

CG4002: Computer Engineering Capstone Project

Overview

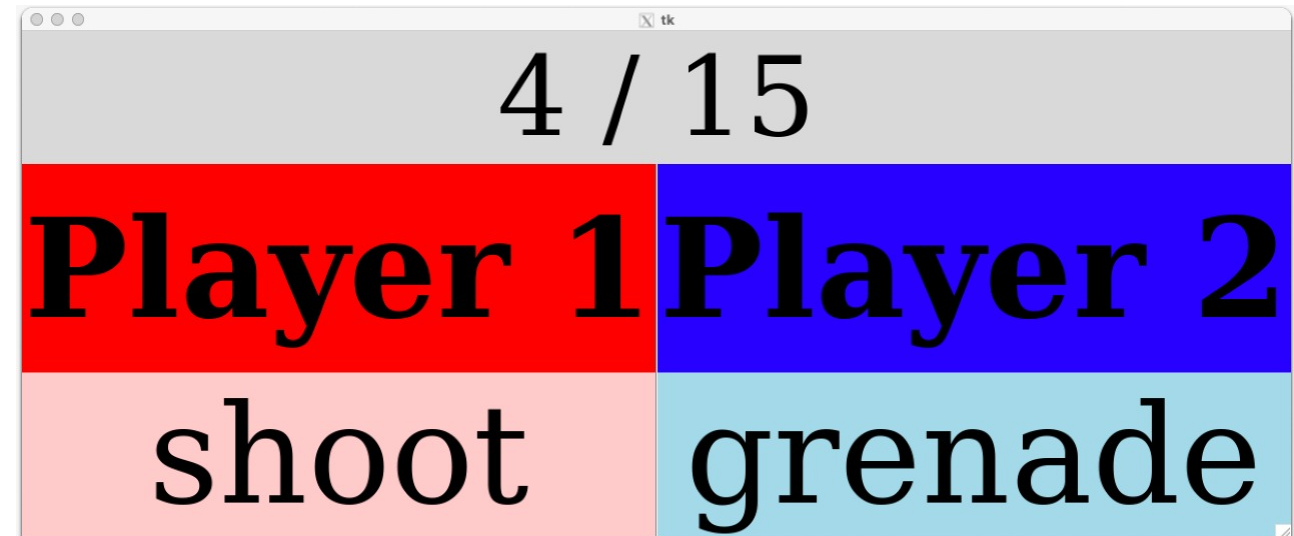
JITHIN VACHERY

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Slides adopted from
Prof. Peh Li Shiuan

Outline

- Course overview
 - Teaching staff
 - Teaching mode
 - Resources
- Project overview
- Timeline



Human Resource

Teaching Staff – The “Human Resource”

Sangit Sasidhar

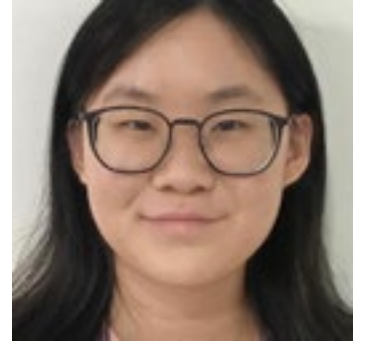
- From ECE
- Oversees the hardware aspects

Jithin Vachery

- From SoC
- Module Coordinator
- Oversees the communications aspects and visualizer

Teaching Staff – The “Human Resource”

- A **go-to TA** for each group
- morning lab:
 - **TBA**
- afternoon lab:
 - **TBA**



- Reach us through Discussion Forum on Canvas so we can “crowd-source” and “crowd-solve” problems

Teaching Mode

Teaching Mode

This is a project module

- Topic lectures will be release online
 - This gives you more time to work
- Labs will be face2face:
 - Makers@SoC
- Evaluations will be hybrid, during lab hours:
 - Group tests face2face
 - Individual evaluation will be mostly online
- Canvas is the one-stop destination for all module related Resources

Project Overview

Module Synopsis

This module exposes students to the development of a **large system from conceptualization to its final implementation.**

It is structured to contain substantial design and development of hardware and software components

- **A culmination of theories and practices learned in several modules:**
 - EPP1 and EPP2
 - Intro Programming, Data Structures, Software Engineering
 - ✓ **Software Track**
 - Programming Devices & Interfaces, Real-time Systems
 - ✓ **Hardware Track**

Module Objective

- **Able to apply hardware and software engineering design principles in specifying, architecting and implementing a complex embedded system**
- **Able to understand team dynamics and successfully manage a reasonably large project**

Motivation - CDIO

- **The CEG degree embodies the CDIO framework**
 - Conceive
 - Design
 - Implement
 - Operate
- **This project aims to be**
 - Challenging
 - Open-ended
 - Solution to a meaningful and real problem.

Motivation – Real-World

- **This project echoes many real-world settings:**
 - You have meaningful design decisions to make
 - You need to learn stuff on your own
 - You need to manage the complexity
 - You are cooperating with others to achieve best results
 - You are competing with other teams to "sell" your product
- **A well-done project of this complexity will look very good on your portfolio**

Motivation – Real-World



*Fitness tracking
on Fitbit*



*Here Maps on
Samsung gear s2*



*Location-based games
on smartwatch*



*Health care
apps on smart
watches*



*Voice recognition
on Huawei glasses*



AR on Google glass

Motivation – Real-World

Research

NUHS embarks on holomedicine research in Singapore, using mixed reality (MR) technology to enhance patient care



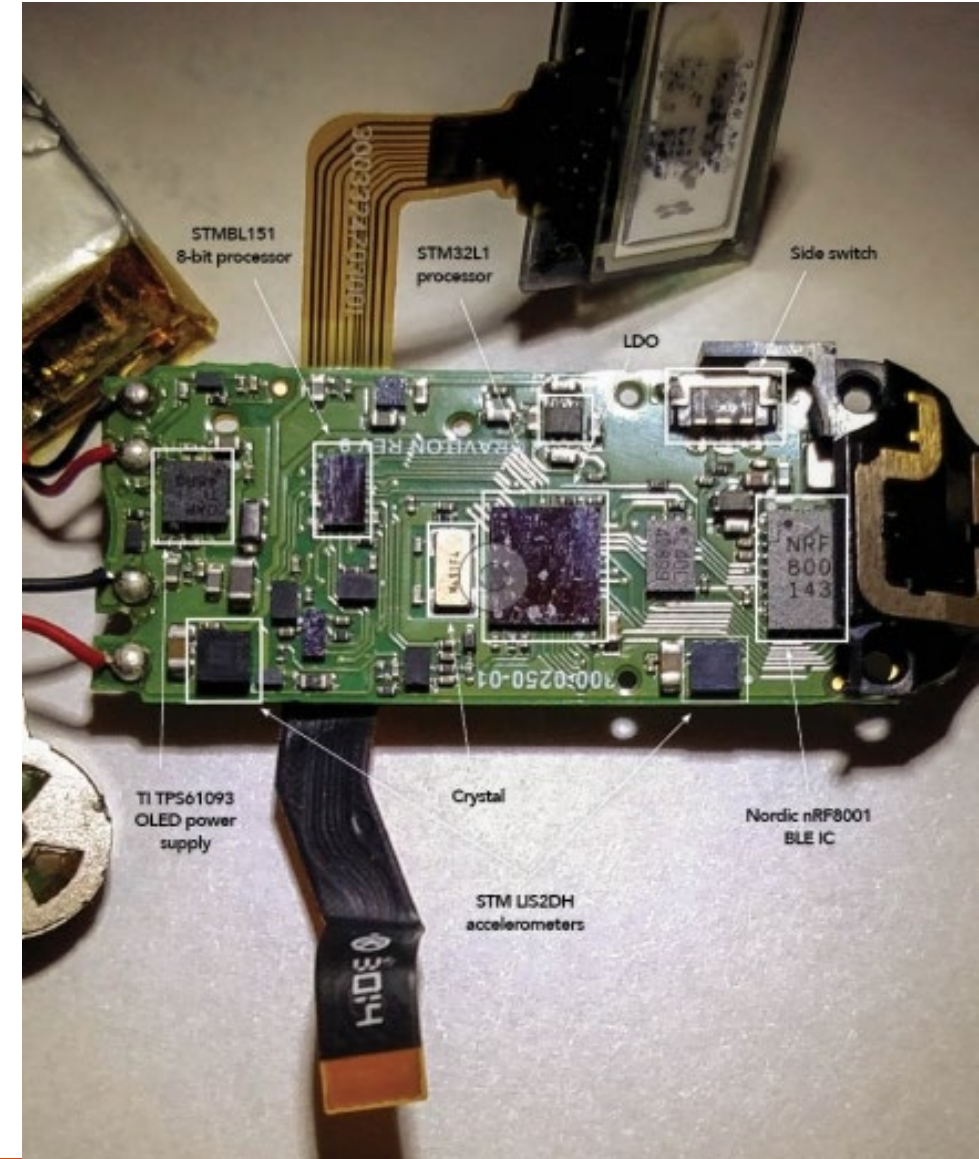
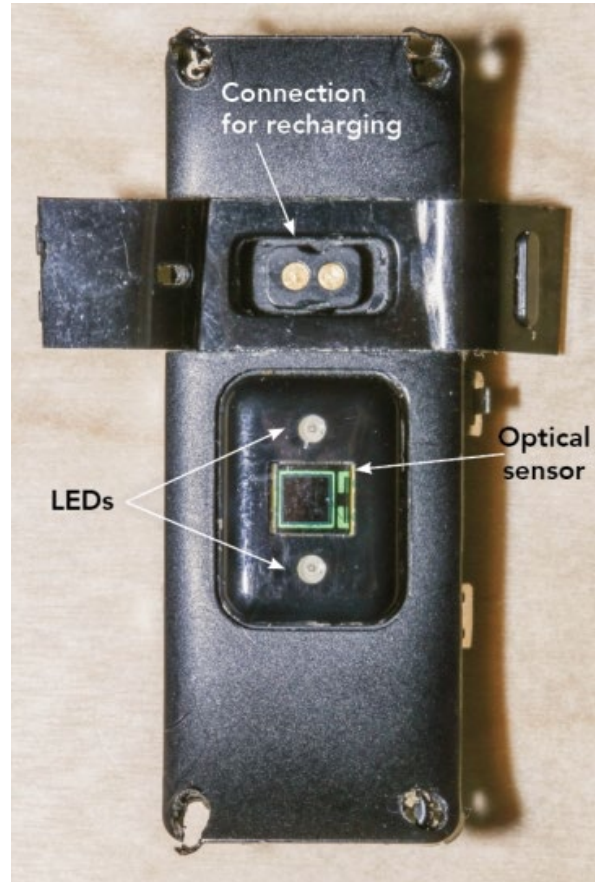
12 August 2021 - This is what happens during a typical brain surgery.

On a computer screen, the surgeon pulls up an image of the patient's brain, taken from an earlier CT scan. This image is an important reference for the surgeon to navigate the far reaches of the brain during an operation – for instance, in search of a tumour.

How does a wearable work (at 10,000 feet)?



Teardown of Fitbit Charge



How does a wearable work (at 10,000 feet)?

- **Hardware:**
 - H/W Sensors:
 - ✓ Sensors (accelerometer, step counter, heart rate sensor) processed by sensor coprocessor
 - H/W AI Accelerators:
 - ✓ Software running on main processor + H/W accelerators
- **Communications:**
 - Comms Internal:
 - ✓ Internal communications between sensor and main processors
 - Comms External:
 - ✓ Communications with your phone/Cloud
- **Software:**
 - S/W Visualizer:
 - ✓ Graphical dashboard on your phone

Problem Statement

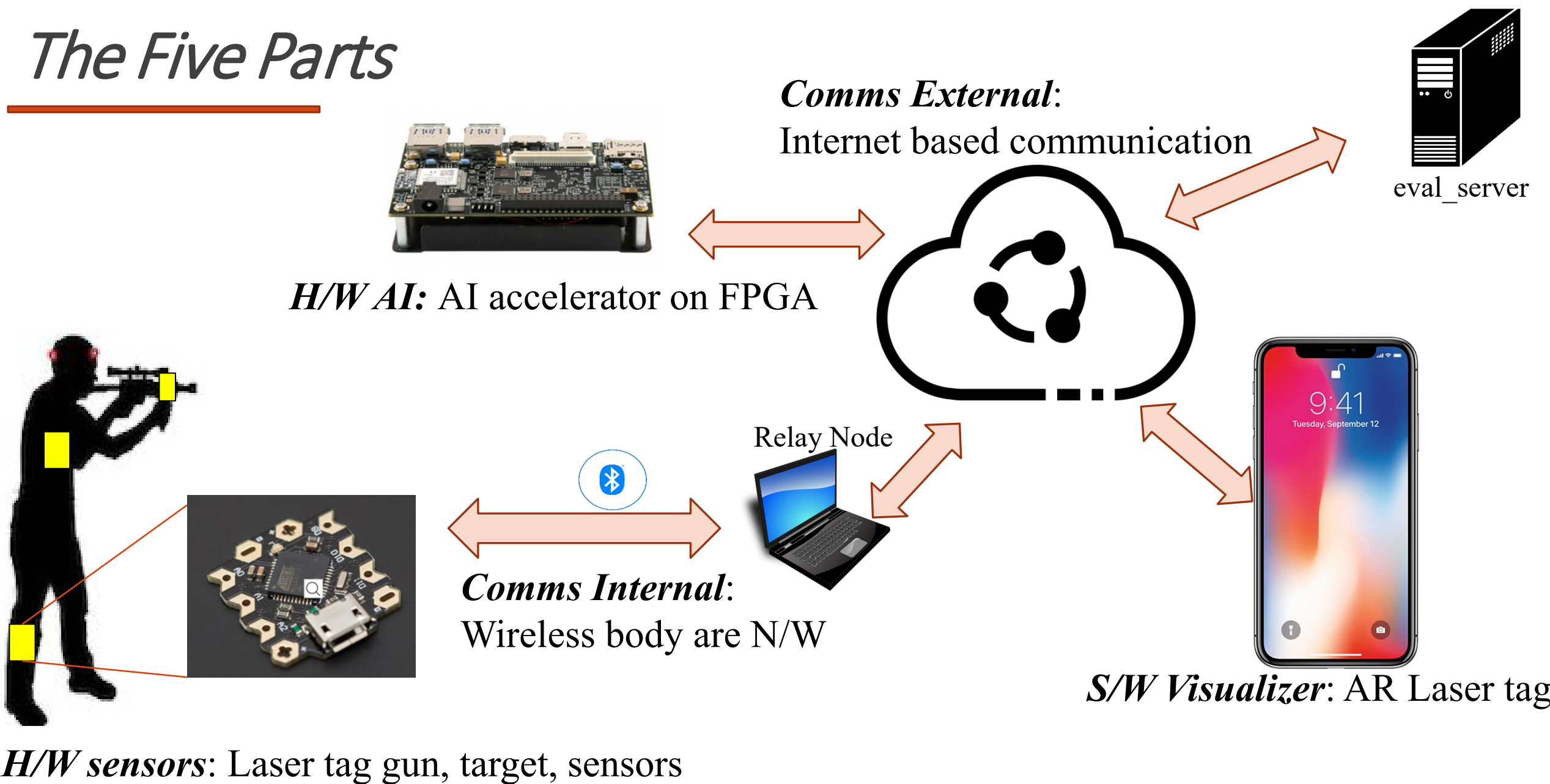
A wearable laser tag game system



CG4002 Project: Laser Tag

- 2 players within 7-10 meters
- Laser tag gun and target wearable
 - *Shoot*: Shoot opponent in line of sight
- Augmented with hand actions
 - *Shield*: Virtual shield blocks shots
 - *Grenade*: Virtual grenade launches
 - *Reload*: Reloads gun with virtual bullets
 - *Logout*: End and leave the game

The Five Parts



Team

- Random grouping of 5 students
 - Mimics real life
 - Teamwork
 - ownership
- Extended team
 - TA
 - Lecturers

Skills Gained

- ***H/W Sensors***: IoTs, phones/wearables for activity sensing, sensors
- ***H/W AI***: AI accelerators, NPUs, TPUs, FPGAs for AI
- ***Comms Internal body-area-network***: Bluetooth low energy, multithreading
- ***Comms External***: Secure socket communications with server, visualizers, concurrency
- ***Software Visualizer***: Front-end design, AR, real-time streaming, Game-engine, concurrency

How does a wearable work (at 10,000 feet)?

- **Hardware:**
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 - H/W AI Accelerators:
 - ✓ **Software running on main processor + H/W accelerators**
- **Communications:**
 - Comms Internal:
 - ✓ **Internal communications between sensor and main processors**
 - Comms External:
 - ✓ **Wireless communications with your phone/Cloud**
- **Software:**
 - S/W Visualizer:
 - ✓ **Graphical dashboard on your phone**
 - ✓ **Central Engine**

- **Hardware:**
 - H/W Sensors:
 - ✓ **Gun, target, actions**
 - H/W AI Accelerators:
 - ✓ **AI algorithms synthesized on Ultra96 FPGA accelerator**
- **Communications:**
 - Comms Internal:
 - ✓ **BLE communication between Arduino Beetle and laptop**
 - Comms External:
 - ✓ **Communication between Laptop, Ultra96, phone and servers over the internet**
- **Software:**
 - S/W Visualizer:
 - ✓ **AR, Game status display.**
 - ✓ **Game Engine**

**CALM DOWN PEOPLE, NOW IS NOT
THE TIME TO PANIC,**



THAT COMES LATER

memegenerator.net

Timeline

Week 2, Team formalization

- Get to know you team
- Divide Components
- Selected a notional leader
- Have Aggressive internal timelines
- Talk to your TA

Week 3 (21 Aug) Initial Design

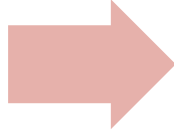
- The main aim of this report is to explain your ideas and designs.
- Make sure the reviewers have enough details to give you feedback and advice.
- The report will be assessed based on:
 - Quality of information.
 - Quality of design: Clearly thought out, Feasible, Easy to manage etc.

Week 6, Full Subsystem Check

- Individual components are fully functional
- All the synchronizations are handled
- Integration with Dummy Data/signals complete

Week 9, 1-Player Game

- System fully integrated
- Relatively simple testing
- Has scope of improvement
- Random Player



Week 12, 2-Player Game

- System ready to carry out a 2-player game
- Simple Arena
- Choreographed move
- Random Players



Week 13, 2-Player Game with unseen players

- System ready to carry out a 2-player unrestricted game
- Open Arena
- Random Players from different team/TA

Game Quality

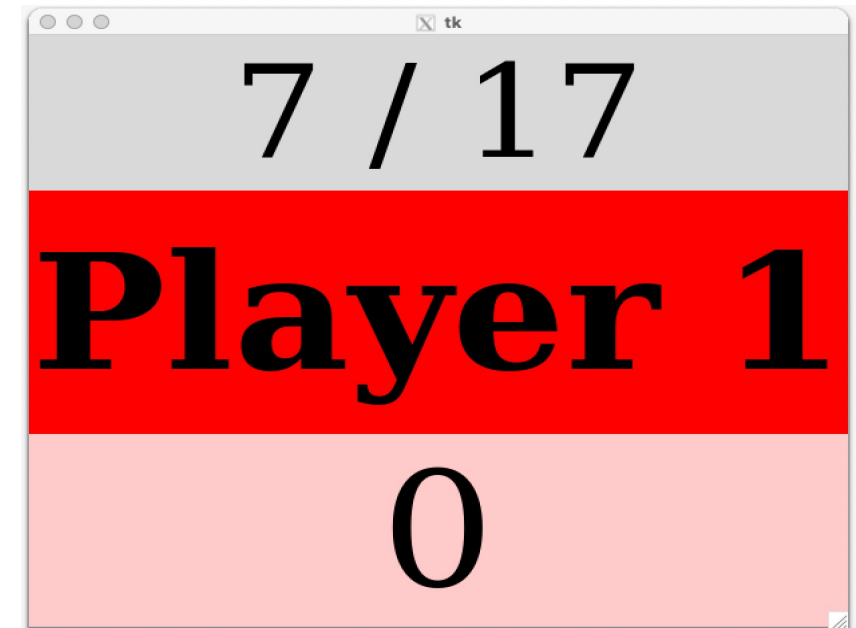
Metrics

- Correctness
- Response Time
- Consistency
- Resilience
- User Experience
- Form Factor

1-Player Game

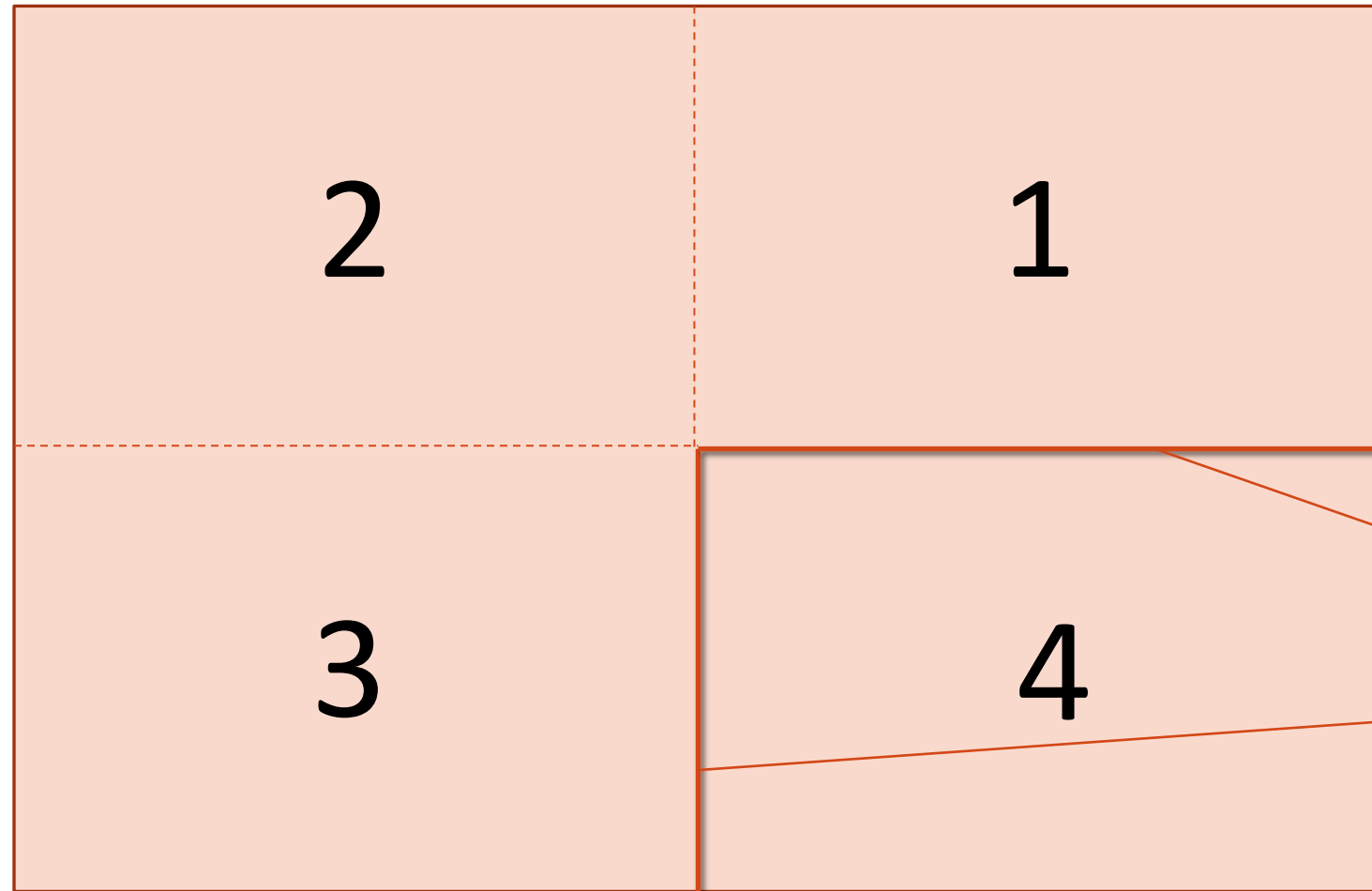
Evaluation

- Any one from the team selected as player
- Player will
 - Wear the sensor
 - Have gun
- Vest, will be registered as player 2
 - Will be kept at a distance from the player
- Visualizer to be streamed on Projector
- Screen recording to be submitted



2-Player Game

Arena



Physical Barrier

Evaluation

- Any two players from the team randomly selected
- Players will be fully geared
- Choreographed sparring.
- Visualizer to be streamed on Projector
- Screen recording to be submitted



A screenshot of a Tk window titled 'tk' showing a 2x2 grid. The top row contains 'Player 1' on a red background and 'Player 2' on a blue background. The bottom row contains '3' on a light pink background and '1' on a light blue background. The score '9 / 15' is displayed in the top header area.

9 / 15	
Player 1	Player 2
3	1



A screenshot of a Tk window titled 'tk' showing a 2x2 grid. The top row contains 'Player 1' on a red background and 'Player 2' on a blue background. The bottom row contains 'shoot' on a light pink background and 'grenade' on a light blue background. The score '4 / 15' is displayed in the top header area.

4 / 15	
Player 1	Player 2
shoot	grenade

Evaluation Server Communication With Game Engine

JSON Received P1:

```
{'hp': 4,  
'action': 'none',  
'bullets': 3,  
'grenades': 17,  
'shield_time': 3,  
'shield_health': 1,  
'num_deaths': 22,  
'num_shield': 12}
```

JSON Expected P1:

```
{'hp': 4,  
'action': 'shoot',  
'bullets': 3,  
'grenades': 1,  
'shield_time': 3,  
'shield_health': 10,  
'num_deaths': 2,  
'num_shield': 1}
```

Design Report

Design Report

- **Section 1:** System Functionalities
 - Describe the intended system functionalities.
- **Section 2:** Overall System Architecture
 - High-level system architecture of the intended system, components, form factor etc
- **Section 3:** Hardware Sensors
- **Section 4:** Hardware AI
- **Section 5:** Internal Communications
- **Section 6:** External Communications
- **Section 7:** Software Visualizer and Game Engine
- **Section 8:** Project Management Plan <Only in Initial Design Report>
 - Timeline, internal deliverables
- **Section 9:** Societal and Ethical Impact <Only for Final Report>

Game Rules

Rules

- Health Point
 - Player: 100 HP.
 - Shield: 30 HP/10 Sec
- Damage
 - Bullet: 10 HP
 - Grenade: 30 HP

Rules

- Ammo and constraints
 - Unlimited magazines
 - 6 bullets per magazine
 - Reload can be performed only if the magazine is empty
 - 2 grenades per life
 - 3 shields per lifetime
 - Cannot activate shield within 10 sec of previous activation, even if 0-HP
- Delays
 - Grenade impact has 2 Sec delay on Visualizer
 - Rebirth is instantaneous

Grading

Assessment

This is a 100% CA module

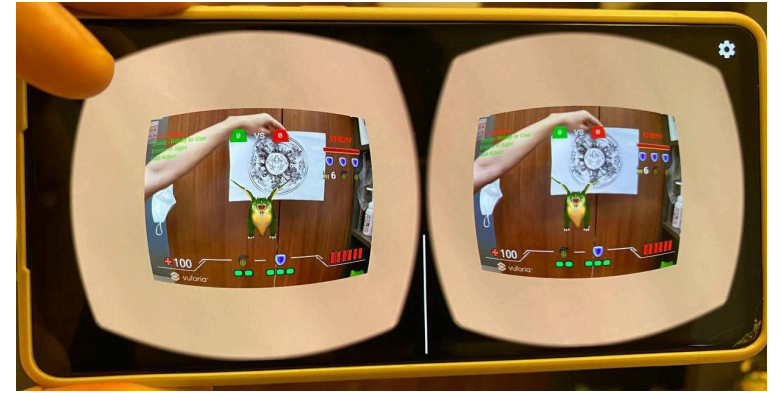
- There is no midterm test nor final exam
- There are multiple check points along the way
- Consistency is critical for a good grade

This is a group project

- Individual assessments
- Group tests
- Peer review

Assessment

Week	Evaluation	Weight
3	Initial design report	3+2
5	Individual progress checkpoint 1	5
6	Individual component test	20
8	Individual progress checkpoint 2	5
9	Peer review	-
9	1-player Game	15
12	2-player Game	30
13	2-player Game with unseen players	10
13	Final design report	10



Covid

Evaluation

- Your team should be ready to work with available members
- Automate all the scripts and setup to avoid panic
- Have your code on Git

