Project Handover Document

**Company: Redback Operations**

**Project: Posture Analysis**

*Trimester 3, 2022*

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# Project Information

## Company Acting Director

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## Project Team

**Project Name: Posture Analysis**

**Team members:** Andrew Mayes, Adrian Grigo, Quintin Xu and Mark Telley.

# Project Overview

The posture of a bike user influences several variables, indirectly and directly. Moreover, posture can be used as a qualitatively (indirectly) particularly when accessing the bike user’s energy levels i.e., if you see a competitor in complete control of their breathing and posture you could assume the competitor is ‘in control,’ or they could be bluffing – controlling posture can provide a competitive psychological edge particularly in a racing environment. Posture also directly impacts performance metrics such as speed and power i.e., When riding at speed (>40kph) on a flat surface or descending a hill, the posture into those circumstances plays directly into aerodynamics. Therefore, being able to analysis a user’s posture during the in-game experience will allow a more realistic simulation of actual outdoor cycling by rewarding good posture and penalising poor posture based on the specific circumstance. Features like this will continue to innovate Redback Operation’s product developing efforts.

The project is divided into two different sub working streams during this trimester to:

1. Build some ML models from scratch with some captured cycling video frames in the Riot lab to classify different cycling pose types.
2. Quickly deliver an MVP prototype webapp using a pre-trained model to detect cyclists’ poses in real time, send human body key points to the 3D cycling game via MQTT and further reflect the movements on an 3D model in the 3D game.

# User Manual

A brief overview and usage guide for the “Pose Detection webapp” can be found here: <https://github.com/redbackoperations/data-analysis/blob/main/Trimester%203%202022/Project%204%20Posture%20Analysis/pose-detection-webapp/README.md>. This webapp can be either used as a standalone application to detect human body’s movements or coordinated with the 3D cycling game to indicate a competitor cyclist’s movements in the game. A quick demo about how to use this webapp can be found here: <https://www.loom.com/share/5319affcb4714b4a9cbfc89ce7a15ee9>

(or [Redback Operations - Pose Detection & Estimation - 14 December 2022.mp4)](https://deakin365.sharepoint.com/:v:/s/RedbackOperations9/EdKDZea1-y5IpZDrw8nhhsoBhF9zXvy1uv3zKBe0yoSKNg?e=7xJ9NK)

An overview of the “pose detection and analysis model” can be found below:

* Video – [Click Here](https://www.youtube.com/watch?v=cebjjlkxeOA)
* Readme – [Click Here](https://github.com/amaye15/data-analysis/tree/main/Trimester%203%202022/Project%204%20Posture%20Analysis/Andrew)

# Completed Deliverables

1. An initial Posture Analysis research report: <https://github.com/redbackoperations/data-analysis/blob/main/Trimester%203%202022/Project%204%20Posture%20Analysis/Posture%20Details/Redback%20Operations%20Posture%20Details.pdf>
2. More than 10min video frames captured in the lab to denote different typical cycling poses ([poses reference)](https://www.velonews.com/gear/study-froomes-super-tuck-actually-isnt-faster):) <https://deakin365-my.sharepoint.com/:u:/g/personal/agrigo_deakin_edu_au/EWS-6KRbPZZHrVV2Bcm1WScBhi-Dsq6KrLgcL2YuVtRf2w>, which can be used as training/testing/validation datasets for building ML models.
3. Get a working “pose detection” web application running under the company GCP account’s VM instance:
   1. Github link: <https://github.com/redbackoperations/data-analysis/tree/main/Trimester%203%202022/Project%204%20Posture%20Analysis/pose-detection-webapp>
   2. The webapp can be accessed at: <http://34.129.10.237:3003/> (username: `admin`, password: `redback`)
      1. The app integrates with a pre-trained pose detection model (“BlazePose” model).
      2. By enabling the webcam, the app can detect body movements in real time and send the predicted 3D key points to a MQTT topic.
      3. The published key points messages can be leveraged in the 3D cycling game to timely indicate another player’s movements.
4. Pose Detection & Analysis Model:
5. Code – [Click Here](https://colab.research.google.com/drive/1Et1kxQC3OpryUeQ09RE5oj5-Xh2U8dZm)
6. Models
7. Prototype
   1. Normal Pose Video – [Click Here](https://www.youtube.com/watch?v=bwq7a58RRRQ)
   2. Aero Pose Video – [Click Here](https://www.youtube.com/watch?v=o7ViRmn7PLI)

# Roadmap

List of features to be completed in the future:

1. Let the 3D cycling game have a proper rigged 3D human model that reflecting a cyclist player’s movements in real time using the received key points MQTT messages sent from the “Pose Detection” webapp.
2. Optimise the “Pose Detection” webapp’s running performance and UI layouts.
3. Implement more custom ML models to predict for different cycling poses using those already captured video frames from this term.
4. Production ready environment for “pose detection & analysis model”

# Open Issues

* Setup a company domain and HTTPs connection for the “Pose Detection” webapp.
  + Due to the security restriction from modern browsers, to enable the webcam in a browser, however, a request connection must be from HTTPS or localhost.
  + To by-pass the limitation, currently, we have to add the remote IP address (http://34.129.10.237:3003) as a "secured origin connection" in the browser settings.

# Lessons Learned

The “Posture Analysis” problem is much more difficult to implement than we’ve originally thought. We should have a clearer defined scope at the beginning for this project to tackle a more specific real-world problem, like classifying different cycling poses, so the underlying ML model will be only about a multiclass classification problem rather than a powerful human body move detection model that we have to bring in a pre-trained model in the end to get some working prototype delivered this term.

# Product Development Life Cycle

We work as a team and focus on delivering measurable values to the project and the company.

We have 3 daily stand-ups each week (start/mid/end of a week’s meeting) to sync the working progress between different team members. We discuss any issues and potential extra works we need to do for the project during the stand-ups. We’ve also had lots of ad-hoc chats in Teams app whenever we need a quick discussion.

We plan tasks in the [Trello board](https://trello.com/b/NSuF3z83/data-analytics) and indicate our progress from there. We create PRs frequently and get them merged timely by the team lead.

## New Tasks

We come up with new tasks along the way while we are working on existing planned tasks or from each stand-up meeting time. Any new tasks will be created in the [Trello board.](https://trello.com/b/NSuF3z83/data-analytics)

## Definition of Done

A DoD list is normally clearly defined in each Trello card, so the card assignee will be able to know exactly when a task is treated as completed by meeting all the DoD items. Additionally, we also have different status labels on each task on the Trello board to indicate their completeness.

## Task Review

Since only the team lead has the permission to merge a PR in GitHub, a task is treated as done when its associated PR is reviewed and merged by the team lead.

## Testing

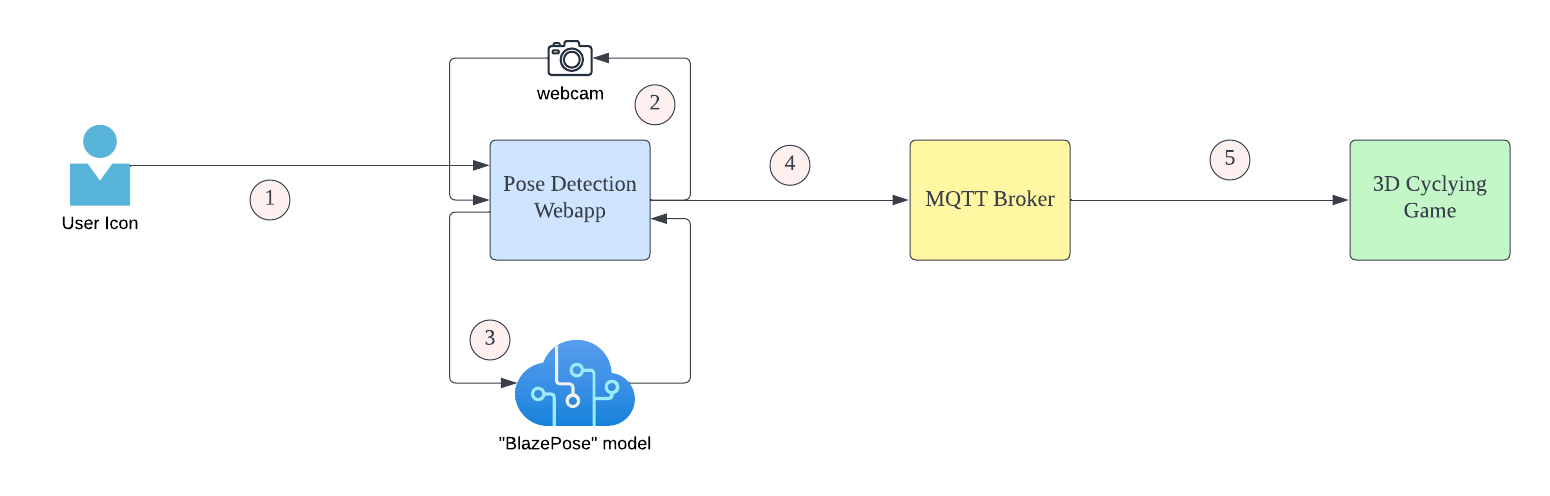
We test this project merely using manual testing due to the intense time limit this term. While we doing a manual test for a task, we ensure all DoDs are met before marking it to be done.

## Branching Strategy

We never directly push any changes into the company’s `main` branch. To make any changes, we either create a new branch based off the latest `main` branch or fork the company’s `main` branch into our own repo. After we’ve finished the changes, we create a PR against the company’s `main` branch, and have it reviewed and merged by the team lead. We also ensure to resolve conflicts (if there’s any) before merging back to the latest `main` branch.

# Product Architecture

## UML Diagram



## Tech Stack

1. ReactJS: a frontend library to easily implement the “Pose Detection” webapp.
2. MQTT.js with web socket: a MQTT client-side library to send MQTT messages via web socket in modern browsers to a MQTT broker.
3. Hive MQTT broker: the used MQTT broker to be able to receive MQTT messages and propagate them to the downstream subscribers (e.g., the 3D game in this project)
4. Docker: the container tool to easily build and deploy webapps to cloud.
5. Nginx: a web server to be used a front-tier guard for the basic user authentication.
6. GCP -> Compute Engine -> VM instance service: the cloud service to serve the web application publicly.
7. Any webcam connected/embedded to the hardware device: the core hardware to detect a human body’s movements in real time.
8. Unity: the game dev platform to implement the 3D cycling game.
9. Python: Programming language widely used in data science.
10. Google Colab: A popular python REPL hosted by google.

# Source Code

* [Pose Detection Webapp](https://github.com/redbackoperations/data-analysis/tree/main/Trimester%203%202022/Project%204%20Posture%20Analysis/pose-detection-webapp)
* [Pose Detection & Analysis Model](https://github.com/amaye15/data-analysis/tree/main/Trimester%203%202022/Project%204%20Posture%20Analysis/Andrew)

# Login Credentials

* To access to the “Pose Detection” webapp at <http://34.129.10.237:3003/>, you’ll need the following creds:
  + username: `admin`
  + password: `redback`
* To access the company’s GCP account: <https://console.cloud.google.com/welcome?project=sit-22t2-redback-infra-612f89e>, you should use your own student email account from Deakin University.
* Redback Operations Youtube Channel:
  + Email - redback.operations.deakin@gmail.com
  + Password - Kucri\*a!r&pA$r4tr&s?awRavUq0cE

# Other Relevant Information

* The “Pose Detection” webapp is currently deployed onto the company owned GCP account’s [VM instance](https://console.cloud.google.com/compute/instancesDetail/zones/australia-southeast2-a/instances/iot-team-instance-1?authuser=1&project=sit-22t2-redback-infra-612f89e) and running as a docker container, the corresponding docker image can be found [here](https://console.cloud.google.com/gcr/images/sit-22t2-redback-infra-612f89e/asia/pose-detection-webapp?authuser=1&project=sit-22t2-redback-infra-612f89e).
* For more details about how to deploy a containerised webapp to GCP, you can refer to this doc: <https://github.com/redbackoperations/iot/blob/main/docs/iot-web-services-deploy-guide.md>

# Appendices

* Trello Board: <https://trello.com/b/NSuF3z83/data-analytics>
* All completed tasks/documents from T3 2022 can be found here: <https://github.com/redbackoperations/data-analysis/tree/main/Trimester%203%202022>