T309: A Computer Vision Approach for Sprinter Optimization

FAMU-FSU Engineering

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Background

The goal of this project is to develop a system to analyze a sprinter's technique to improve their performance. In a short sprint, the difference between winning and losing a race is a fraction of second, and any slight change in technique may drastically change the outcome.

Scope

- Distance: 100m
- Athlete: Collegiate
- Technique: Stride length and stride frequency

System Set Up

- GoPro Hero 8 (120fps at 2.7k)
- Markers

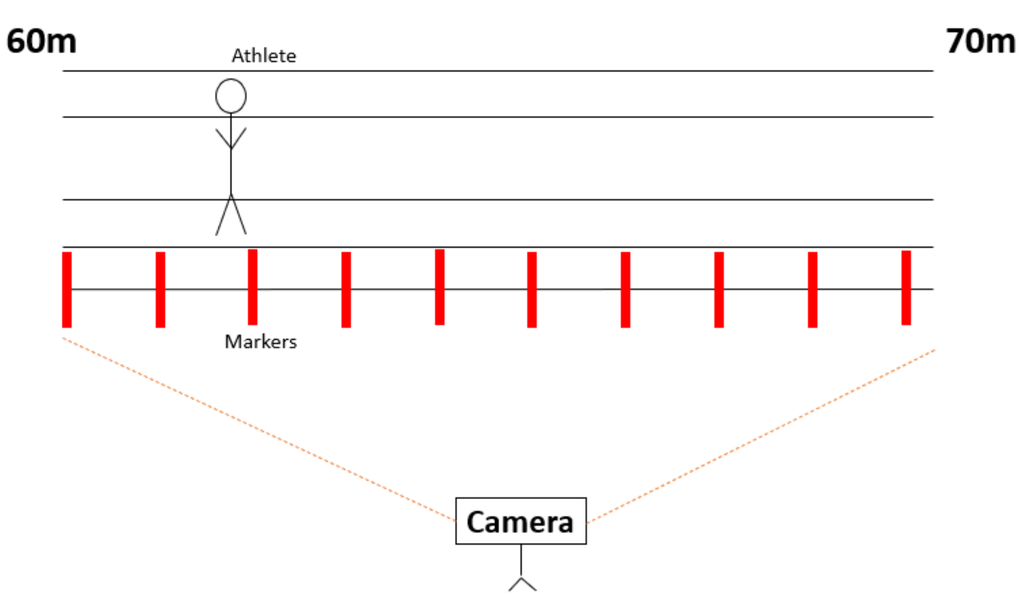

Figure 1: System set up with camera capturing 10m of the sprint

Video Transfer

- Use bluetooth for quick data transfer
- SD card if too slow

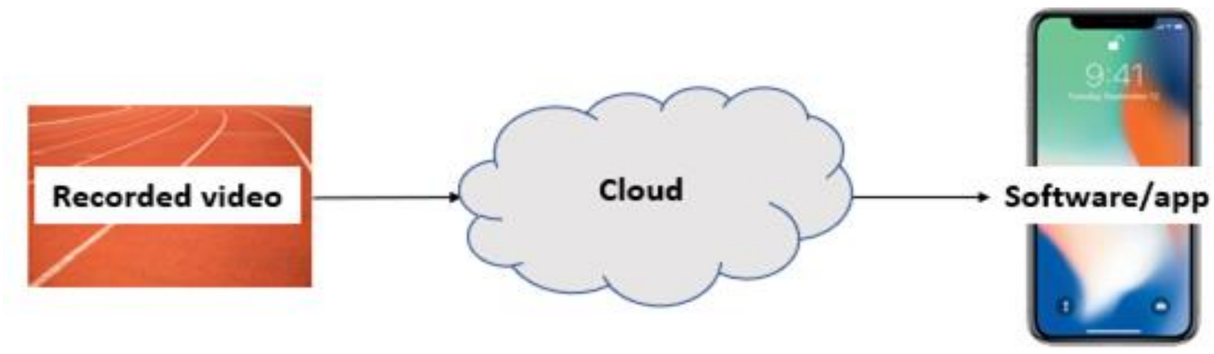

Figure 2: Video/data transfer concept

User Interface

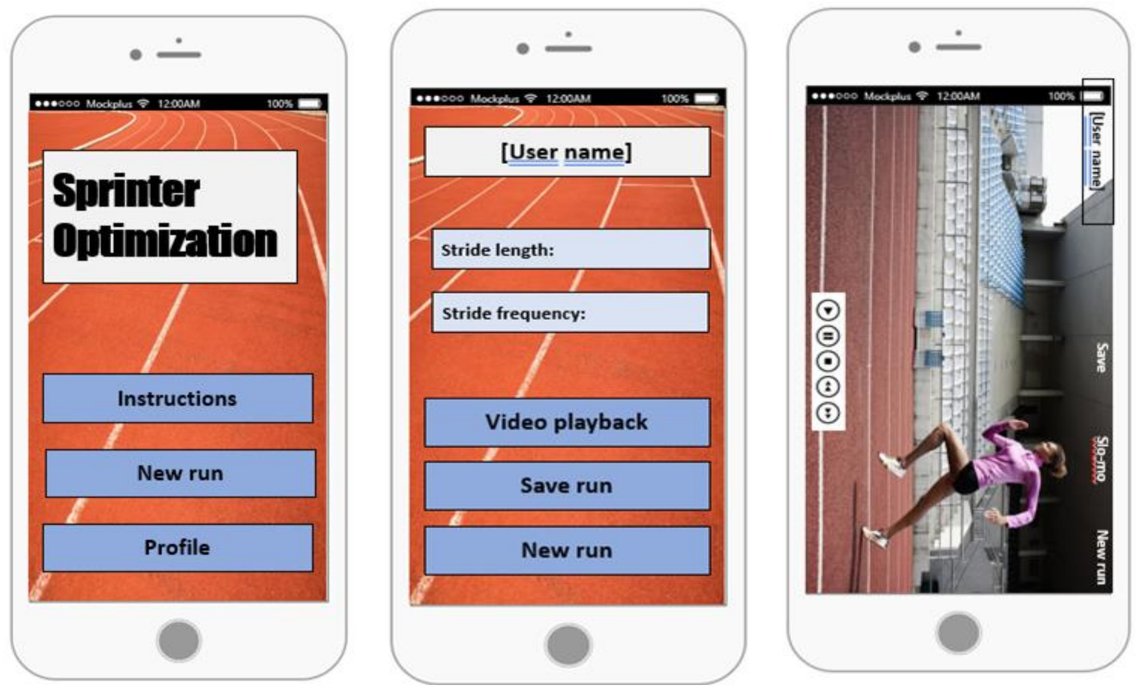

Figure 3: Different user interfaces on the app

Data Collection

- Shoe Extraction

Algorithm 1 Mat Extraction Algorithm

```
procedure MAT–EXTRACTION
    Crop frame of mat video
    Perform histogram equalization operation
    Remove noise using Gaussian Filter
    Convert frame to binary image
    Use Canny operator to extract edges of markers
    Count the number of markers
    Exclude unpaired markers
    Connect paired markers with a line of best fit
end procedure
```

- Track detection

Algorithm 2 Shoe Detection Algorithm

```
procedure SHOE DETECTION
    Crop frame of walking video
    Detect edges using modified Canny operator
    Use edge traversing to find edges belonging to shoe
    while largest gap between edges > ϵ do
        Lower edge detecting threshold for operator
        Detect edges using modified Canny operator
        Use edge traversing to find edges
    end while
    Interpolate edges to get the closed contour
end procedure
```

- Stride Length

Algorithm 3 Stride Length Estimation Algorithm

```
procedure STRIDE LENGTH ESTIMATION
    Find stationary frames
    Find front point on shoe contour
    Convert from pixels to cm using mapping function
    Estimate stride length
end procedure
```

- Stride Frequency

$$stride\ frequency = \frac{distance\ x\ frames\ per\ second}{number\ of\ frames\ x\ stride\ length}$$

References

1. https://smcnus.comp.nus.edu.sg/wp-content/uploads/2013/09/Zhu2016.pdf
2. https://commons.nmu.edu/cgi/viewcontent.cgi?article=1517&context=isbs

Discussion

Our design consists of a camera to record the sprints and an app on the users smartphone. We will use the OpenCV library in Python to analyze the recording and determine the stride length and frequency.