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CG4002 Embedded System Design Project
AY 2019/2020 Semester 1
Project Specification (Overview)

Welcome to CG4002, the capstone project (aka weekend burning, lab camping, crazy final project) for the CEG programme. This project module is meant to challenge your creativity, knowledge and skills to the extreme, i.e. it is going to be very demanding! Be prepared for head-scratching confusions, wall-banging frustrations, but also jumping-up-and-down eureka moments ahead. You have been warned.☺

For a start, we will give an overview of the project specification. Instead of dumping a whole lot of information on you, this document gives you only an overall picture with limited detail. We will dish out information at the right moment in the upcoming lectures.

There are two sections in this document:

1. Specification overview
2. Timeline of evaluations and milestones

Section 1: Specification Overview

Wearables provide a way for detecting human activity automatically, and have been used in wide-ranging scenarios. Fitness tracking is likely the most prevalent use of activity detection. Using wearables such as smartwatches or fitness trackers, users can monitor their step count, as well as more advanced sports training such as stride and pace for running, strike force for tennis, stance for basketball etc. Activity detection has also been used in medical scenarios, such as detecting falls or anomalous movements that indicate medical conditions. In our daily life, activity detection has been applied to infer our minute-by-minute activities at home, during commute, at work or school, while shopping, exercising, etc.

In this project, the goal is simple – design a wearable device that can detect specific human activities automatically.

To make it more fun, each activity will correspond to a dance move, so you can get a dance workout while working on the project!

Problem Statement:
A wearable system that detects and coaches dance moves of a dance group

Main requirements:

- <u>Three</u> dancers performing the same random <u>dance move</u> shown on the server screen, moving to requested <u>locations relative</u> to each other.

- The device must be a wearable worn on the dancer. All sensing and compute must be done on this wearable. Weight, form factor and comfort are all potential evaluation criteria.

- Wearable automatically detects these dance moves (Check out videos of dance moves on IVLE)

- The wearable should work when worn by anyone and used anywhere (i.e. no infrastructure sensors).

- The wearable should have biometric authentication of each dancer, so that personalized data can be stored and analyzed.

- By performing the specific activities, the wearable detects the dance move and communicates the detected dance move to the class server in a secure manner (The wireless interface with the server will be published)

- Server will indicate random dance moves and relative locations, then the individuals will perform the dance move with the wearable system, and the system will be evaluated to see if it has correctly recognized the specific dance move and locations.

- You should design a final move that will trigger your system to send a "logout" message to the server indicating the end of the dance routine.

- The system must include a power measurement circuit that measures the power consumed by the wearable system. The power consumption must be communicated to the server and will be used as a metric for evaluation.

- The system must include a coaching dashboard that stores the history of dance moves of each dancer, their accuracy, synchronization, so as to provide analytics feedback to dancers. This dashboard can run on your own server or in the cloud, but needs to support secure access.

- Hardware platform:
    - A Raspberry Pi 3 mini computer
    - An Arduino mega board
    - A set of standard sensors
    - $300 per team for additional items

- The system will be evaluated based on performance, power and design. Performance refers to detection accuracy – whether dance moves are detected correctly, and detection speed – how fast each move is detected, measured from when the server displays the specific move to when the message with the detected move is received at the server. Power refers to the power measurement accuracy as well as overall power consumption. Design refers to reliability, aesthetics, comfort, weight, etc.

Total (and scary) Design Freedom:

Most aspects of the project are open:

- Hardware: What kind of sensors will you use to detect each move and differentiate amongst the moves? How will you get useful data from the sensors?

- Hardware: What circuits will you use to measure the power consumed by your system? How will you optimize and design a low-power system?

- Communications: How will you communicate sensed data between different components worn on different parts of your body -- wired/wireless? How will you determine the relative location of the 3 dancers?

- Communications: How will you communicate between your wearable to our server in a secure and reliable manner?

- Software: How will you learn and classify the different moves and handle different individuals, including new dancers?

- Software: How will you analyze the dance data for each individual securely, and what analytics can you provide to coach the dancers?

Section 2: Timeline of evaluations and milestones

The project has the following milestones:

1	**Overall System Design** Design the high-level system architecture. Figure out the interfaces between subsystems. A good design allows each subsystem to be developed and optimized independently.
2	**Individual Subsystems** Develop the subsystems concurrently. By adhering to the designed interfaces, the subsystems should be able to work together in the next phase.
3	**Integrated System** The subsystems are integrated and works as a whole. Fixing integration bugs is the main focus in this phase.
4	**Baseline System** The integrated system is working well and meets the baseline requirements as given below, for a known dancer: 1. Measures power of system 2. Detects the first 5 moves (shown in bold) 3. Communicates the moves to the server securely
5	**Final System** The integrated system works well for the full project specs: When given a sequence of specific dance moves, the dancers performs each move in turn and the system detects

	and communicates the moves to the server. This should work for unseen dancers.

The evaluation timeline follows closely the milestones given above. The criteria of each evaluation will be clarified at the appropriate time. Note that the schedule and evaluation criteria may be adjusted depending on the cohort's progress as a whole.

Week	**Evaluation**
4	**Design Report: (10%)** - Overall system design - High level subsystem design - Independent research describing prior art and explaining proposed design - Submission through IVLE
5	**Progress checkpoint: (5%)** - Feedback on design report - Ensure team is on the path for 1st prototype
7	**Individual subsystem test: (20%)** - Subsystems will be evaluated independently - Criteria will be given
10	**Baseline 5 moves evaluation: (20%)** - Subsystems must be integrated - Based on Baseline requirements as stated in the milestones
11	**Peer Review: (5% + potential grade adjustment)**
13	**Final Demo: (30%)** - Based on Final system requirements as stated in the milestones
13	**Final Report: (10%)** - Detailed description of final design and components - Detailed explanation of final design choices - Submission through IVLE