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Project: Heart Rate Monitoring System

Section 1.1

The Heart Rate Monitoring System we are working on is a wearable heart rate measuring device. We vision a device that is in a practical wearable form factor that reads a person's heart rate. We want it to be simple to use while being unobtrusive to a person's daily activity. Not only will it read heart rate but it will also log the data for a time interval and send the data to a mobile device that will present the data in an easy to understand format.

The origin of our project steamed from three main needs, the growing popularity of wearable technology, collecting heart rate data, and a practical and unobtrusive method of integrating the data in to life. From there we looked multiple heart rate monitoring devices and the need for them. For the average user having a heart rate monitoring device gives real time feed back of the intensity of an activity and helps set goals. Not only can having heart rate data measure the intensity of an activity but it gives a goal for the user to reach a heart rate zone that could be optimal for desire effects.

Heart rate data could also benefit researchers who are studying the correlation between heart condition and diseases and health condition. There are many conditions out there that affects a person's heart rate, so by having a collective data of a person's heart rate over time and how it fluctuates it could lead to more in-depth research diagnostic. That kind of data would be able to give researchers an idea of how different daily life activity affects our overall heart and health. So we believe there is a need for a smart wearable heart rate monitoring system in the research field.

Another important need for our project lies in the medical care field. If doctors and medical professionals have access to a collective amount of heart rate data on a patient it allows for a more informed and in-depth diagnostic of a patient. By understand how a patients heart rate fluctuate through out a period of time a doctor could have a better understanding of the patients life style so a more effective and personalize treatment could be prescribed. Not only that but also a doctor or medical professional could also us heart rate data to analysis the effectiveness of a treatment.

In general there is a need for a practical and unobtrusive method for obtaining and logging heart data. The application for heart rate data is vast and being explore. So we believe there is a great need for this project.

As we mentioned a good target audience for a project of this nature is in research. Researchers rely on data to validate their ideas and as a data collection device it fits in the research field. As a medical device it is also targeted towards doctors and medical professionals. A doctor would use this device for a more detailed diagnostic of a patient. Health and fitness trainers would use this to track and analysis the performance of their patients or clients. Heart rate monitoring is also relevant in psychiatry. There is a connection between stress levels and heart conditions. By

having a collection of heart rate data psychiatrists can analysis and understand a patient's stress level.

This project is also targeted towards the elderly for in home monitoring. By having the heart rate of an elderly that lives that home care takers and nurse can monitor and be alerted when something happens. This gives caretakers the ability to track their patient's heart rate that might have a history of heart problems.

Section 1.2

Heart rate sensor	Body location	HR measurements	Tool
PPG sensor	Finger, temple	Yes	IR led
ECG	Torso, waist, legs	Yes	Electrodes
Communication with mobile devices	Data payload throughput	Range	Power Consumption
Bluetooth	2mbps	1000m max	Low
Bluetooth LE	100kbps	250m max	Medium
NFC	424kbps max	Short	Very low
WIFI	802.11n 600mbps max	Varies	High
Intuitive UI	Cost	Power consumption	
Touch Screen	High	High	
LCD	Medium	Medium	
E-ink	Medium	Low	
Buttons	Low	Low	
Practical form factor			
Watch			
Headband			
Waistband			
Battery powered	Rechargeable	Capacity	Voltage drop
Lions	Yes	High	Low
Alkaline	No	Low	High
NiMH	Yes	High	Low
Ni-cad	Yes	Medium	Medium
Smart Watches	Heart rate sensor	Connectivity	Display
Pebble smart watch	No	Bluetooth 2.1	E-ink
Samsung Galaxy Gear	No	Bluetooth 4 & LE	Touch screen LCD
Sony Smart Watch 2	No	Bluetooth 3 & NFC	Touch screen LCD
Smart fitness device	Data tracks	Connectivity	Battery life
Nike+ Fuel band	Calories & step	Bluetooth	Up to 7days
Fitbit Force	Steps, distance, sleep hrs, calories	Bluetooth 4 & NFC	
Heart Rate monitoring Devices	Heart rate sensor	Sensor	Connectivity
Mio Alpha	Yes	PPG	Bluetooth 2.1

Section 1.3

When it comes to heart rate sensors there are two common methods that are used to read heart rate. One is a PPG sensor, which uses infrared LEDs to shine at a blood stream and a phototransistor to measure the reflected light to calculate heart rate. This method is commonly used on fingertips and the temple. Another method is an ECG sensor, which measures the tiny electric changes on a skin using electrodes. An ECG sensor is more precise and accurate than the PPG sensor. For this project both methods will be taken into consideration.

In order to send the recorded measurements to a mobile device the Heart Rate Monitoring System will have some form of wireless communication. There is classic Bluetooth, Bluetooth LE (Low Energy), NFC, and Wi-Fi. NFC consumes very little power but a short range is need while Wi-Fi needs a lot of power but has an extended range. Bluetooth LE gives the optimal range while consuming very little power. The draw back of Bluetooth LE over classic Bluetooth is that the data throughput is considerably less.

How the user interacts with the device is very important so in order to create an intuitive user interface we looked into touchscreens, LCD, E-ink displays, and buttons. Touchscreens seem to be the most intuitive way of controlling a device but it also is the most power hungry and complex. So for this project a combination of buttons and low power screens (LCD or E-ink display) will be implemented.

When looking into common form factors for wearable technologies we found watches, headbands, and waistbands were the more common. The waistband form factors are taken but heavy fitness tracking devices designed for athletes or fitness enthusiast. The headband form factor was the least common among the three and was used for sleep monitoring. The watch form factor seems to be the most common and the least obtrusive to daily life activities.

There are many types of batteries that we could use for our project but we like lithium ions and Nickel-metal hydride batteries because they are rechargeable unlike Alkaline. Ni-cads didn't have as high of a capacity as Lithium-ions and NiMH.

When looking at the competition of other smart watches on the market there was the Pebble smart watch, Samsung Galaxy Gear, and the Sony Smartwatch 2. All of these use Bluetooth of some form and ahs a display. But they all are lacking a heart rate sensor. These smart watches can tell time, send data via Bluetooth, and have other features but they lack any form of medical monitoring. While fitness devices like the Nike+ Fuelband and Fitbit Force only measured fitness data such as steps taken, calories burned, distances traveled, and sleep. There is no screen on these fitness devices because their sole purpose is to read motion data and send it to a mobile device.

The only practical wearable heart rate monitoring device we found was the Mio Alpha. This watch tells the time and uses a PPG sensor to read heart rate data then send it to a phone via classic Bluetooth. This suggest the field for a smart and practical heart rate monitoring device is no crowed and would be an interesting area to look into.

Section 1.4

Consumer Requirements

1. Measures Heart rate
2. Communication with mobile device
3. Intuitive user interface
4. Practical form factor
5. Battery powered.

Number	Requirement	Corresponding consumer requirements
1	Uses PPG sensor to read heart rate	1
2	Uses ECG sensor to read heart rate	1
3	Have Bluetooth LE communication	2
4	Battery life must be at least 24 hours	5
5	Display time	3
6	Have a display	3
7	Have a smart phone application	2
8	Uses accelerometer	1
9	Logs heart rate data for battery life span	1
10	Heart rate range warning	1
11	Battery level indicator	5
12	Charging circuit	5
13	Alert when battery is low	5
14	Weigh less than 1lb	4
15	Have a power switch	3
16	Power indicator	3