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|  <b>University of<br/>Central Lancashire</b><br>UCLan<br><br>School of Engineering | <b>UCLan Coursework Assessment Brief</b>                             |  | Academic<br>Year |
|  | Module Title: Electronic Systems Applications<br>Module Code: EL2205 |  | 2020/2021        |
|  | <b>Biometric Monitoring System<br/>Design and Implementation</b>     | This assessment is worth<br>100% of the overall module<br>mark |                  |

## THE BRIEF/INSTRUCTIONS

The following Learning outcomes will be assessed in this assessment

**Manage** a small design project.

**Develop** an electronic system to a given requirement specification.

**Document** a system design and participate in design reviews.

**Take account of** the economic, social and environmental context of engineering activity.

| Assessment Criteria  | Weighting (%) |
|--|---------------|
| Presentation of the working hardware and software system with justifications and a technical and operational overview.                                   | 20            |
| Interim presentation of individual proposal and design review  | 10            |
| Report outlining the development, testing and Implementation of the system including project management (up to 25 pages, including diagrams and tables). | 30            |
| Development of a suitable PCB shield for the system  | 20            |
| Instruction set/ user guide for the operation of the system  | 20            |
| <b>Total</b>   | <b>100</b>    |

## Introduction and background

With the development of cheap and powerful microcontrollers and sensors it has become possible to track human activity non-invasively and discreetly. This has led to a revolution in tracking activity for health monitoring, achieving exercise goals, or sports performance analysis. This has developed into a multimillion pound industry with many applications. Some examples are below:

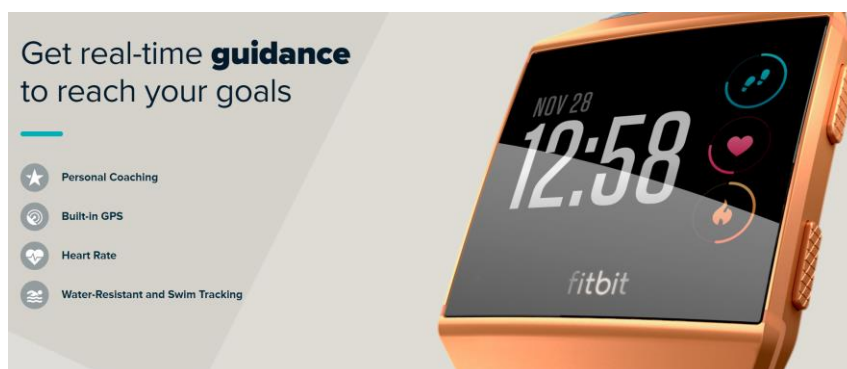


Figure 1 – Fitbit Ionic

Figure 1 shows the Fitbit Ionic, this is a commercial smartwatch that contains GPS, heart rate monitoring and motion analysis. Differing exercises can be tracked and logged and observed over time. Resting heart rate over time can be tracked as well as calories burned.

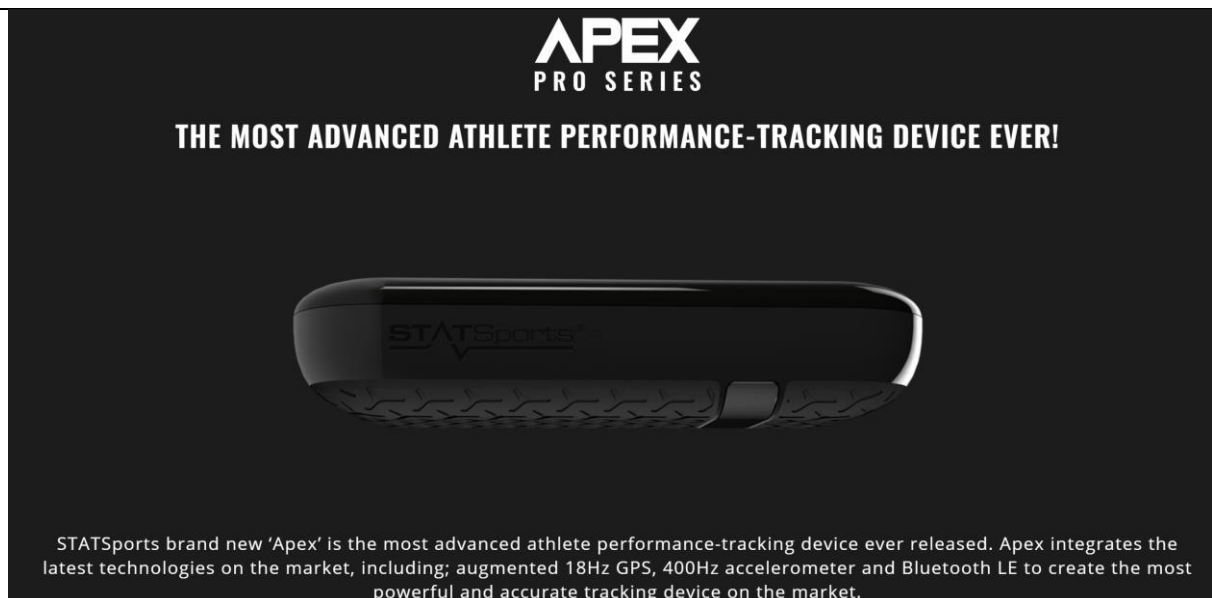


Figure 2 – Statsports Apex Pro

Statsports Apex pro is an athlete tracker used for professional team sports. Data is captured and processed on the device and then sent to a PC for analysis. The system can determine many metrics as noted in figure 3 .

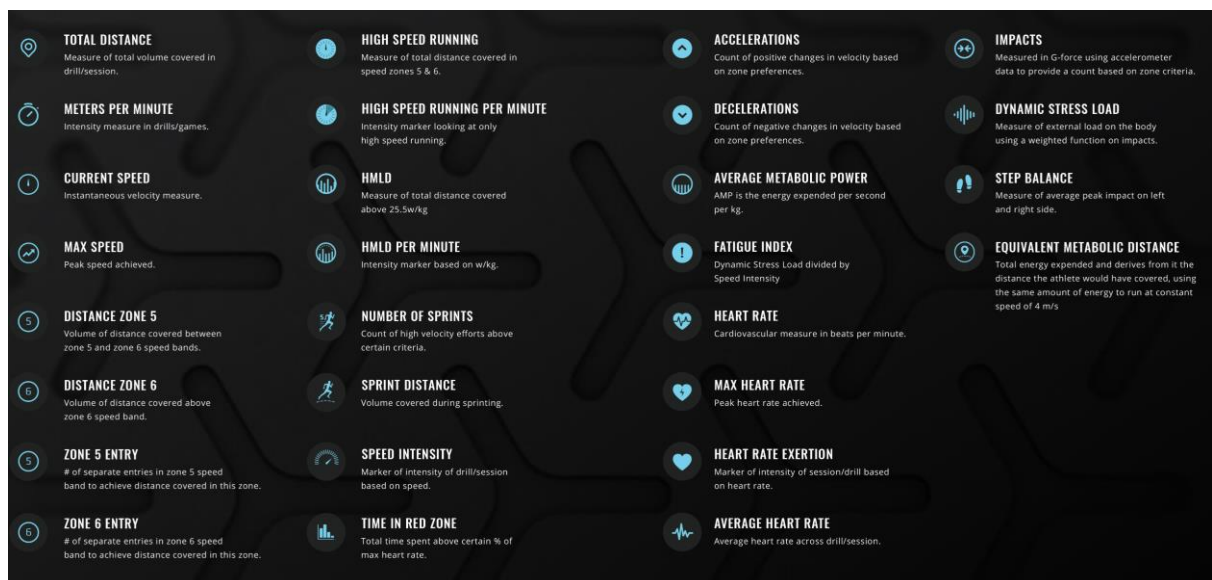


Figure 3 – Statsports Metrics

The above metrics are more tailored to sports and are designed to be interpreted by a coaching team to improve team and individual performance.



Figure 4 – Boditrax System

The boditrax systems shown in figure 4 is a medically backed body composition system that measures weight, metabolic rate, muscle mass, fat mass and bone mass.

As can be seen there are many applications for activity/biometric monitoring from generally health, medical and to sports performance and analysis.

### Project Overview

In a group (nominally a **group size of 3-4**) you are required to produce a proof of concept biometric tracking system, similar to the Fitbit, Samsung Gear, Garmin tracker or other more sports specific applications outlined above. The system will include the hardware and appropriate software enable the system to gather and operate as well as a “front end” that will display information to the user. The project is to be planned and implemented using appropriate project management techniques as outlined in the lecture sessions.

The practical aspect of the project will be to develop a system suitable monitoring human subjects whilst undertaking physical activity. The system will monitor **three key biometrics** from a subject; **heart rate, movement and skin temperature**. **Additional** biometrics or suitable sensors **can be added** where deemed appropriate for the application decided by the team.

**Prior to** developing the system you are required to define a suitable application that the system will be used for. You are encouraged to discuss this as a group and come up with a defined aim and set of objectives prior to any physical development, **discuss this with staff** to form a suitable project base.

This will be presented as a proposal and feedback will be given. Examples of suitable applications include the following suggestions:

- Training and monitoring system for a field team sport. This system includes the above biometrics as well as additional accelerometers for impact monitoring (to check if the player has sustained an impact that could cause injury) and a GPS monitoring system incorporated into the player's armour. Information is relayed back to the coach to monitor player positions and activity level.
- Gaming monitoring system that monitors the biometrics as well as records the player's movements within the game and gives feedback to the developers on the state of excitement of the player in the game.
- Training system for cyclists. This monitors the biometrics and provides feedback to the rider on how much power they are exerting at a given time based on pressure sensors, heart rate and temperature as well as positional information relayed via GPS. This instant feedback is displayed to the user whilst riding the bike and is recorded for further analysis on a PC later on.

Note the above is indicative of applications that can be implemented. Note that the applications use the basic biometrics required and add a "problem to be solved" over being a general monitoring system.

The biometrics that will be essential to the system and to be monitored as a **minimum** are the following;

**Skin Temperature** – The temperature of a subject's skin using a temperature sensor, this data should be instantaneously monitored and logged for review.

**Heart rate** - The pulse rate of a subject will be recorded to provide a reading for the beats per minute of the subject (this data can be logged, as well as used to provide a reading based off a desired minimum time frame).

**Movement** - The movement of the subject will also be recorded to allow steps or activity to be monitored. This is considered a key element of a fitness tracking system and determines if the user is engaging in activity or not and the level of the activity they are doing.

**Other biometrics**, as well as other sensors, where needed by the application of the system, discussed previously, may be included with justification and discussion with the academic team running the module.

The system may **be packaged** into a more suitable nature for the application, for example a glove or a t-shirt as a proof of concept or a working prototype.

To deliver the above there are 2 main elements to the project; hardware and software. Further details are below;

## **Hardware**

The hardware system will be designed around the **Mbed** prototyping system. It is envisioned that this will be used to gather **raw data** from the sensor systems used to record the biometrics. The Mbed will gather and **process** the raw data to provide a basic transformation of data from the analog voltages produced by the sensor to an "expected" data value (e.g. temperature in degrees C). The data will then be sent to a PC, or other suitable system (e.g. phone or tablet) for further processing, data logging and visual display.

Specific sensors will be determined by the application requirements (such as predicated minimum and maximum variations needed). Pulse sensors schematics will be provided for you to build and test these. Temperature sensors and accelerometers for detecting movement will be provided. You will be required to construct the pulse sensor yourselves as a group.

**If you require any additional sensors** these will have to be discussed with the academics as they may need to be ordered and will have an associated lead time that must be taken into account in your project planning.

Prototype the hardware using breadboard to ensure that the system works as expected. Once testing has been completed transfer the hardware to a custom PCB that is configured as a “shield” to mount onto the Arduino pin configuration on the Mbed board. Include schematics and PCB layout in your report, you can use any suitable PCB software for the design.

### Software

The software on the PC (or mobile device) will process the information taken from the Mbed and display this in an easy to read and use system. The software should provide a GUI (Graphical User Interface) to display the biometrics (including live data movements, data logging and storage). In addition the system should also be able to provide the user with feedback on the sensor levels such as the normal, upper and lower boundaries of the biometrics.

Further developments to the system should also be implemented: these may include multiple monitoring of subjects, the determination of stress or activity level of the subjects that are being monitored, or the use of additional shields to control the Mbed system. This will be determined by the desired application of the system.

You will be provided with suitable modules for the transmission of data as well as additional shields that will help you implement additional features and functionality (where discussed). These may include the following; having direct feedback of the biometrics displayed on a LCD screen connected to the Mbed as well as transmitting the data to the PC system via Bluetooth, providing adjustment of the biometric levels as the system is operating, or by having LEDs to show levels in the Mbed system.

### Implementation

As an individual you are required to produce a crude working prototype of your group’s product. This will take approximate 6 weeks to develop. At the end of this you and your group will compare each group members system against the groups set requirements. The group will peer review each system and the most promising will then be developed into the final system. Note that the work from other group members can be incorporated into the final system.

When developing your systems (both as a group and individual ensure that you are taking notes and pictures and logging these on your MS Teams area. These can then be included in the final report.

Develop a GUI system that will capture and log the data. This can be done in C# via a windows form or in another suitable programming language. The system should display the data sent and where needed, provide a graphical interface to show the biometrics. In addition you should aim to provide some feedback to the user of the system (such as when a biometric goes outside of a user set boundary). This could then be sent back to the system to provide remote feedback to the subject. You must document the development and testing regime used for the GUI system and include this in the final report.

When the prototyping phase is completed you must package the system so that it is suitable for deployment in a doctors surgery, hospital or for mobile use by the subject; for example, the system could be implemented into a hat or a vest that the subject wears for the duration of the testing thus allowing an easy to use and configure system.

**You will have time in the labs to be able to develop the project. In this time you will be able to receive informal feedback from staff, use these sessions to develop and optimise your project.**

### Deliverables

During the development cycle of the project you will be required to present your work at set intervals in the timetabled lab sessions. These sessions will give you feedback on the project and help you to monitor project

management, adjust the timescales and develop further tasks to be able to deliver the project to the set deadlines. The dates and times of the presentations will be communicated via Blackboard two weeks prior to taking place, these will be:

- Project proposal – You will be required to present, as a group, your proposal for the biometric system. This will include project planning and an outline of the system based off the introductory lab sessions and will take place towards the end of the first term (circa November/December). Provide details of who will be doing what element to meet the deliverables.
- Progress presentation – As a group you will present the progress of the project to date, any amendments to the original project management plan, hardware and software development to date. This will take place sometime **in February**.

The above do not carry any marks and are formative, this does not mean that are not important to attend and contribute towards. The sessions will allow you to focus your project and think about its direction. You will also be given feedback on your proposal and progress and be able to use this to focus and develop your system for higher marks.

### **Submission of work and Progress**

To develop your work and allow active collaboration you are required to use **Microsoft Teams** (or other platforms suitable for BIT). Teams allows you to create a Team, with a suitable group name, that all of your group members have access to. In addition to your group members add the relevant staff to the team's area. This will allow staff to monitor your progress and see your project develop. Microsoft teams is available as part of your Office 365 account provided by UCLan and can be accessed using the following link:

[https://www.uclan.ac.uk/students/library-it/it/office\\_365.php](https://www.uclan.ac.uk/students/library-it/it/office_365.php)

Within the teams area you are free to discuss progress and results as well as create a repository for any data sheets/code/ testing and development, this will contribute to you creating your collaborative group report which will be your final submission.

### **Note on Group work**

You are required to work as a team to develop the project and the system. To this end each group member is required to “pull their weight”, this will be determined by your attendance and by feedback from group members. If you are not engaging with the work then you will be given a “multiplier” that varies from 0-1. The final mark for the group will be multiplied by this to give you a final mark, for example, if your multiplier is 0.5 and the group mark is 80% then your final mark will be 40%. At the start of the project the multiplier is set to 1, if your engagement drops your multiplier will drop, this will be communicated to you, if your engagement increases to a satisfactory level then your multiplier will increase.

**This is implemented as it simply is not fair on working group members when someone who has not contributed to the project gets the same final mark as them.**

The summative (mark carrying) deliverables for the project will consist of the following:

- Interim presentation of the individual group members work. At this session the group and a member of staff will select the most promising system for further development. Please note that elements from other group members can be included in the final product.
- A group presentation of the final project, including the development, justification, and a demonstration of the operation of the hardware and software. This will be approximately 15 minutes, with an



additional 5-10 minutes of questions and take place in the lab timetabled slots. The timetable for the presentations will be published closer to the project deadline and available on Blackboard.

- A detailed report of the projects development. This should be structured into sections. The report is to include project management with detailed work breakdown structures, Gantt charts, timescales, group responsibilities and deadlines with any amendments to the original plan, a detailed description of the development of the system with plans, wiring diagrams, photographs and screen shots to describe the implementation and testing for both the hardware and the software. Introduce the project detailing the biometrics on test, any development of sensor systems and biometric performance levels based on research gathered, referenced using the faculty Harvard referencing system. Provide appropriate appendices such as logbooks of development process within the labs.
- Provide a set of instructions/user guide on how to operate the system to gather meaningful data; include any relevant illustrations and images and include a troubleshooting guide with any problems that the user may have when operating the system and how to overcome these.

Submit the project report, instructions/user guide and the final code for the Mbed/GUI interface in 1 file via your Microsoft Teams area.

#### PREPARATION FOR THE ASSESSMENT

- Preparation for the assessment is given in the labs, these include an introduction to using the MBed platform and project management lectures. You will also be completing formative presentations of your progress and development of the system. This is detailed in the brief above.

#### RELEASE DATES AND HAND IN DEADLINE

**Assessment Release date: 30/10/2020 for BIT**

Assessment Deadline Date and time: 11.59pm 24/03/2021  
(report)  
18/03/2021 (presentation)

**For BIT, report, 15:59 (China time zone), 16/04/2021  
presentation 19/04/2021**

Please note that this is the final time you can submit – not the time to submit!

Your feedback/feed forward and mark for this assessment will be provided within the University's 15 working day policy for feedback. Written feedback will be available on Microsoft Teams on the 14<sup>th</sup> April. You will also receive verbal feedback when presenting your work in the formative and summative assessments.

#### SUBMISSION DETAILS

Submit a single word file containing your report, instruction set and code. This to be uploaded to your Microsoft Teams area **before 11.59pm 24/03/2021**

**Note – Instruction set, code and appendices are not included in the page limit of 25 pages.**

#### HELP AND SUPPORT

- Support for the assessment is provided in the lab sessions. Additional support can be provided by booking a session with the module team via MSTEams (or others)/drop in when available.
- For support with using library resources, please contact Bob Frost [rsfrost@uclan.ac.uk](mailto:rsfrost@uclan.ac.uk) or [SubjectLibrarians@uclan.ac.uk](mailto:SubjectLibrarians@uclan.ac.uk). You will find links to lots of useful resources in the My Library tab on Blackboard.
- If you have not yet made the university aware of any disability, specific learning difficulty, long-term health or mental health condition, please complete a Disclosure Form. The Inclusive Support team will then contact to discuss reasonable adjustments and support relating to any disability. For more information, visit the Inclusive Support site.

- To access mental health and wellbeing support, please complete our [online referral form](#). Alternatively, you can email [wellbeing@uclan.ac.uk](mailto:wellbeing@uclan.ac.uk), call 01772 893020 or visit our [UCLan Wellbeing Service](#) pages for more information.
- If you have any other query or require further support you can contact The <i>, The Student Information and Support Centre. Speak with us for advice on accessing all the University services as well as the Library services. Whatever your query, our expert staff will be able to help and support you. For more information , how to contact us and our opening hours visit [Student Information and Support Centre](#).
- If you have any valid mitigating circumstances that mean you cannot meet an assessment submission deadline and you wish to request an extension, you will need to apply online prior to the deadline.

Disclaimer: The information provided in this assessment brief is correct at time of publication. In the unlikely event that any changes are deemed necessary, they will be communicated clearly via e-mail and a new version of this assessment brief will be circulated.

Version: 1