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# TRAINIT:

## DETECTION AND CLASSIFICATION OF WRONG PLAYED STROKES IN TABLE TENNIS.


**GROUP MEMBERS:**

HABIBA HEGAZY, MOHAMED ABDELSALAM, MOUSTAFA HUSSIEN AND SEIF ELMOSALAMY

**SUPERVISED BY:**

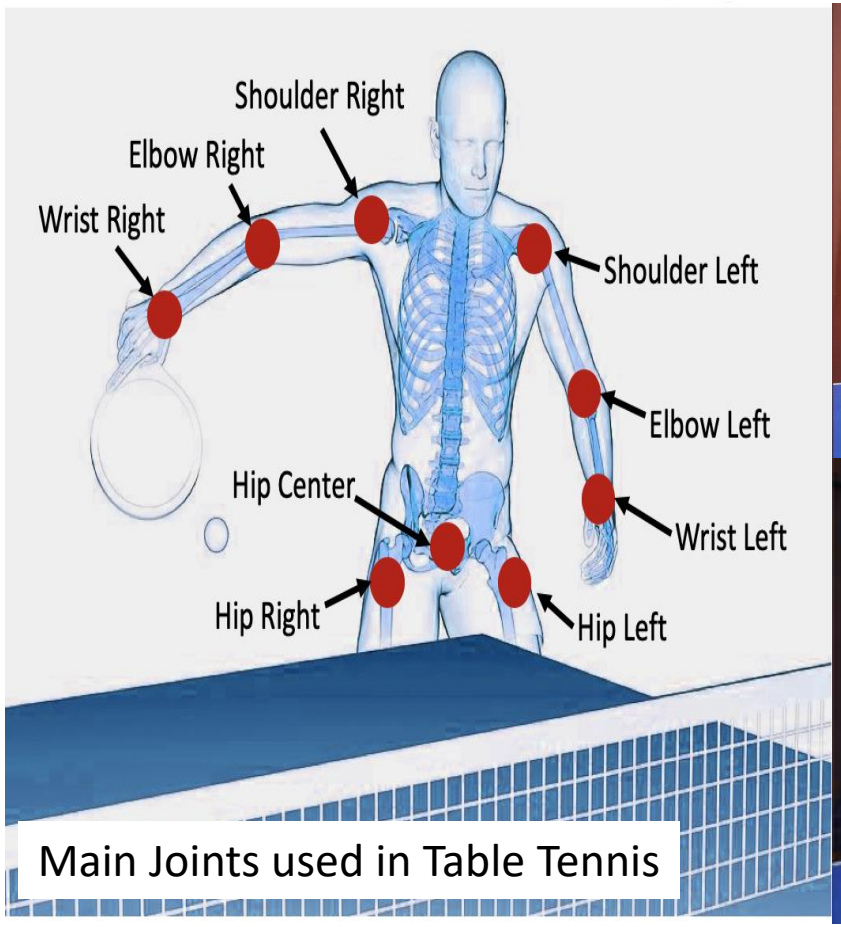
DR. AYMAN EZZAT, DR AYMAN NABIL

**TEACHING ASSISTANT:**

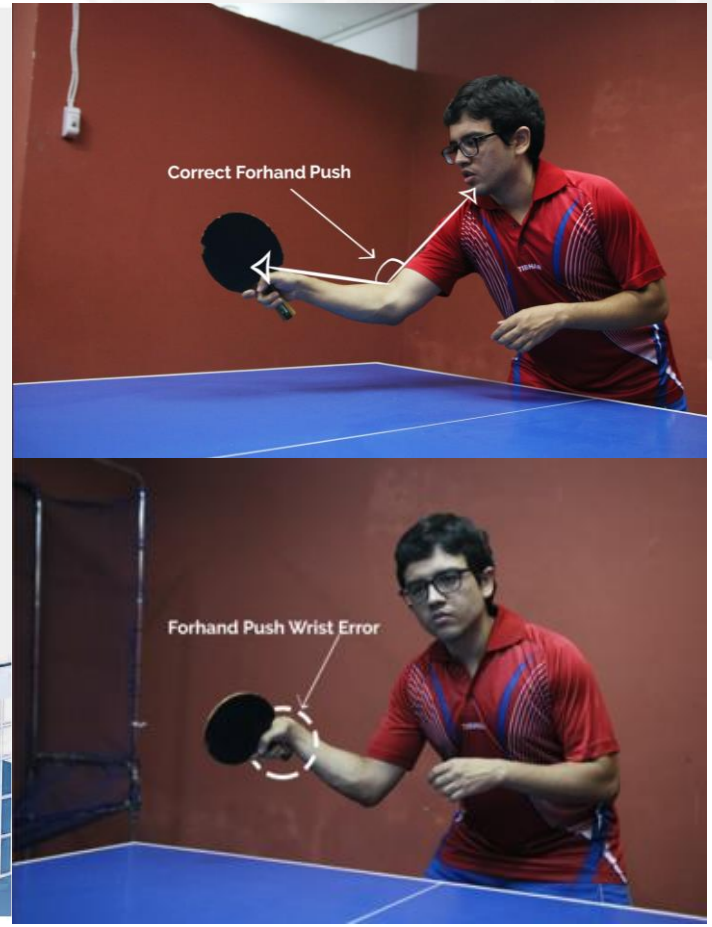
YOUMNA IBRAHIM

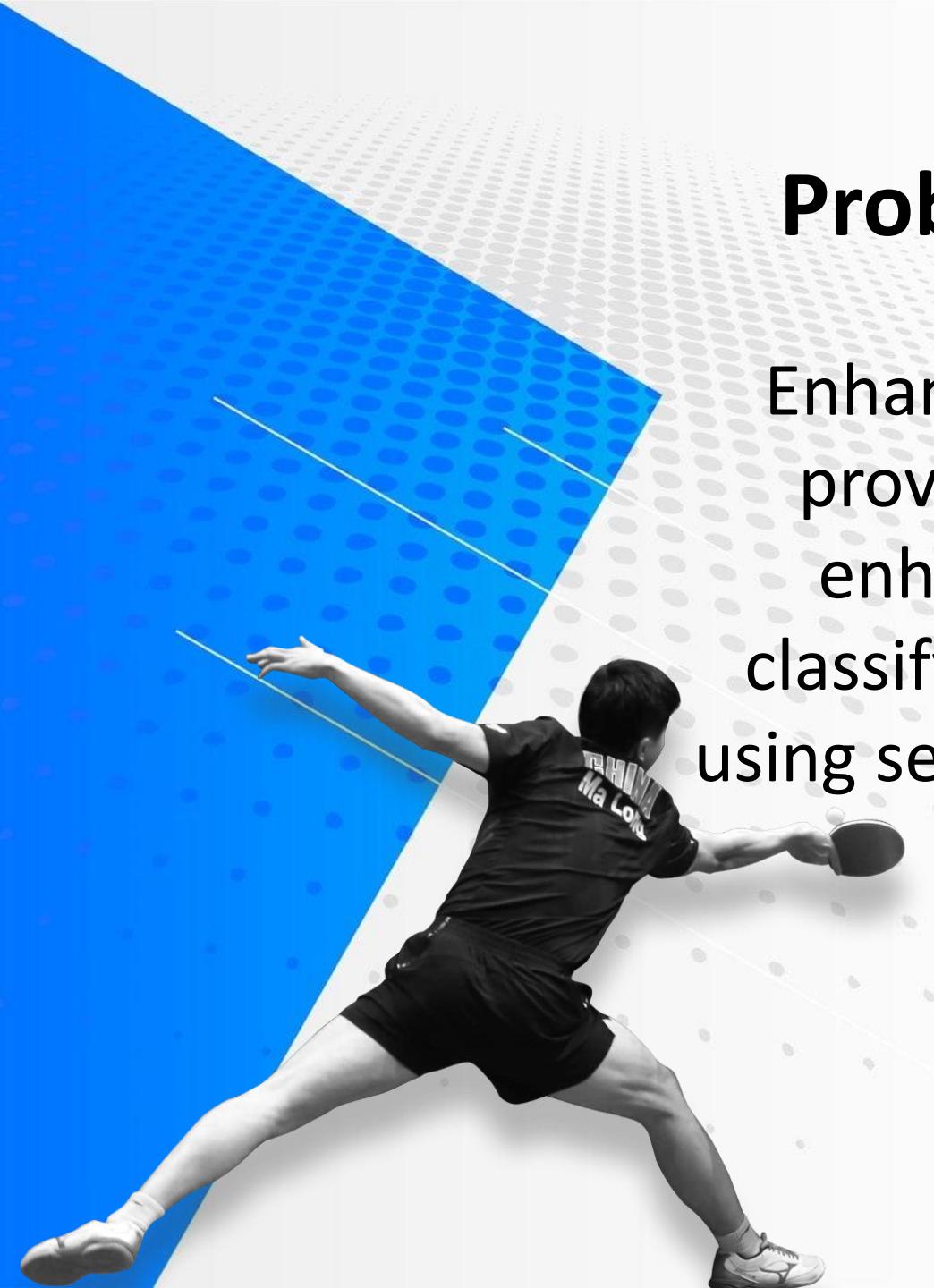
# Introduction

- Table Tennis became popular to reach 16 million players.
- Table Tennis major mistakes while playing:
  1- Waist movement mistake.
  2- Elbow extends.
  3- The racket ends higher than the table.



Main Joints used in Table Tennis

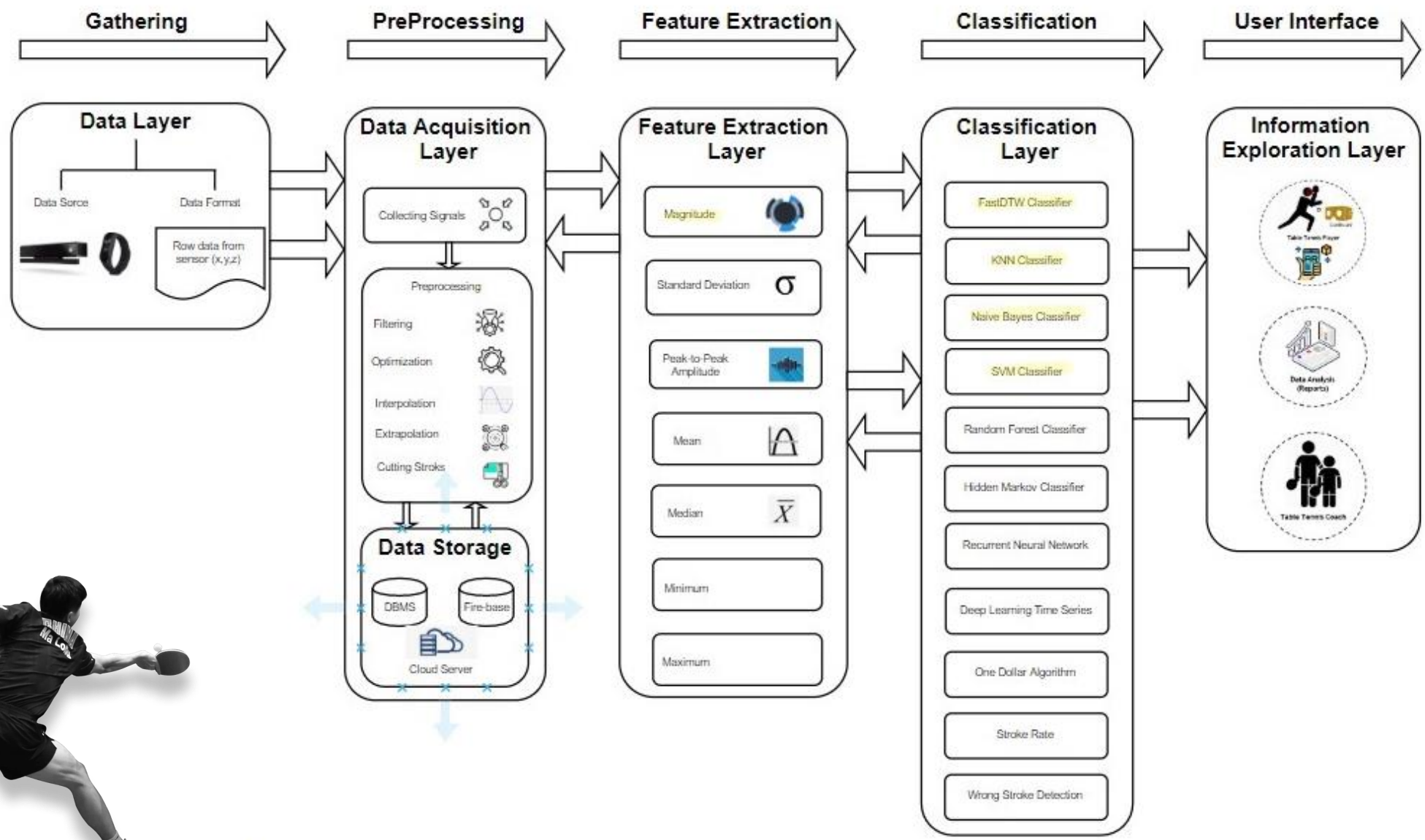




# Problem definition

Enhance the classification accuracy and provide online real-time feedback for enhancing the player stroke style by classifying the correct and wrong strokes using sensor device and IR depth camera on different body joints.

# System Architecture Block Technical Diagram




# FastDTW Algorithm

## Toward accurate dynamic time warping in linear time and space

- They introduced FastDTW, a linear and accurate approximation of dynamic time warping (DTW).
- FastDTW uses a multilevel approach that recursively projects a warp path to a higher resolution and refines it.
- Result: an average error of 8.6% with a radius of only 1, and increasing the radius to 20 lowered the error to under 1%.

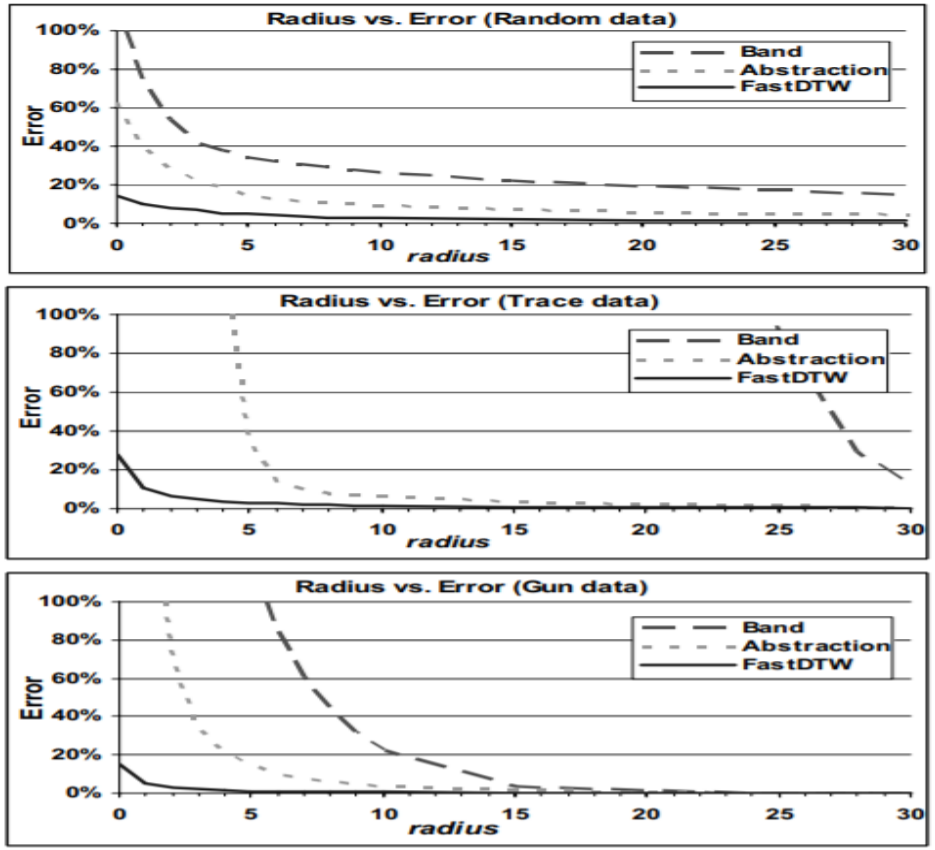



Fig. 9. Accuracy of FastDTW compared to Bands and Abstraction on all three groups of data.

[1] S. Salvador and P. Chan, “Toward accurate dynamic time warping in linear time and space,” Intell. Data Anal., vol. 11, pp. 561–580, 10 2007.

# Kalman Filter Algorithm

## Improving Joint Position Estimation Of Kinect Using Anthropometric Constraint Based Adaptive Kalman Filter For Rehabilitation

- They proposed a novel algorithm to improve accuracy of Kinect skeletal joint.
- Using a second order Kalman filter with adaptive measurement noise to accurately track dynamic trajectory joint center location over time.
- Results: The STD of the bone length computed improves by at least 40%.

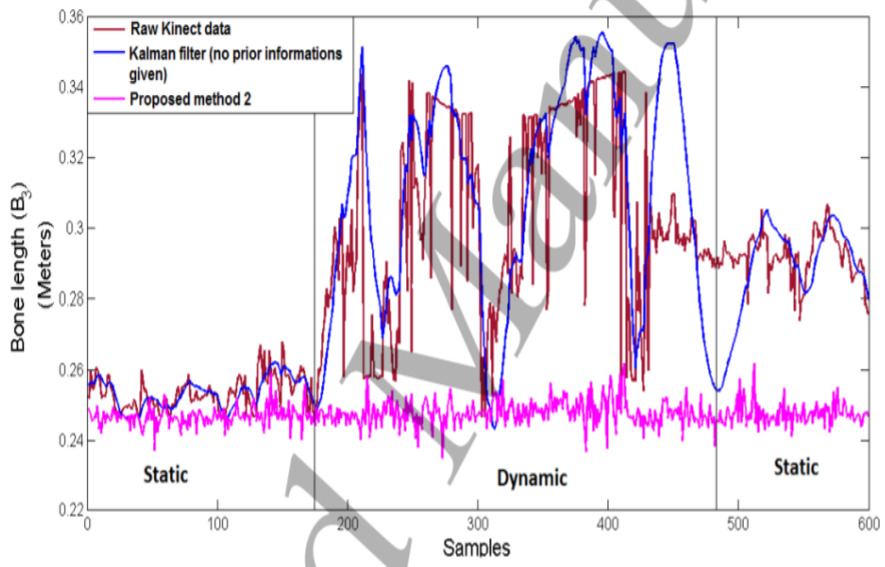



**Figure 12.** Performance of Kalman filter and our proposed approach. The left arm length is shown for the raw data, Kalman and Proposed method2.

[2] P. Das, K. Chakravarty, A. Chowdhury, D. Chatterjee, A. Sinha, and A. Pal, "Improving joint position estimation of kinect using anthropometric constraint based adaptive kalman filter for rehabilitation,"Biomedical Physics and Engineering Express, vol. 4, 12 2017.

# Functional Requirement

| Title | Stroke Classification |
|---|---|
| ID | FR07 |
| Description | This function is for classifying player stroke by comparing the array of optimized strokes from FR06 with the matched templates from the dataset. |
| Type | Functional requirement |
| Input | Array of testing data |
| Action | If the classifier result close to any of the templates from the dataset then the result will be returned. Otherwise, the stroke will be classified as unknown movement. |
| Output | Object of type Classification Result |
| Precondition | Array of cutted strokes (FR05) and optimized strokes (FR06). |
| Post-condition | Database is updated and stroke marked as classified. |
| Dependencies | FR05, FR06 |

# Non-Functional Requirement

- **Architecture change** existence of Inner server and output server.
- The response time need to be very short as the stroke takes milliseconds to be ended.

Performance and speed

- **Architecture change** of a cloud computing to store data on and the usage of IoT.
- Measured by increasing workloads on the system and measure number of transactions per second and response time.

Scalability

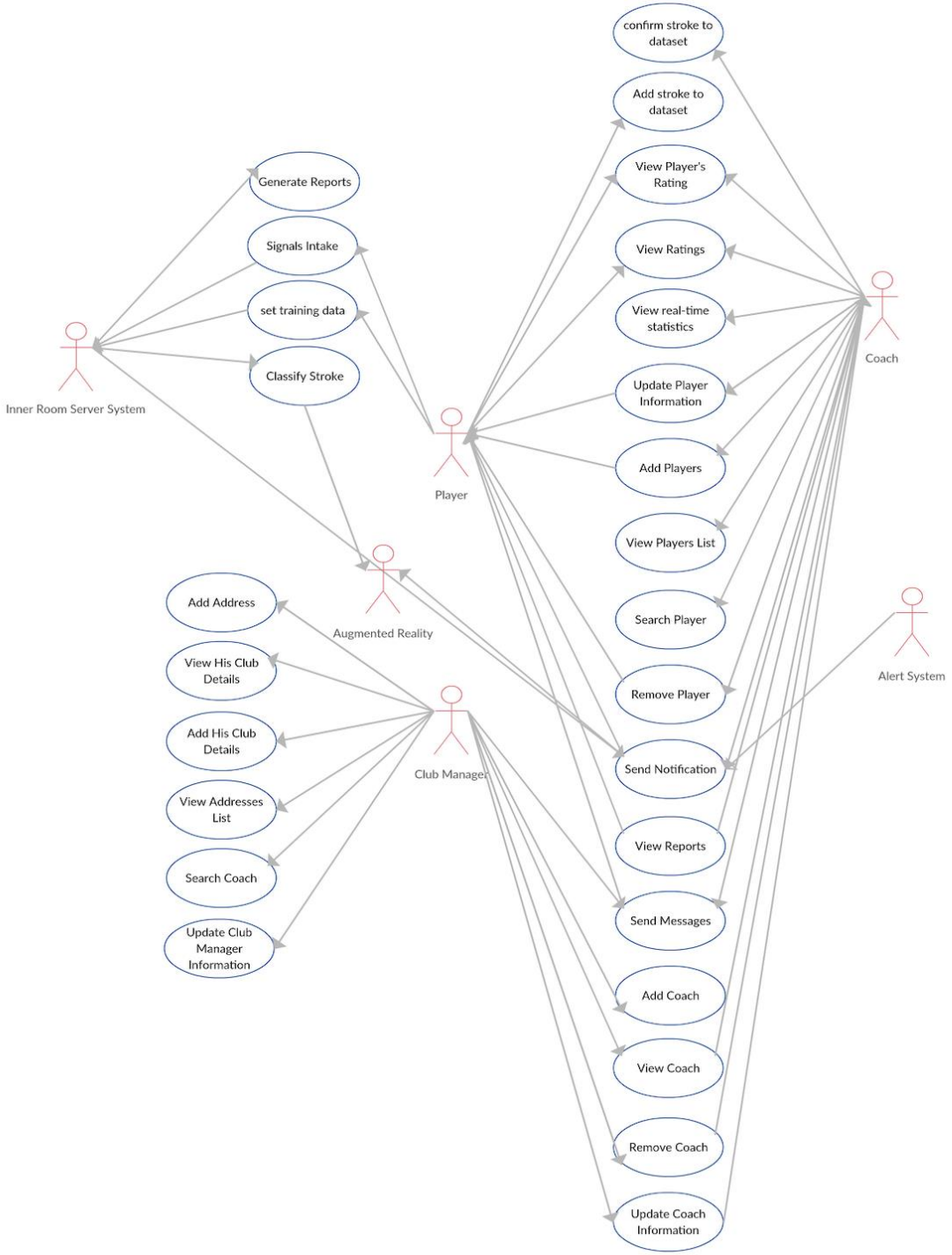
- **Interface** needed to be simple and easy to be use, due to the surrounding environment of the player.
- This is done by applying Nielsen 10 heuristics measurements of usability.
- There will be experimental user study done by the end of the project.

Usability

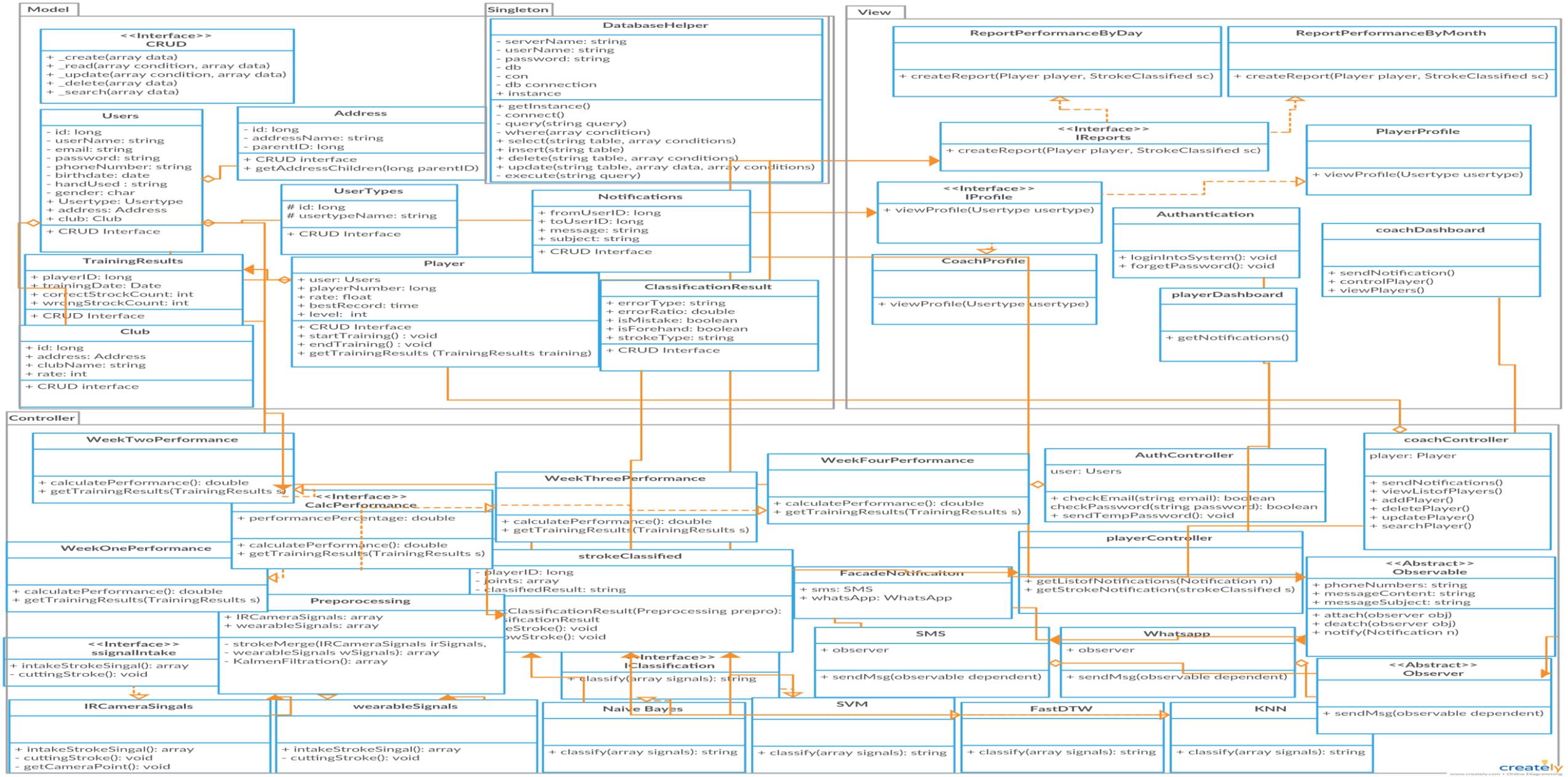
- **A functional Requirement** is that the system needs to be easy to maintain to minimize the amount of changes that would be done to the code.
- This is done by implementing MVC pattern and lots of design patterns.

Maintainability

# Usecase Diagram

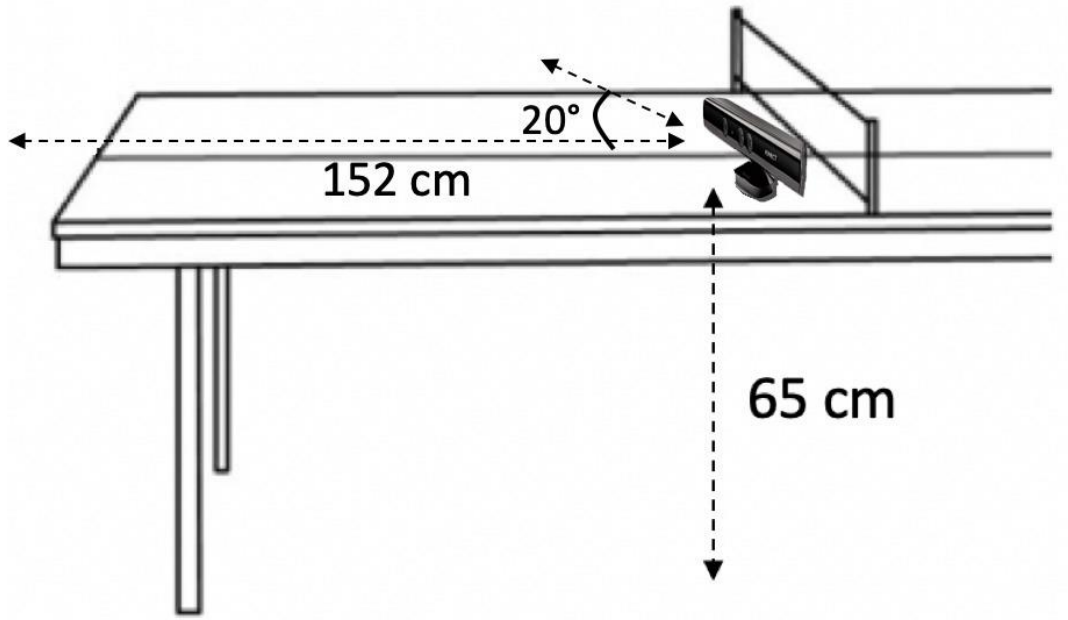



# Class Diagram

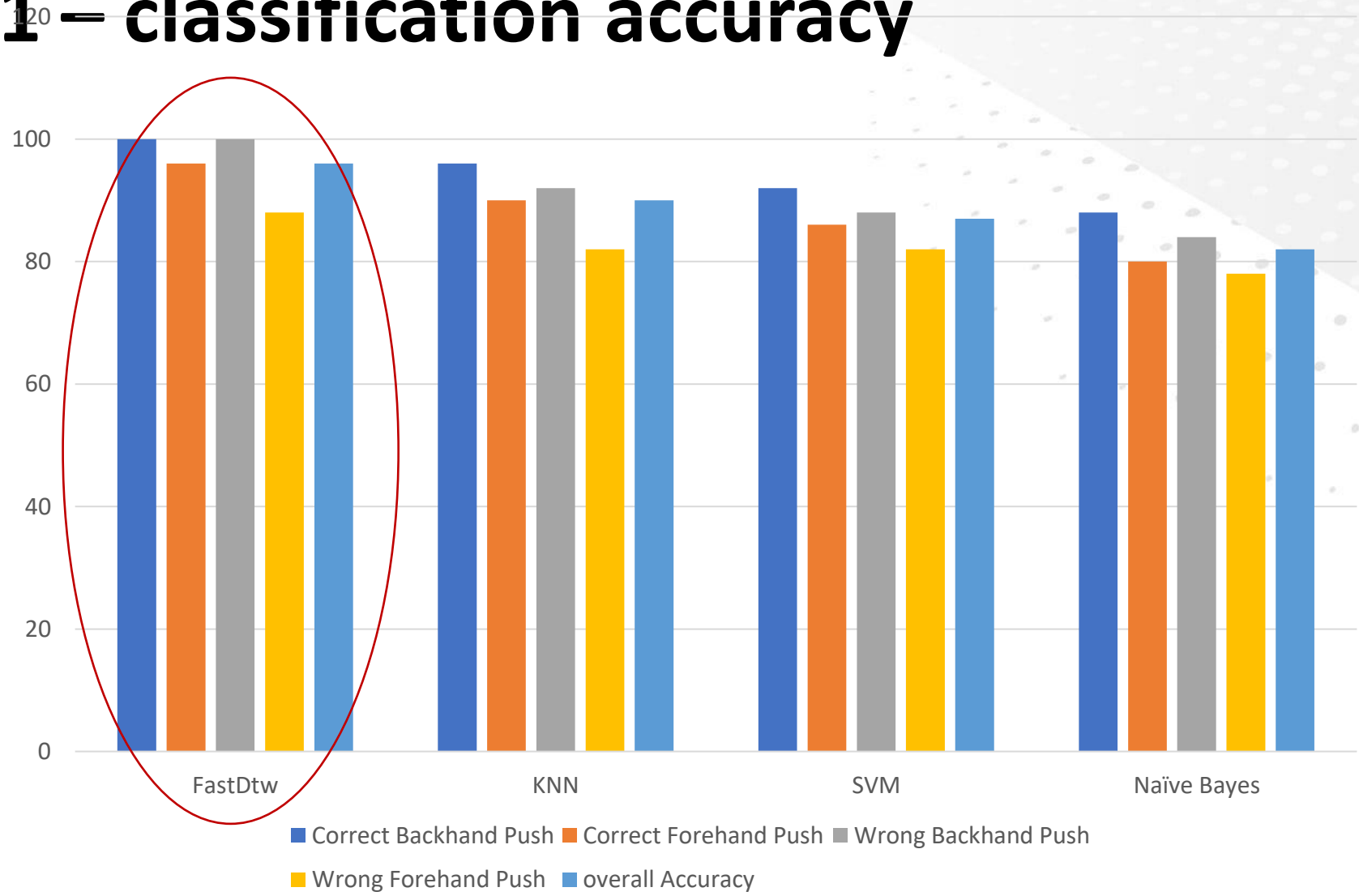


# Experiments Setup

- Kinect was placed on a box with height, **65 cm** from the ground.
- The player is standing away from it with a distance between **152 cm and** an angle **20** degrees with the Kinect.
- **500** strokes was recorded from **5** different players.



# Results 1 – classification accuracy




FastDTW achieved high accuracy

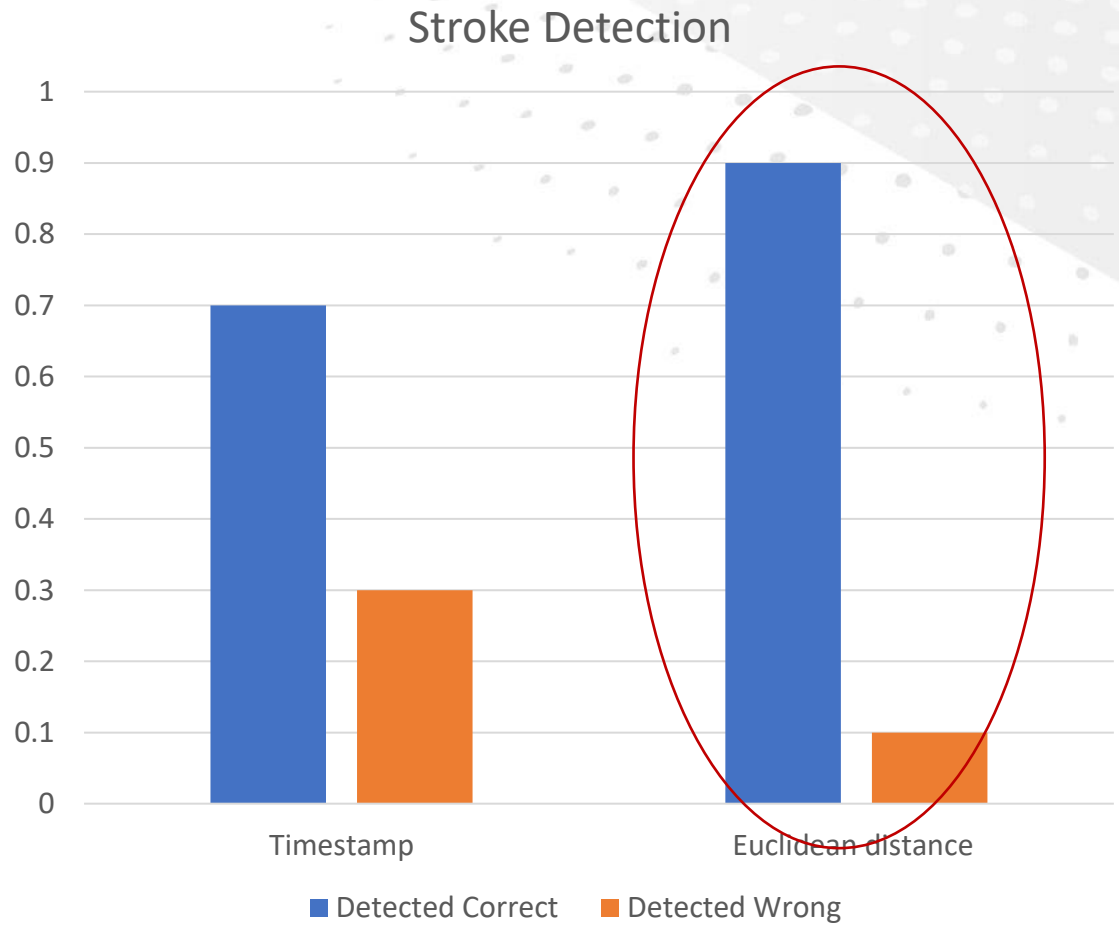
# Results 2 – cutting stroke method accuracy

Timestamp based

- Stroke was cut before or after the stroke finishes.

Euclidean distance based

- Neglected unwanted movements and achieved more accuracy than timestamp by 20%



# Demo

Video is Uploaded

- The paper was **accepted** in (*The 11th International Conference on Ambient Systems, Networks and Technologies)* in Poland under the title of “Online detection and classification of in-corrected played strokes in table tennis using IR depth camera.”

ANT 2020

- In collaboration with Al Ahly Club and Table Tennis Federation.

# Comments on paper

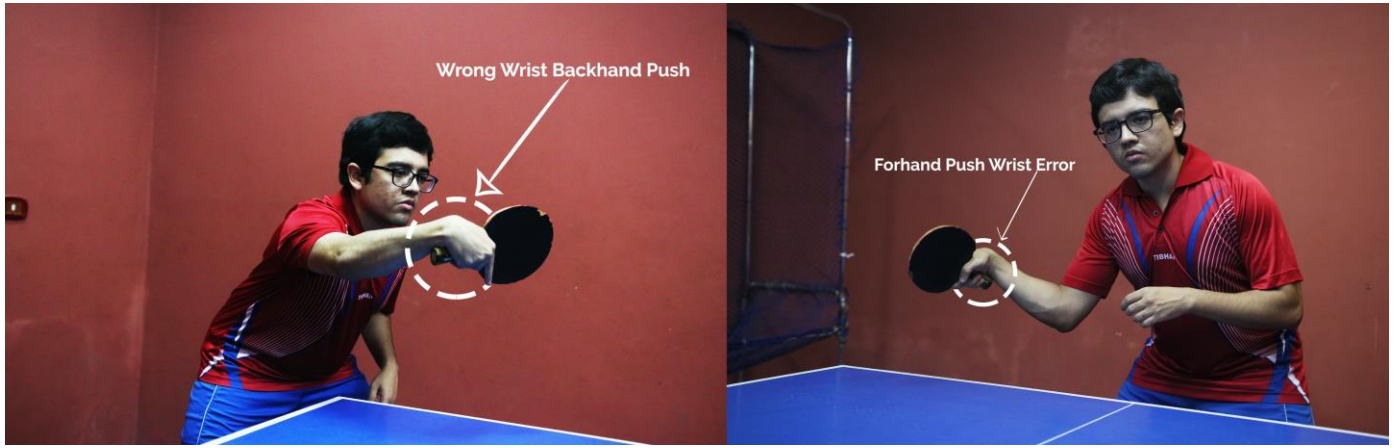
----- TEXT:
The paper presents a method to identify played strokes in table tennis in order to check their correctness.
The proposed method uses an IR depth camera and the results are convincing.
The article is generally well written with few typos and errors in English (for exemple, Main text ==> Introduction).
The authors should check carefully to correct this small problem.
Equation (1) can be simplified.

# THANK YOU!

Any Questions?

# Common Mistakes

## Common Mistakes in Push Stroke




Wrong wrist Movement

Wrong starting angle

## Common Mistakes between strokes

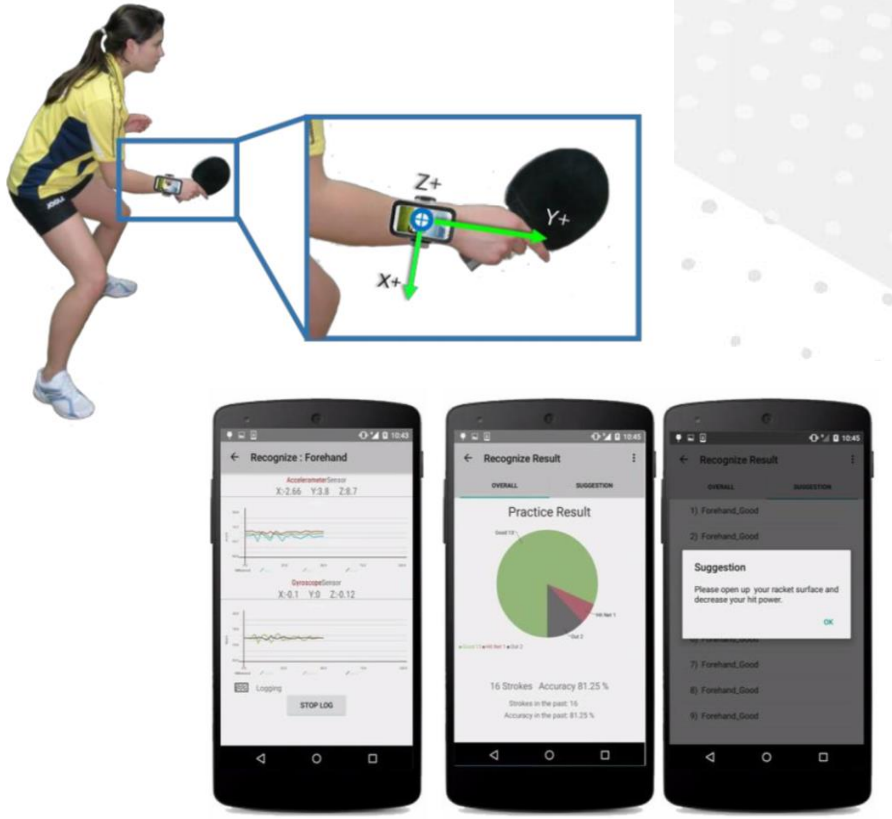

Elbow Extends

The racket Position ends higher than the table level

# Similar Systems (1/2)

*Average accuracy stroke detection and classification*

- Device Used: mobile device.
- The system detects and classifies tennis strokes: forehand and backhand.
- Average accuracy 77.21% and 69.63%
- Detection the wrist movement.
- Online Feedback.

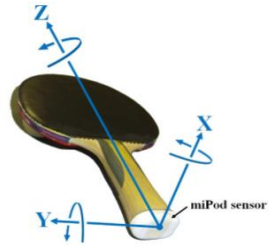


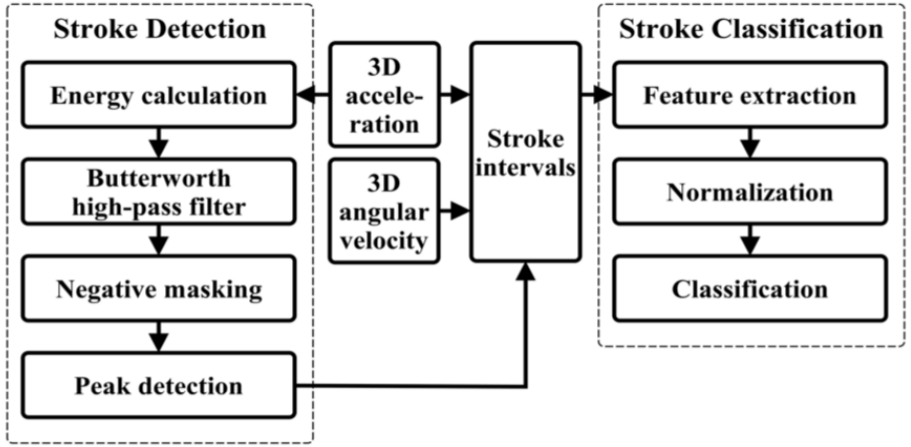

Viyanon, Waraporn & Kosasaeng, Vimvipa & Chatchawal, Sittichai & Komonpetch, Abhirat. (2016). SwingPong: analysis and suggestion based on motion data from mobile sensors for table tennis strokes using decision tree. 1-6. 10.1145/3028842.3028860.

# Similar Systems (2/2)

*Offline stroke detection and classification*

- Used *miPod* sensor attached to the racket handle.
- Detected and classified 8 types of strokes with overall Precision of 95.7%
- Best accuracy was SVM RBF algorithm.
- Classification based on the player movement of the racket.
- Detection the wrist movement.
- Offline Feedback.




Blank, P., Hoßbach, J., Schuldhaus, D., & Eskofier, B. M. (**2015**). Sensor-based stroke detection and stroke type classification in table tennis. Proceedings of the 2015 **ACM** International Symposium on Wearable Computers - ISWC '15.