Proposal Document

Alkinoos Sarioglou – Individual Project

Project Title: Development of medical bracelet measuring heart rate and producing an ECG

Project Outline

Motivation

This individual project aims at using technology in order to address the problem of heart condition monitoring. More specifically, the ageing population due to reduced mobility finds it difficult to schedule regular appointments with their cardiologist to track the condition of their heart. Furthermore, people suffering from heart-related problems do not have a continuous check of their heart health, which could lead to fatal incidents such as a stroke or a heart attack. In some cases these could have been avoided if they had been detected instantly. Therefore, detecting an abnormality in the blood flow early enough could save lives.

In the market at the moment, state-of-the-art includes heart-rate monitors and medical devices. First, heart-rate monitors measure the heartbeat of the user, but this is mainly related to fitness activities rather than medical monitoring. In other words, an instability in the heart function cannot be communicated to a doctor automatically and therefore no immediate action can be taken. Furthermore, other medical devices in the market include conductive pads, on which the patient places two fingers and the ElectroCardioGraph (ECG) is produced on the screen of a phone along with the heart rate in real time. These can be communicated to a doctor through the app. However, this solution requires the user to be recording an ECG regularly in order to track their heart's condition. It is understood that old people will have to be reminded to do so very often, which might pose difficulties in their everyday lives. If they do not follow a regular check, there will be no continuous tracking of their heart's condition.

Scope

The solution which is proposed in this document is a low-cost medical bracelet. This bracelet will be worn by a patient on their wrist and without any intervention (passive use) it will be measuring the heart rate and it will be producing an ECG at a frequency depending on the patient's condition.

This device will ensure continuous monitoring of the patient's heart condition by sending the information from the sensors to an App or a Webpage, where their doctor will be able to examine the results in real time and act quickly if an unusual activity is detected. The app will incorporate the following features:

- Patient Medical Profile
- Display of Heart rate in BPM
- Display of the ECG on the screen of a phone

Also, the app will have a different version for the patients and the doctors. On one hand, patients will be able to see their own data by viewing their ECG and heart rate. On the other hand, doctors' view of the app will be a list of their patients and live streaming of their data. Therefore, when an incident comes up, this will be shown on their record in real time and they will be able to contact the patient to propose an instant action.

It is understandable that some people, mostly elderly above 70 years of age, are not able to use technology effectively and therefore to view their own heart condition in the app. In these cases, all they need to do is wear the bracelet for the entire day and their doctor will be keeping track of their condition. Additionally, their relatives (such as the children or grandchildren of older people) will be able to keep an eye on their heart health through the app and take immediate action in case of emergency. Hence, this technology can greatly decrease the reaction time in heart-related incidents and therefore save lives.

Aims

The aim of the overall project is the successful development of the working low-cost medical bracelet, which can be easily used by people of all ages. Also, the design of the practical app which will be able to receive data from the bracelet and display them in a user-friendly way.

Objectives

The main objectives of the project are directly related to the features that the medical bracelet will incorporate. These include:

- Measurement of heart rate in BPM
- Display of the ECG of a patient in real time on the screen of a phone
- Interaction between Patients and Doctors through the App

An additional objective concerns the completion of the Final Report and the Presentation Slides which will be presenting the idea and the technology used to implement it.

These are the core objectives in order for the project to be considered successful. Given the availability of time additional features can be added to extend the functionality of this solution, such as:

- Notifications to doctors about emergency situations
- Measurement of blood pressure
- Automatic Feedback by the App on the heart's condition, like Normal, Atrial Fibrillation etc.
- Button on the device which will be requesting a measurement manually
- Capability of doctors to request a measurement from the device and set the frequency of measurements depending on the patient's condition

Deliverables

To accomplish the successful completion of the final report but also of the practical work by the end of the year, a clear schedule needs to be designed. This will include the timeline of the deliverables that need to be carried out in order to reach the main aims. For the final report these are:

- Overview and Background, which include the abstract, aims, objectives, state-of-the-art
- Technical Achievement, which includes design, implementation, testing, results
- Presentation and Content Structure, which include checking of the format and proof-reading

Then, for the practical work these are:

- Components Selection/Order
- Circuit and PCB Complete Design
- Working Prototype
- Bracelet Complete Design
- 3D-print of Bracelet
- Bracelet and PCB Integration
- App Development
- Bluetooth data receiving and displaying
- App Interface for Patients and Doctors

The timeline regarding these deliverables is presented in the Project Plan section.
Furthermore, the upcoming milestones of the project can be summarized as:

- Draft Introduction
- Academic Malpractice
- Project Method
- Draft Final Report
- Final Report
- Presentation Slides

Constraints

The constraints that apply for this project concern the following factors:

- Battery Life
- Charging Time
- Accuracy of Sensors
- Speed of Transmission of Data
- Size of the device

Concerning the battery life, the aim is to create a device that will be able to be active for at least 5 days. For the purpose of reducing the overall power consumption and therefore extending the battery life, the bracelet will not incorporate an LCD or touch screen. Moreover, the charging time should be approximately 1 hour. As far as the sensor is concerned, it will be an off-the-shelf component therefore choosing a sensor with good accuracy should solve this problem. It is understandable though that such a sensor would be consuming more power, which would limit the battery life considerably. Also, the above factors might pose restrictions on the size of the device. Therefore, to remove insecurities about decisions made on the project, the following priority will be followed:

1) Size
2) Battery Life

3) Accuracy of Sensors
4) Charging Time
5) Speed of Transmission of Data

Costs

For the initial part of the project, a simple heart rate sensor will be ordered which costs £13. Also, a development board containing a microcontroller will be needed which comes at a price of £24. As the project progresses and more features are added in the product, such as the capability of producing an ECG, items such as ECG Electrodes will be purchased. A pack of 30 electrodes costs £6. Finally, a Lithium Ion Polymer battery which will be used for the power needs of the device costs £5. Therefore, in order for the core objectives to be accomplished the projected cost is £48. Additional costs might come up in case extra features are added in the device.

Individual 3rd Year Project Planner

Select a period to highlight at right. A legend describing the charting follows.

Period Highlight: 3 | Plan Duration | Actual Start | % Complete | Actual (beyond plan) | % Complete (beyond plan

ACTIVITY	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Fixed Deliverable Deadlines					
Project Outline, Project Plan and Risk Assessment	3	1			
Draft Introduction and Academic Malpractice	8	1			
Project Method	20	1			
Final Report - Draft	25	1			
Final Report - Final Version	28	1			
Presentation Slides	28	1			
Presentation	30	1			
Project Management					
Complete Project Plan (Gantt Chart)	1	1			100%
Technical Specifications	3	1			
Project Aims and Objectives	2	2	2	1	100%
Project Risk Assessment	2	2	2	1	100%
Health and Safety Risk Assessment	3	3	2	1	100%
Hardware Progress Tracking - Hackster Blog	3	26			
Introduction Development	7	2			
Academic Malpractice	7	2			
Project Method Preparation	19	2			
Draft Report Preparation	19	7			
Final Report Writing	26	3			
Final Report Proof-read / Check	28	1			
Presentation Slides Preparation	26	3			
Background Reading and Research					
Existing Solutions	2	1	2	1	100%
Technical Solution Planning	2	1	2		
Online Research	2	8	1		
Available Hardware Research (Sensors, Op-amps, etc.)	2	2	3		
Communication of Data from Hardware to App	19	5			
3D CAD Design Training (Bracelet)	21	4			
App Development Training	19	6			

PERIODS 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36

ACTIVITY	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Hardware Development (Prototype & Test)					
Component Selection	2	2	3	1	
Component Order	3	1	3	1	
Sensors Testing	4	6			
myDAQ Circuit Prototyping	4	9			
Stripboard Circuit Implementation	7	6			
PCB Design	8	5			
Bracelet 3D CAD Design	21	4			
3D-print draft bracelets	24	3			
Hardware Development (System Integration)					
Integrate PCB with bracelet	27	2			
Hardware Debugging	28	3			
Software Development					
Communication of Data to the Mobile App	19	5			
App Development					
Main page Development	21	2			
Receive data	22	2			
Process data	23	2			
Display Data	24	3			
Develop Interface for users and doctors	26	3			
Contingencies					
Order Late Arrival	4	2			
New hardware needed	5	4			
Further hardware testing	7	5			
Bracelet Design Correction and 3D-print again	26	3			
Stretch Objectives					
Send notifications to doctors about emergency	29	2			
Display ECG	29	2			
Blood pressure	29	2			
Give automatic feedback of health condition	29	2			

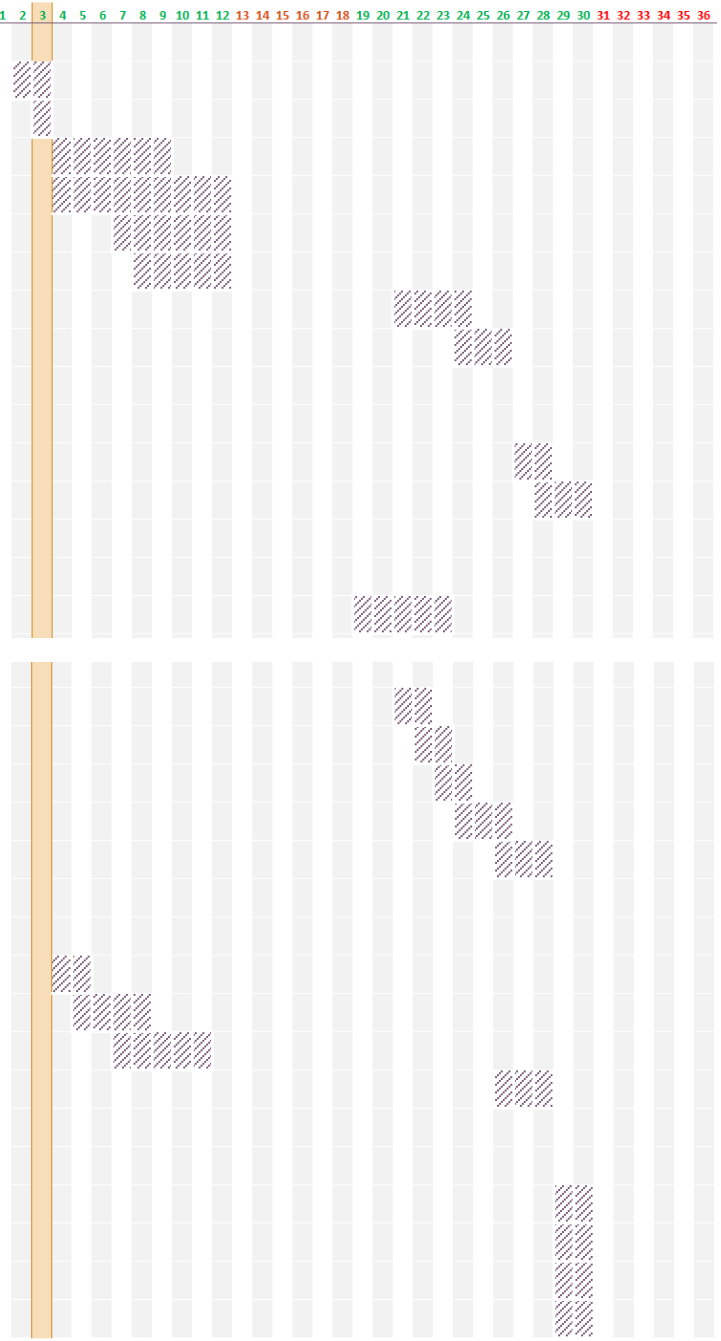

Figure 1: Project Gantt Chart

Risks

As it can be seen in the Contingencies section of Figure 1, the following risks are associated with the completion of the project:

- Order late arrival
- Hardware Replacement
- New Hardware Testing
- Corrections in the Bracelet Design and an extra 3D-print
- Data loss

Strategies

There is nothing that can be done for a potential late arrival of the components other than ordering them early enough to allow for time flexibility. Additionally, a possible hardware replacement, which includes ordering other sensors because of errors in the initial ones, could be avoided by careful research and validation of the research results on the sensors to be purchased. This would prevent additional time for the testing of the new components. Also, corrections in the 3D design of the bracelet could be bypassed by careful design with all the dimensions specified. Finally, a potential loss of data of the project like the final report draft would be catastrophic for its successful completion and it can be avoided by taking a regular back-up of all the files in a cloud at the end of every week. All of the above can be used to create the Project Risk Assessment:

Risk Title	**Risk Description**	**Likely Consequences**	**Schedule Impact**	**Existing Mitigation Measures in Use**
Data loss or corruption	Loss of data related to the project.	Project progress impeded significantly. Also, loss of marks as a result of being unable to complete objectives.	Minor to significant depending on the amount of data lost.	Ensure all data is backed up in at least two, physically separate locations at least once per week.
Order late arrival	An order of components arrives late in the University.	Slow progression of the project. The deadlines and milestones are not met.	Minor as other tasks can be sacrificed to find additional time and make up for the late arrival.	Order placed early in the semester to allow for time flexibility.

Risk Title	Risk Description	Likely Consequences	Schedule Impact	Existing Mitigation Measures in Use
New Hardware Testing	The time taken to test the new hardware purchased to replace the old components.	Slows down the progress of the project. Possible to miss deadlines and not deliver the objectives.	Significant due to the time limit of the project.	Careful research when purchasing components initially.
Redesign bracelet	Redesigning the bracelet in CAD tools to fix errors and 3D-print it again.	Delay the successful delivery of the project. Waste time that could be used in the development of the circuit or the app.	Significant due to the time limit of the project.	Careful initial design with all the dimensions specified.

Table 1: Project Risk Assessment

MANCHESTER 1824
The University of Manchester

General Risk Assessment Form

Date: (1)	**Assessed by:** (2)	**Checked / Validated* by:** (3)	**Location:** (4)	**Assessment ref no** (5)	**Review date:** (6)
10/10/2019	**Alkinoos Sarioglou**		**C34 Sackville Street Building**		

Task / premises: (7)

Practical development work in student laboratory C34, Sackville Street Building

Activity (8)	**Hazard** (9)	**Who might be harmed and how** (10)	**Existing measures to control risk** (11)	**Risk rating** (12)	**Result** (13)
Wrong use of electrical components	Component polarity wrong	Worker and all lab users Injury, Burn Component burnt, blown up, Fire	Read the instructions carefully on how to use the component	LOW	A
Use of electrical equipment	Electric shock or fire	Worker and all lab users Severe Injury or death	All equipment used in the laboratory is tested beforehand for correct functionality and is used according to the manufacturer's instructions	LOW	A
Measurements – low voltage (<30V DC)	Electric shock, Components overheating	Worker and all lab users Severe Injury, Skin burn or death	Caution on first power-up, Limit supply current, avoid close visual inspection of circuits not validated to be working correctly, avoid touching components which could overheat, ensure measurement probes are attached before power-up	LOW	A
Soldering	Touching the soldering lead, No fume extractor	Worker and all lab users Skin burn, breath irritation or injury	Turn on the fume extractor, take extra care when soldering components not to come in contact with the soldering lead	LOW	A
Moving around the laboratory	Falling or Tripping on laboratory equipment	Worker and other lab users Injury	Careful arrangement of lab equipment Personal belongings stored in specific rooms	LOW	A

Activity (8)	**Hazard** (9)	**Who might be harmed and how** (10)	**Existing measures to control risk** (11)	**Risk rating** (12)	**Result** (13)
Working on computer	Incorrect posture, Close contact with the screen	Worker Injury, Sight decline, Back pain	Take regular break off the screen and take care to keep a good posture using a good desk chair	LOW	A
Food and Drink	Electric shock, Toxic contamination	Worker Poisoned by food	No food to be consumed in the lab	LOW	A
Use of hand tools	Sharp tools	Worker Cut, Eye injuries	Correct tools are used for the specific activity Use PPE for extra safety	LOW	A

Table 2: Health and Safety Risk Assessment

The action plan to mitigate these risks can then be produced:

Action plan (14)				
Ref No	**Further action required**	**Action by whom**	**Action by when**	**Done**
	Read datasheet for correct use of components ordered when they arrive.	Alkinoos	30/10/2019	

Table 3: Action Plan