APP SUPPORTING STRENGTH SPORTS TRAINING

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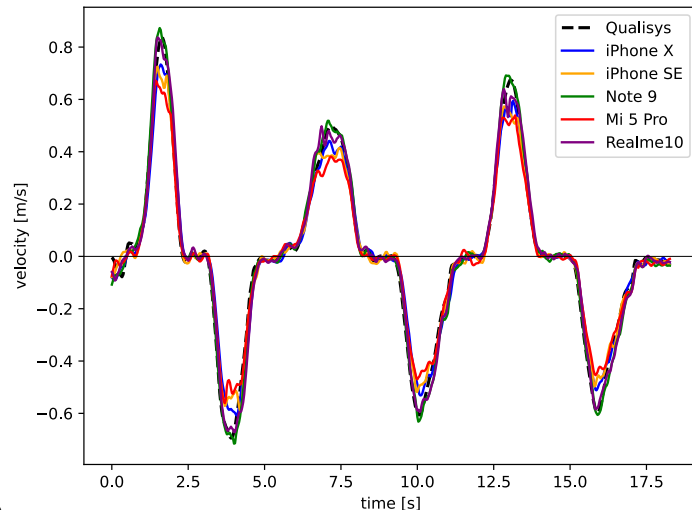Faculty of Information Technology

1. MOTIVATION

Strength athletes lack practical tools for analyzing movement dynamics, which is crucial for optimizing training programs [2]. Existing solutions require **cumbersome hardware** or **expensive**, non-portable systems, while available mobile apps demand specific camera angles, making them **impractical in public gyms**. There is a **need for an accessible, flexible solution** that delivers objective feedback without high costs or restrictive requirements. Those issues were addressed.
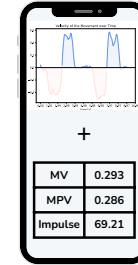
2. ARCHITECTURE

CLIENT — API — SERVER

ESTIMATE KEYPOINTS — RTMDET + RTMPOSE [1]

SMOOTHENING — KALMAN FILTER [3]

VELOCITY
$$v = ms^{-1}$$

METRICS

- MV $\quad V_{\mathrm{m}} = \frac{1}{n} \sum_{i=1}^{n} \frac{d_i}{\Delta t}$

- MPV $\quad V_{\mathrm{mp}} = \frac{1}{m} \sum_{i=1}^{m} \frac{d_i}{\Delta t}$

- IMPULSE $\quad I = \int_{t_1}^{t_2} F(t)\,dt$

MV	0.293
MPV	0.286
Impulse	69.21

3. EXPERIMENTS AND EVALUATION

An evaluation using multiple mobile devices (multiple brands) was performed. The evaluation was conducted using the Qualisys system on CESA VUT. The velocity graph of the deadlift exercise (three controlled repetitions) can be seen below on the left. The **professional Qualisys system** used for the evaluation can be seen on the right.
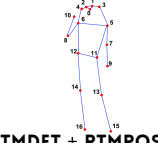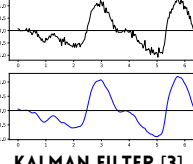

4. USAGE AND FUTURE

The solution provides **objective, quantitative insights** into athlete performance through velocity-based metrics. It is implemented for strength sports like weightlifting and powerlifting but it **can be adapted for calisthenics and more**. The solution **requires no specific camera positioning**, and **weight plates can be entirely out of view**, enhancing its practicality. Future developments include running the model inference on edge devices for better scaling and privacy. Additionally, the solution holds **potential for rehabilitation and medical use**, allowing physiotherapists to monitor patients, create rehabilitation programs, or establish entirely home-based rehabilitation use cases.

[1] Jiang, T., Lu, P., Zhang, L., Ma, N., Han, R. et al. RTMPose: Real-Time Multi-Person Pose Estimation based on MMPose. 2023
[2] González Badillo, L. Movement Velocity as a Measure of Loading Intensity in Resistance Training. Int J Sports Med. Apr 2010, vol. 31, no. 05, p. 347–352
[3] Jurić, D. Object Tracking: Kalman Filter with Ease. January 2015. Available at: https://www.codeproject.com/Articles/865935/Object-Tracking-Kalman-Filter-with-Ease