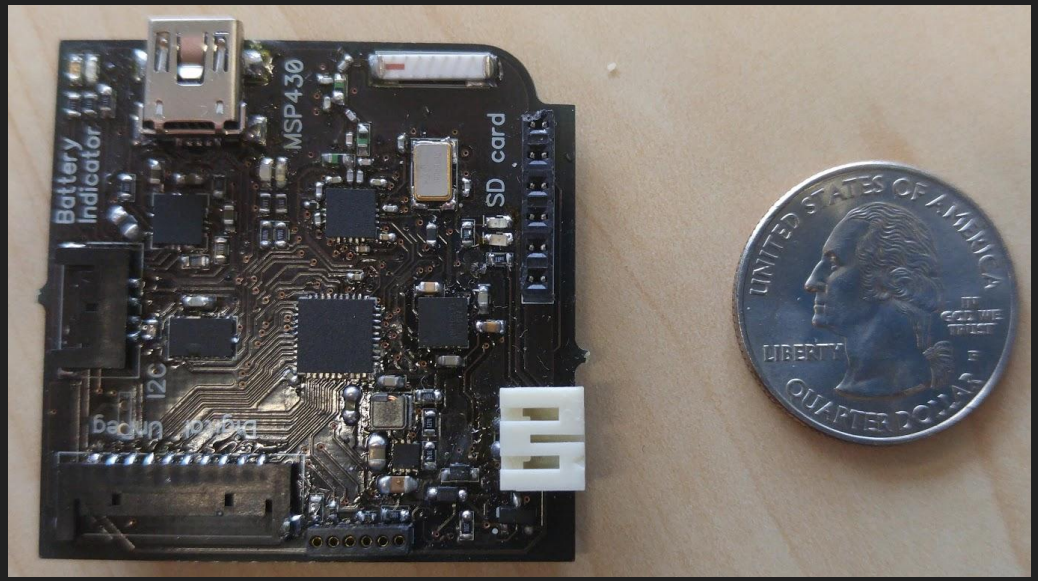
Problem Statement

Current wearable devices are unable to interface with other device and are unable to give the necessary resolution for gait analysis in a community setting.

Project Introduction

KineTrax Device:

- Wearable device
- Records full body kinematics
  - Position and rotation of limbs
- Gait analysis
  - Movement impairments
  - Physical impairments
  - **Prosthetic limbs**
  - Sports medicine



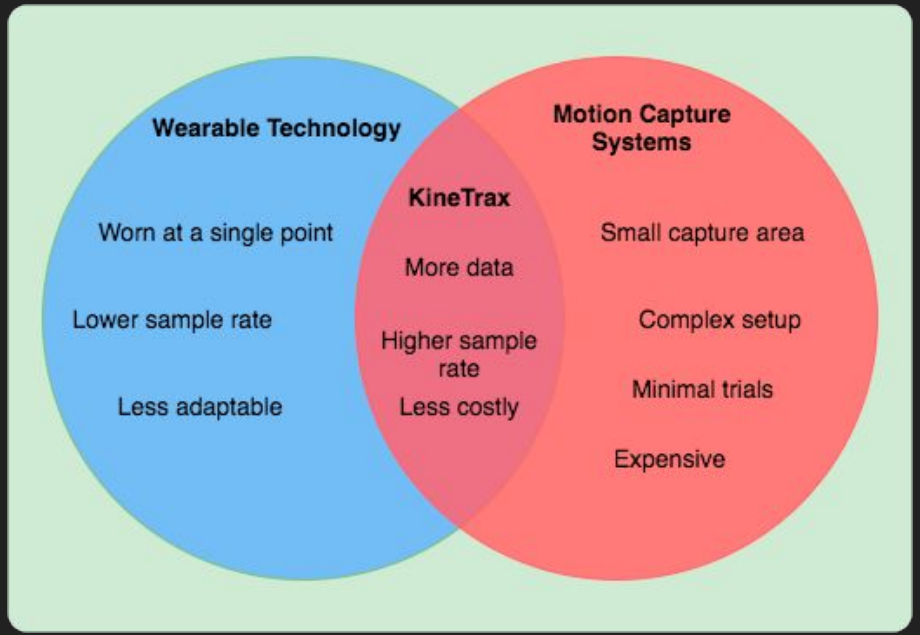
Solution Overview

What the KineTrax offers:

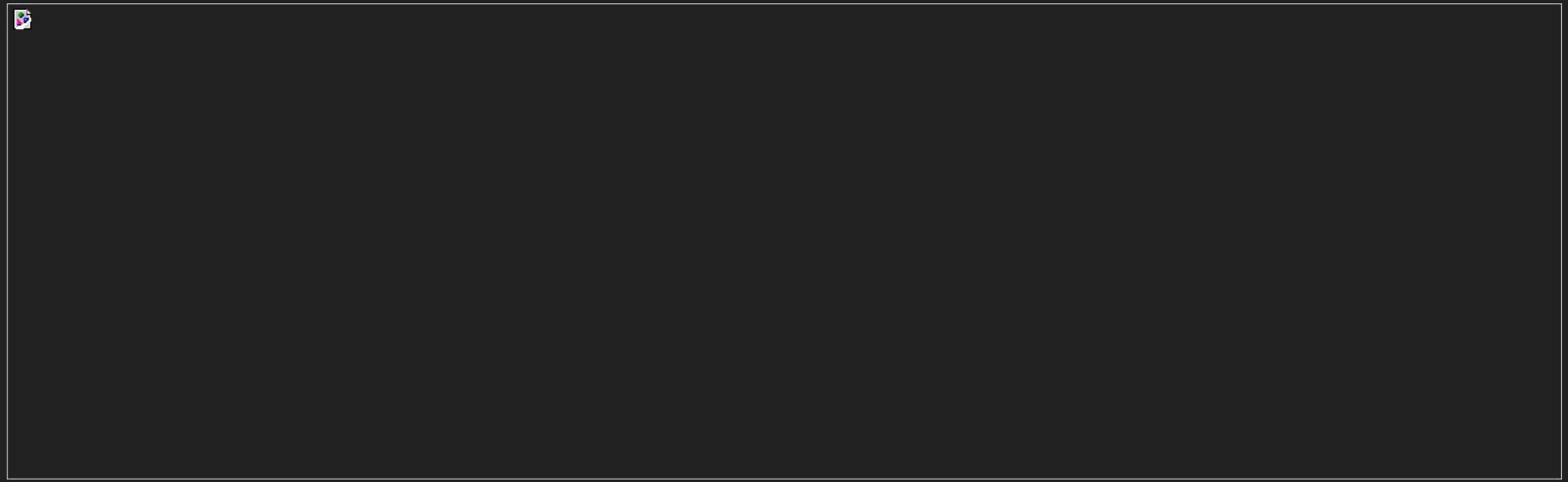
- Digital I/O ports
- Analog I/O ports
- I2C bus, allowing 127 sensors/peripherals

Create software that allows:

- Time synchronization between devices (Embedded)
- Recording of timestamped accelerometer/gyroscope data to SD card (Embedded)
- Data offloading from SD cards (Embedded/PC)
- Device configuration via processing language (PC)

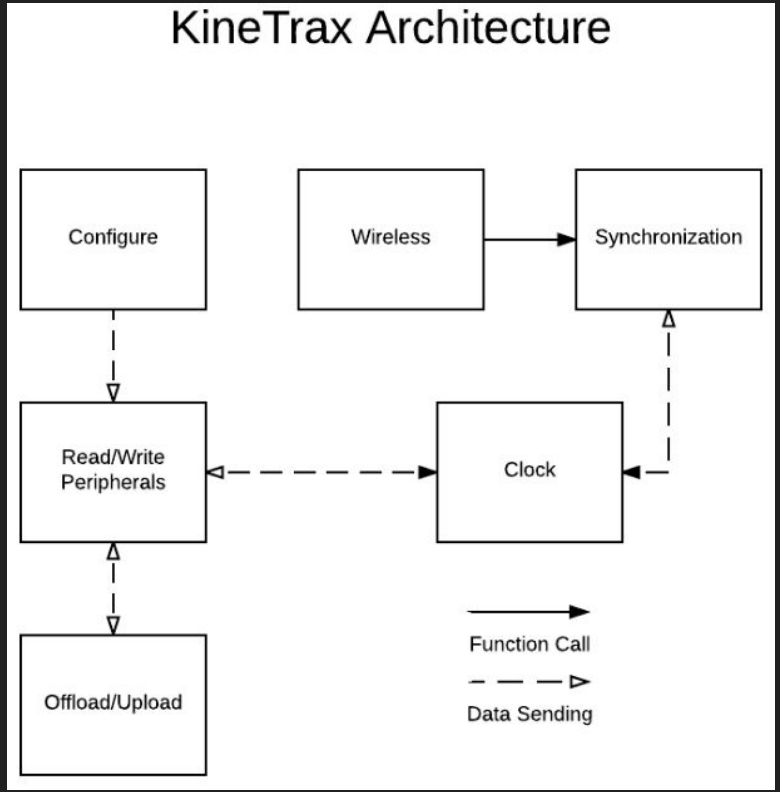


Implementation Overview



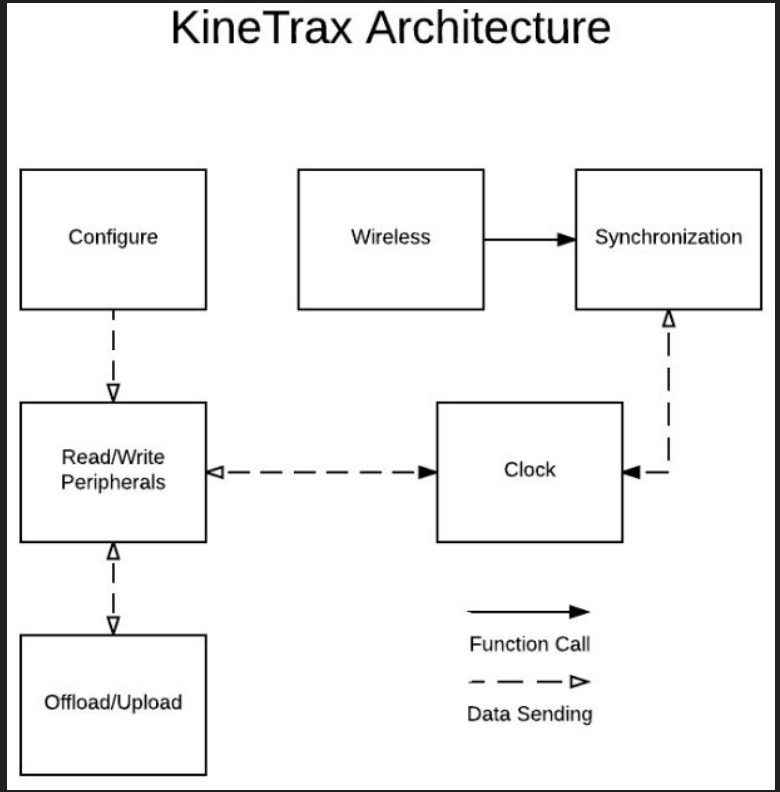
Architectural Overview(Embedded)

- Peripherals
  - Peripherals accessed through Inter-Integrated Circuit (I2C) and Universal Asynchronous Receiver/Transmitter (UART)
  - Key functions:
    - read()
    - write()
- Wireless Communication
  - Communication with other devices via 2.4 GHz Radio Frequency
  - Utilizes SimpliciTI Protocol
  - Key functions:
    - connect()
    - getMessage()
    - sendMessage()
- Synchronization
  - Calculates offset between time from Real Time Clock and time received from wireless messages.



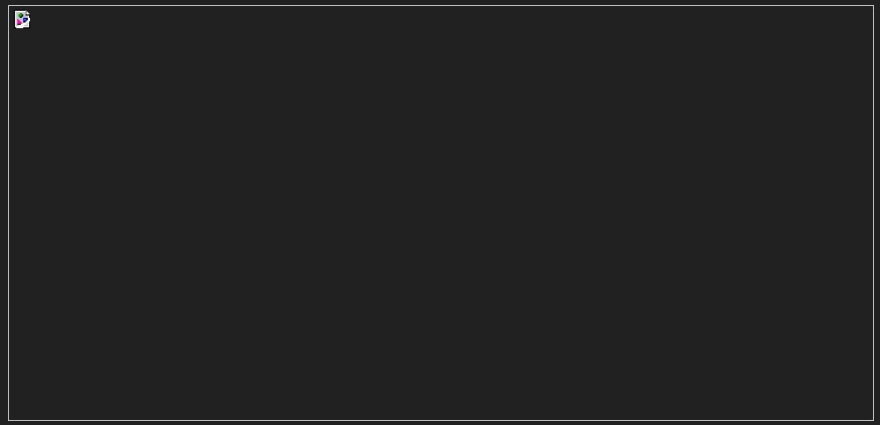
Architectural Overview(Embedded) (cont.)

- Real-time Clock
  - Responsible for getting and setting time
  - Communicates via I2C and UART
- Configuration
  - Sets peripheral addresses
  - Sets peripheral sample rates
  - Information assigned to variables for use
- Offload/Upload
  - Write configuration data to SD card from offload software
  - Send data from SD card to offload software
  - SD card accessed via OpenLog protocol
  - Serial communication used for offload software
  - Key functions:
    - checkForConnection()
    - sendInfo()
    - getInfo()



Architectural Overview(PC)

- Offload Data from Device
  - Reading data from device
  - Raw data to CSV
- Configuration
  - Loading from configuration file
  - Saving to configuration file
  - Setting configuration on device



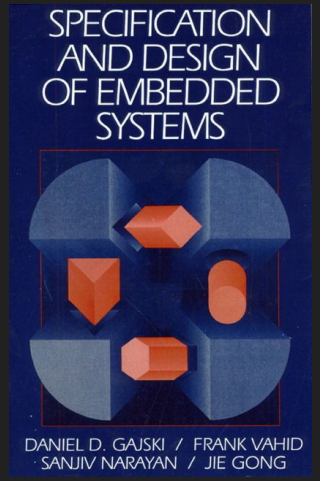
Challenges and Resolutions

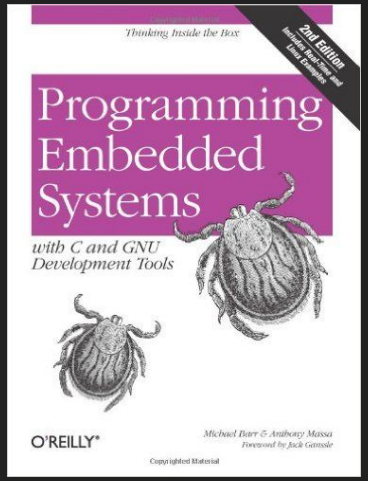
Big Challenges:

- Code Composer Studio(IDE)
  - Debugging
    - Print statements
    - Break points
  - Understanding the stages in the build process
- Embedded Systems
  - Learning curve for embedded systems
  - Acronyms (RTC,I2C,SPI,etc.)
- Existing Code has minimal documentation

Resolution:

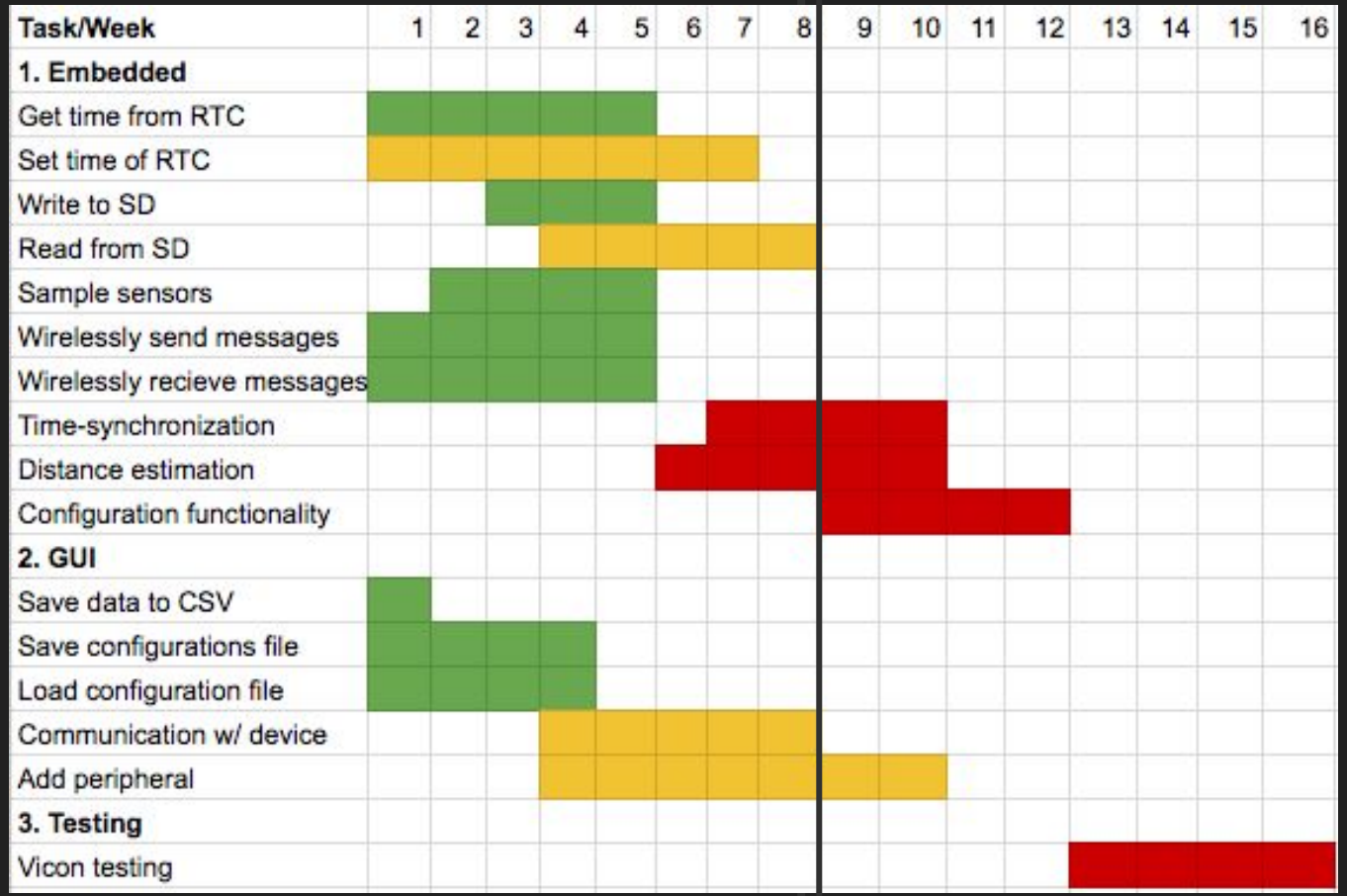
- Research
  - Existing Documentation/Sample Code
  - Texas Instruments forums
  - Embedded System Books





Schedule

Legend
Completed
In-progress
Not started



(Spring break not included)

Conclusion

KineTrax has the potential to benefit lots of areas:

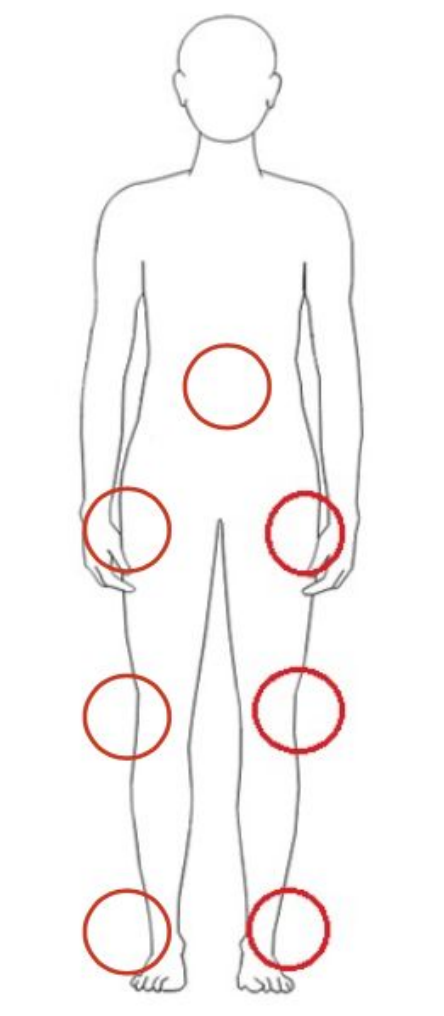
- Movement impairments
- Prosthetic limbs
- Sports medicine
- Farm animals

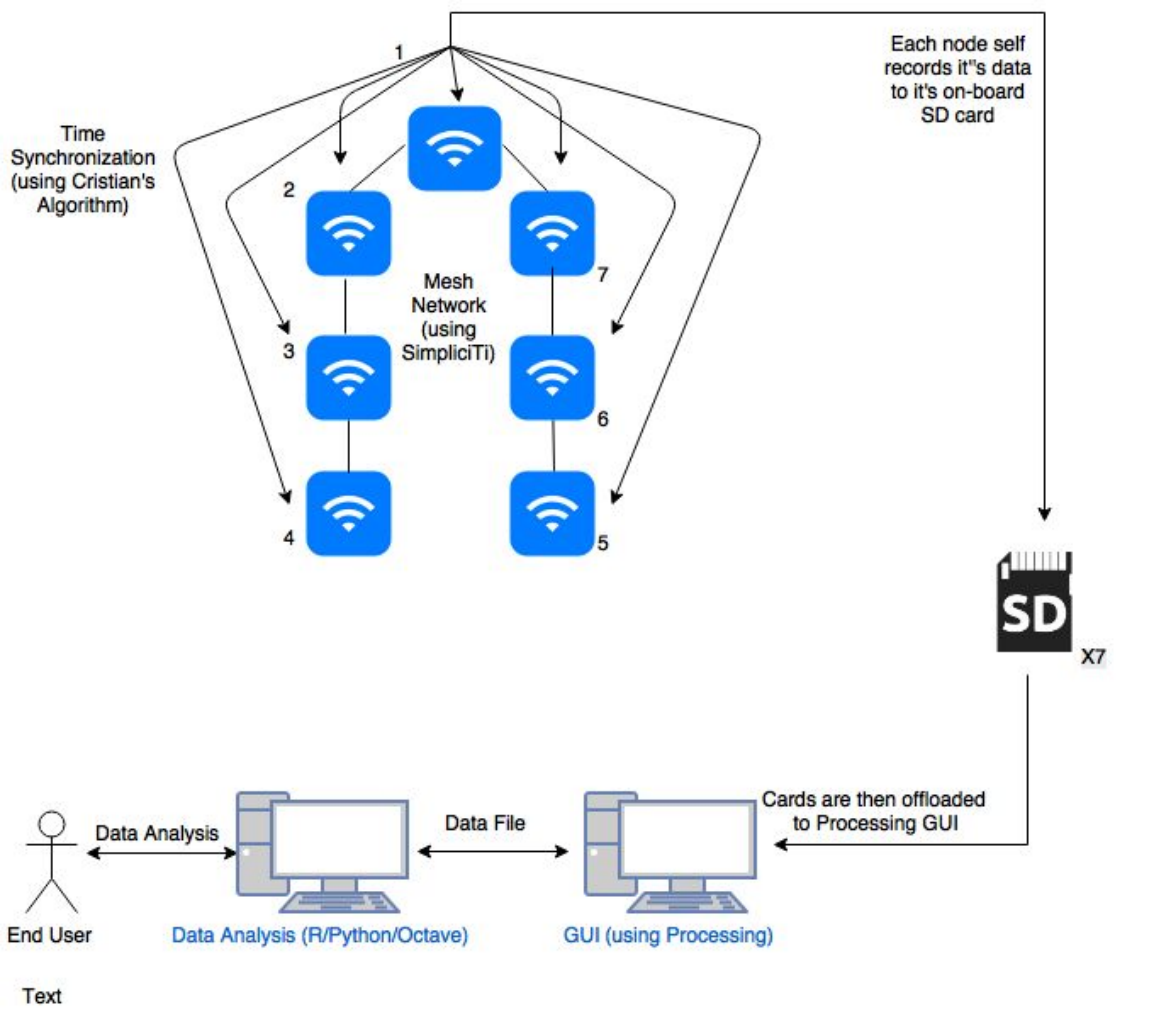
Lots of progress has been made:

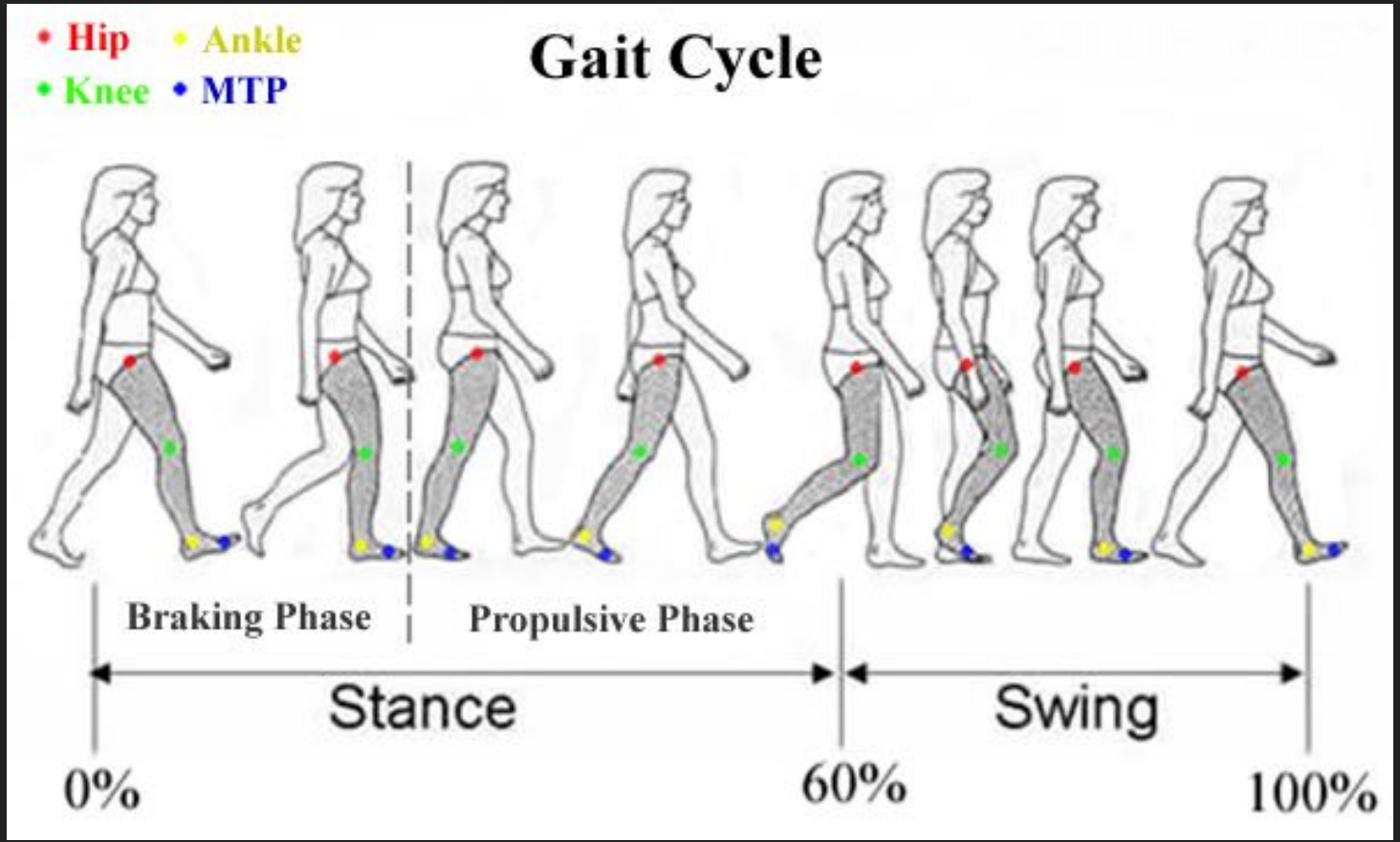
- Device can sample sensors
- Device can get time from RTC
- Device can wirelessly communicate
- GUI reads raw serial data to CSV
- GUI loads configuration file
- GUI can save configuration file

References

1. http://evenamed.com/eyes-on-glasses/
2. http://www.fabricatingandmetalworking.com/2015/02/waterjet-used-make-prosthetic-limb/Winfree
3. http://www.pcclassesonline.com/fitbit-charge-hr-vs-surge-review-and-tutorial/
4. http://www.operationward57.org/2011/03/new-bionic-prosthetic-for-lower-leg-amputees/
5. http://toughasia.com/blog/wearable-tech-vylyv-labs-smart-shorts-enable-men-to-strengthen-pelvic-floor-muscles/
6. https://www.amazon.com/Programming-Embedded-Systems-Development-Tools/dp/0596009836
7. https://www.pearsonhighered.com/program/Gajski-Specification-and-Design-of-Embedded-Systems/PGM30685.html
8. http://www.quintic.com/education/case_studies/Gait%20Analysis.html




1
2
3
4
5
6
7
Time Synchronization (using Cristian's Algorithm)
Mesh Network (using SimpliciTi)
Each node self records it"s data to it's on-board SD card
SD
X7
Cards are then offloaded to Processing GUI
Data Analysis
Data File
End User
Data Analysis (R/Python/Octave)
GUI (using Processing)
Text

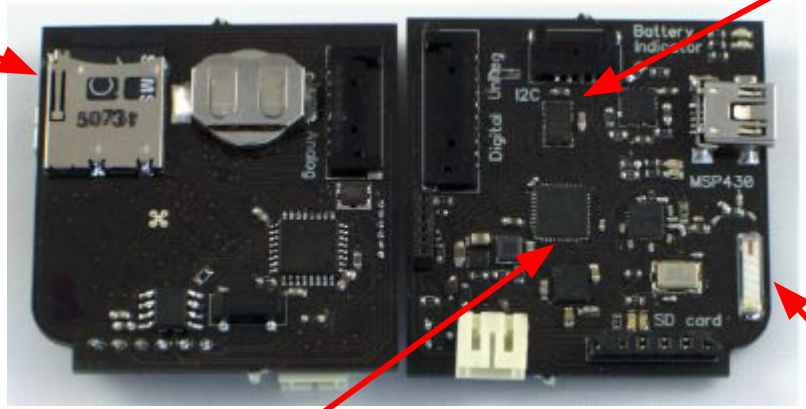

• Hip • Ankle
• Knee • MTP
Gait Cycle
Braking Phase
Propulsive Phase
Stance
Swing
0%
60%
100%

Records data (accelerometer) daily into 32GB (per month storage)

Tracks time

I2C(RTC protocol)

SD CARD



Radio antenna(communication to other KineTrax devices)

MSP430 CHIP

Gets data from different parts of body