Wireless Wearable Electrocardiogram (WWECG)

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Project Overview

The Wireless Wearable Electrocardiogram is a portable wrist mounted sensor that detects the heart's electrical activity and displays it to the user through an android developed application.

The WWECG system is comprised of two wrist mounted sensors and an external processing hub. The wrist mounted sensors use medical grade disposable wet electrodes to obtain the signal from the body and transmit the signal wirelessly to the hub. The hub processes and analyzes the data with algorithms to detect the QRS complexes, heart rate, and any arrhythmia from the user's heart rhythm. This information is then transmitted to the user application via Bluetooth LE.

Goals and Objectives

The overall objective of this project is to create a fully functional wireless ECG allowing the user to move about freely and monitor their heart activity.

- Hands free wrist mounted device
- Live mobile application that stores and displays user data
- One full hour of monitoring when fully charged
- Make device comfortable enough to wear that gives the user free range of motion
- High resolution image of the users data in a graphical format
- Notify user of possible cardiac health concerns (arrhythmia, atrial fibrillation, etc.)
- Provide an accurate representation of heart's rhythm, QRS complex locations, and calculation of heart rate.

The Complete System
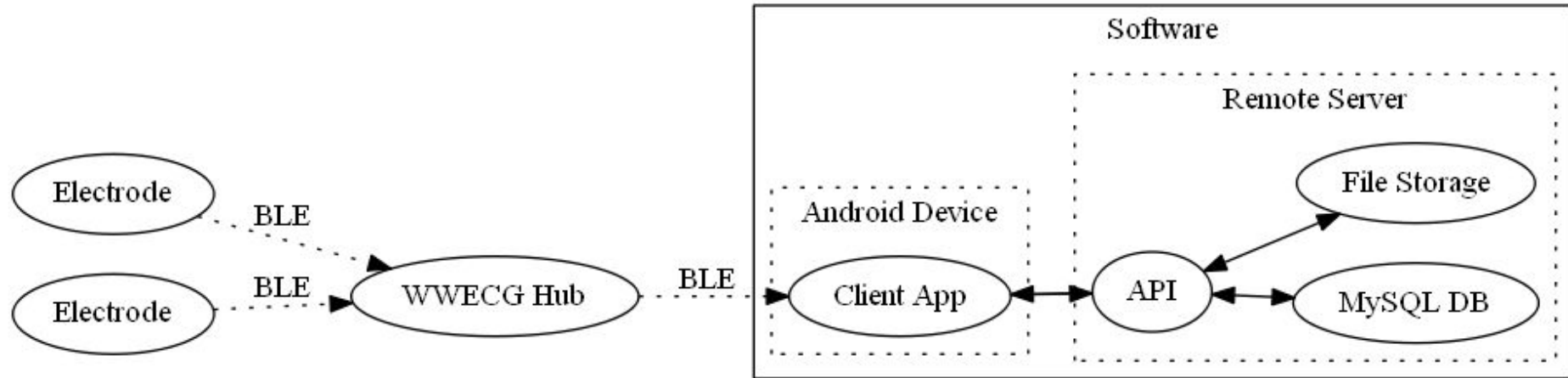
Project Responsibilities

Topic	Primary Focus	Secondary Focus
Analog Signal Processing	Ulbert Botero	Ryan Shifman
Digital Signal Processing	Ulbert Botero	Alex Consunji
Embedded Processing	Alex Consunji	Ulbert Botero
Application/Server Development	Karson Kimbrel	Alex Consunji
Power Management	Ryan Shifman	Ulbert Botero
PCB Design	Ryan Shifman	Ulbert Botero
Wireless Transmission/Comms.	Alex Consunji	Karson Kimbrel

System Requirements

- Live display of local WWECG sessions
- Local and remote storage of past WWECG sessions
- Playback of past WWECG sessions
- The ability for a doctor to record WWECG sessions of his patients
- Authentication and registration of users
- Networking for initial login and playback of WWECG sessions that are not stored on the device
- The application client must be compatible with Android 5.0+
- Support for doctors

Types of Users

- Non-Doctors
  - Have the ability to view, record, playback, and save remotely WWECG sessions
- Doctors
  - Have the additional ability to create arbitrary patient ids and store WWECG sessions for the patients
    - No personally identifiable information is collected for these patients
    - The doctor may view the randomly generated patient id and use it for his own records
    - Doing this prevents us from being required to be HIPPA compliant
  - Doctors must be flagged as a doctor via a database administrator

Resources Used

- Android Studio
- Android 5.0
- OAuth2 Authentication
- MySQL
- Google Cloud
- Apache2
- Debian Linux
- HTTPS
- JSON

Security

- Serverside WWECG session files are encrypted with a global AES-256 key
- Clientside WWECG session files are encrypted with a randomly generated AES-256 key
  - The key is generated when the app is first run
- Passwords are NOT stored on the client thanks to OAuth2
- Passwords on the serverside are run through a PBKDF2 (a password based Key Derivation Function) with a global salt, a user specific salt, and an iteration count of 1024
- All connections between the API and client are HTTPS
  - Any HTTP traffic is redirected

Serverside Endpoints

- /auth
  - /placebo
  - /register
  - /revoke
  - /token
    - Supports the password, client_credentials, and refresh_token grant types
- /data
  - /privacy
  - /tos
- /user
  - /whoami
  - /whois

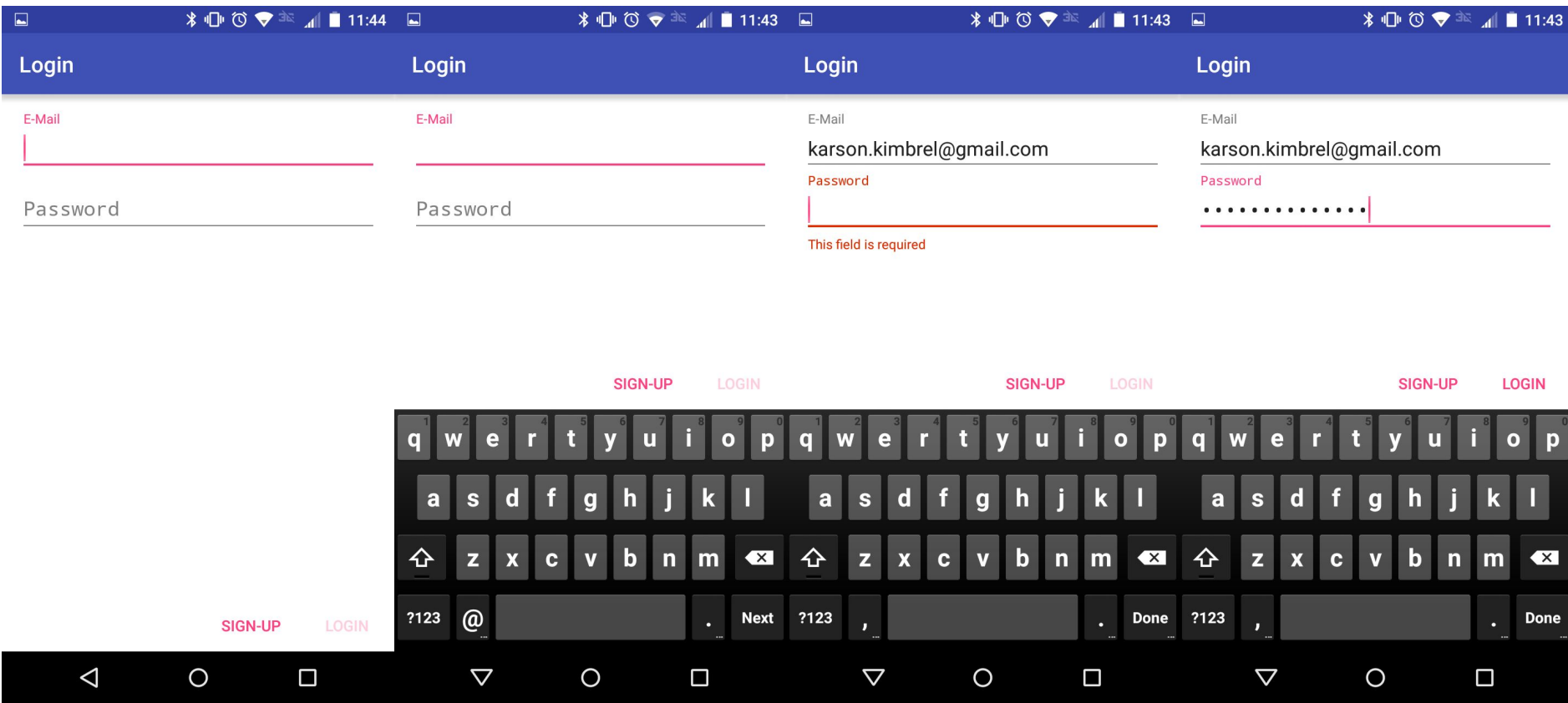# Serverside Endpoints

- /ecg
  - /file
    - Download a file
  - /files
    - Get a list of files for a user
  - /newpatient (for use by doctors only)
    - Creates a new patient for the doctor
  - /patients (for use by doctors only)
    - Get a list of the user's patients
  - /upload
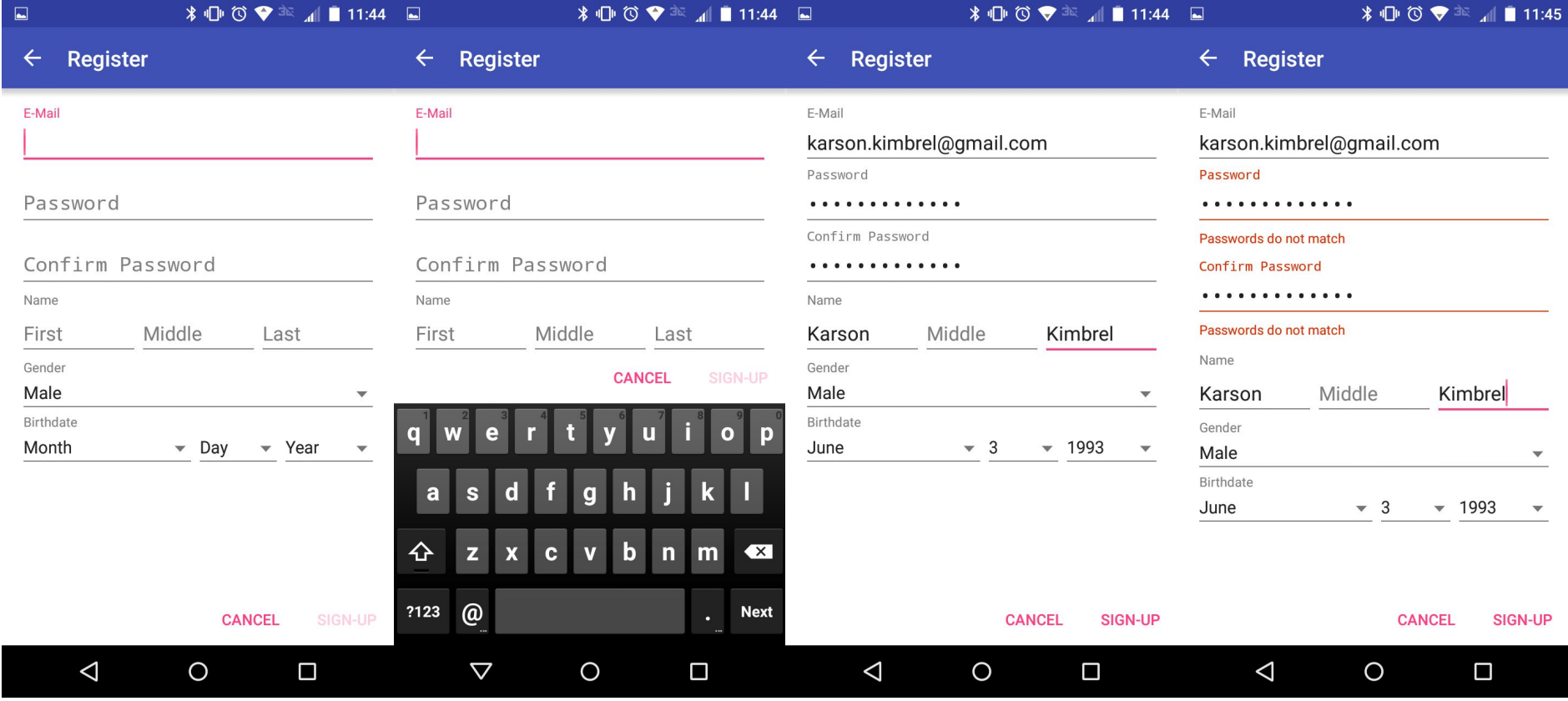   - Upload a WWECG session

Application Screen Flow

Dotted lines mean the user can navigate directly to the previous screen
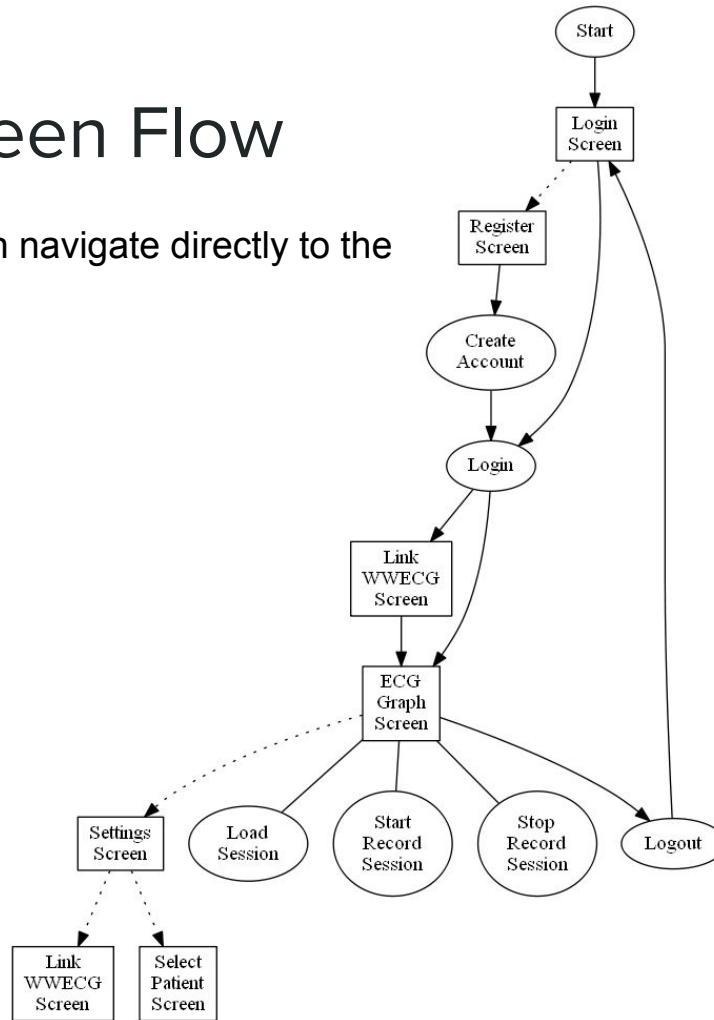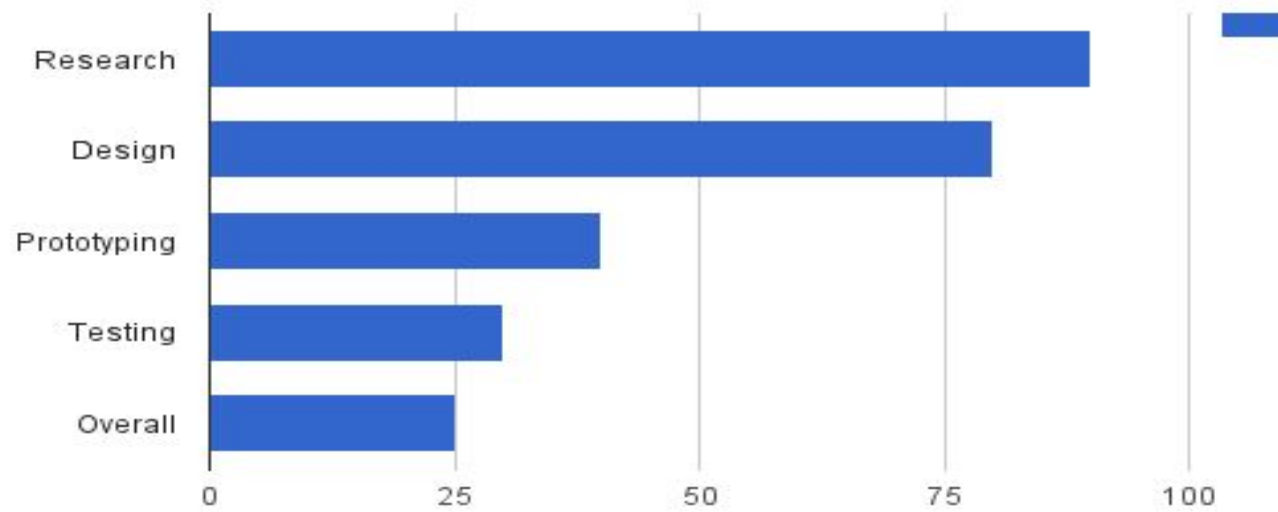
Login Screen

Register Screen

Costs

SOIC to DIP Adapter	$10
DSP Development kit	$100
JTAG	$70
AFE prototype board	$20
MSP430	$7 + Samples
DSP Chip	Free TI Samples
TL084	Free TI samples
MSP432	$15
Electrode Pads	$25
Electrode Leads	$15
MSP430 100-Pin Dev Board	$25

Software Progress

Task	Progress
Serverside Setup and Endpoints	90%
Login and Registration Flow	95%
ECG Display Screen	5%
Settings Screen	5%
Link WWECG Device Screen	25%
Link Doctor Dialog	25%
App Backend	75%

Overall Progress

Tangible Progress