ECEN425 Assignment 2 – Technical Report

Form Tracking – *CableSense*

Introduction

This report covers the specifics of how CableSense will enable and drive its form tracking and spotting features. The techniques that will form the basis of the features, the data that will be collected and outlining how it will/can be processed. To support this feature tracking goals and technique are considered, solution/approaches for both pose tracking and performance monitoring and their supporting components and design considerations.

1. Form Tracking and Spotting

The form correction system is responsible for analysing the user's body position during exercises. This includes the cameras, wearable tracking tech and data from the resistance system. This feature will be available for loaded preset exercise routines and provide immediate corrective feedback to the user about stance and form to better their exercise, as well as collecting performance data for progress summary and tracking.

2. Pose Tracking Wearables

At first, we investigated the possibility of AI-assisted computer vision pose tracking techniques such as BlazePose [1]. However, though these techniques are maturing they are still in the realm of research and require desktop-grade CPU's and GPU's to enable any usable realtime use. This is outside of the products constraints so was shelved for now.

As a replacement technique, compression-style wearables with **Fiducial Marker-based** tracking patterns (various options/varieties available) can be included and tracked via 2 cameras positioned within the frame. There a variety of standards with OpenCV libraries and integration [2] (figure 1a).

Less complex 'keystone' marks are to be included on the machine frame within view of the camera for an automated (user free) calibration set up to map the volume. These 2D barcode style markers (figure 1b, April tags) allow for full 3D space tracking.

2.1 Tracking Tags

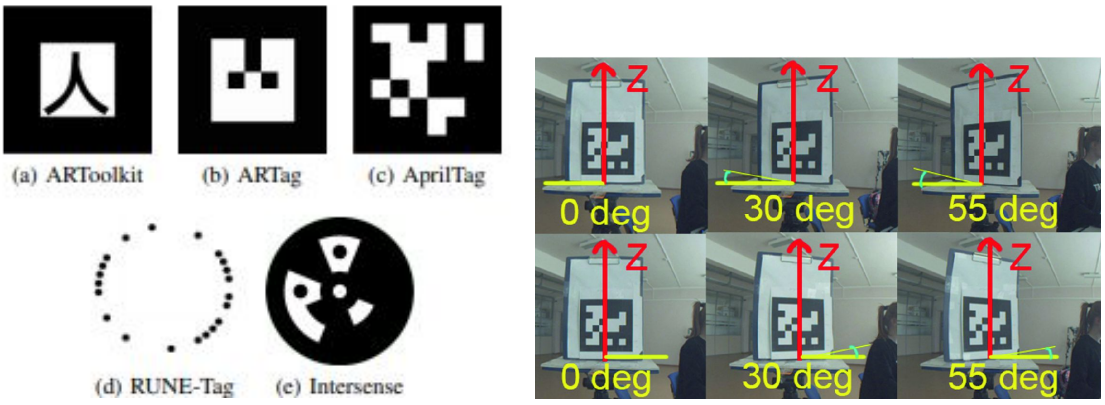

Figure 1(ab): Options and Example usage of markers

2.2 Camera

Full-colour cameras are not necessary and the short distance (<2m) from the sensor to target reduces the spatial resolution requirements such that a simple USB interfaced mono 2MP max camera module is more than sufficient to track the targets.

3. Cable Monitoring

Track the ongoing performance of the user as well as their form, for progress and feedback and for input in the spotter function.

To monitor the user's physical performance, rotary encoder data can be read from the cable reel and compared to preset expectations.

- Position, speed and acceleration of cable runout/retraction
- Position tracked via high accuracy rotary encoders on BLDC motors (required and integrated with for Odrive see *Power System and Motor Resistance*)
- Collect time series data and derived time series (pos, vel, acc) compared with expected curves for set exercise routines and feedback progress, performance, and feedback based on error.

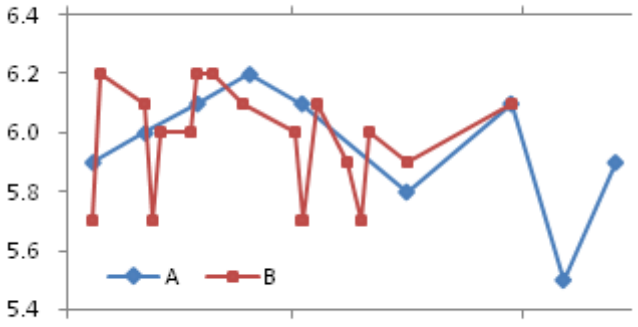

Figure 2: Illustrative of mismatch between expected and actual performance

BOM

#Qnty	#Qnty	Cost (ex GST) / each
OV9726 USB Camera Module 1MP 74 Degree Lens Board	2	5.21 NZD
Rotary encoders - CUI AMT102-V	4	30.01746 NZD (min 500)
Estimated wearable wholesale cost	Assume bulk purchase from eg china: 3-10 NZD manufacturing cost per item 15 NZD international shipping *ref: sewport 2020*	

References

[1] https://ai.googleblog.com/2020/08/on-device-real-time-body-pose-tracking.html
[2] https://april.eecs.umich.edu/software/apriltag