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TRAINIT:

DETECTION AND CLASSIFICATION OF WRONG PLAYED STROKES IN TABLE TENNIS.

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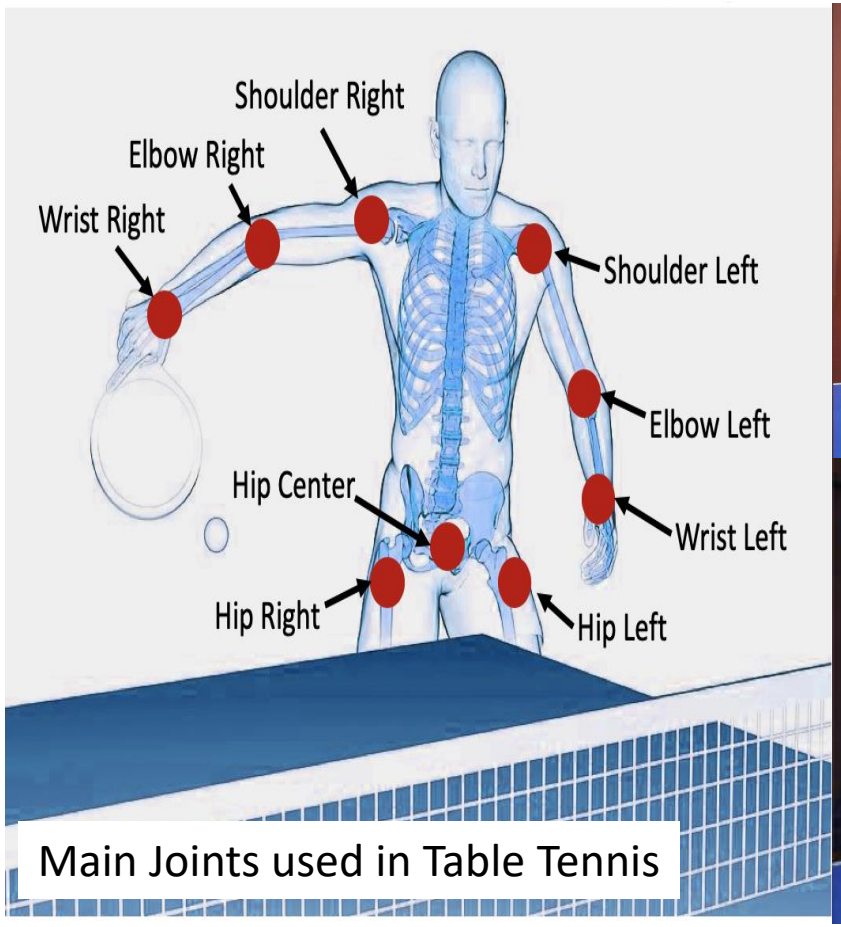
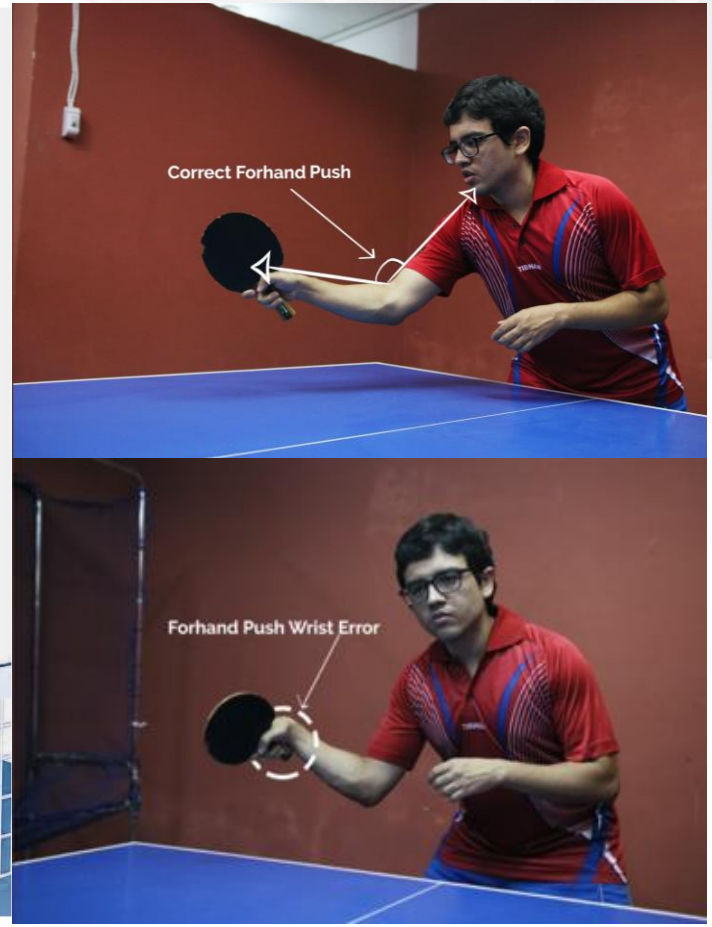
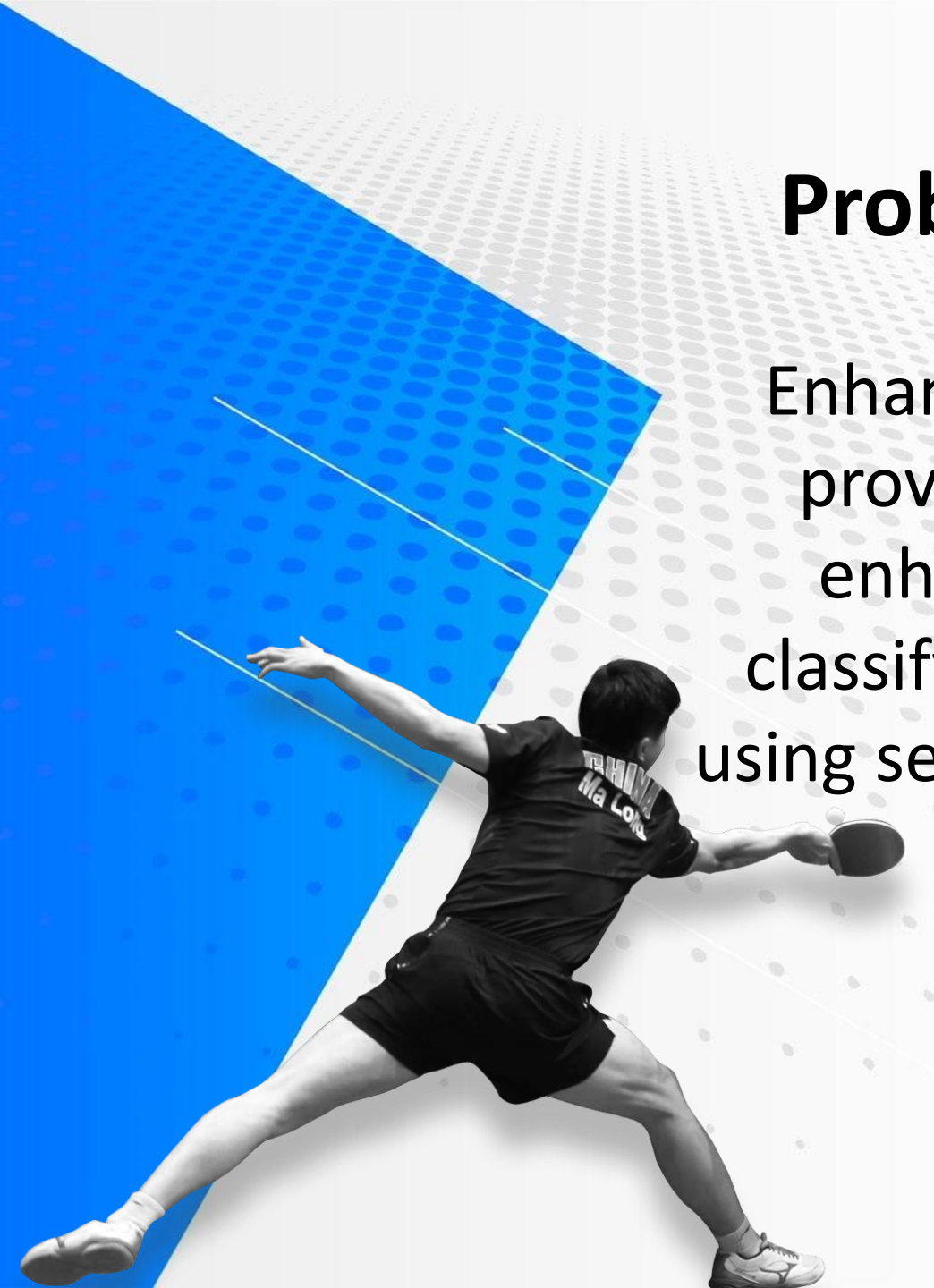
Introduction

- 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

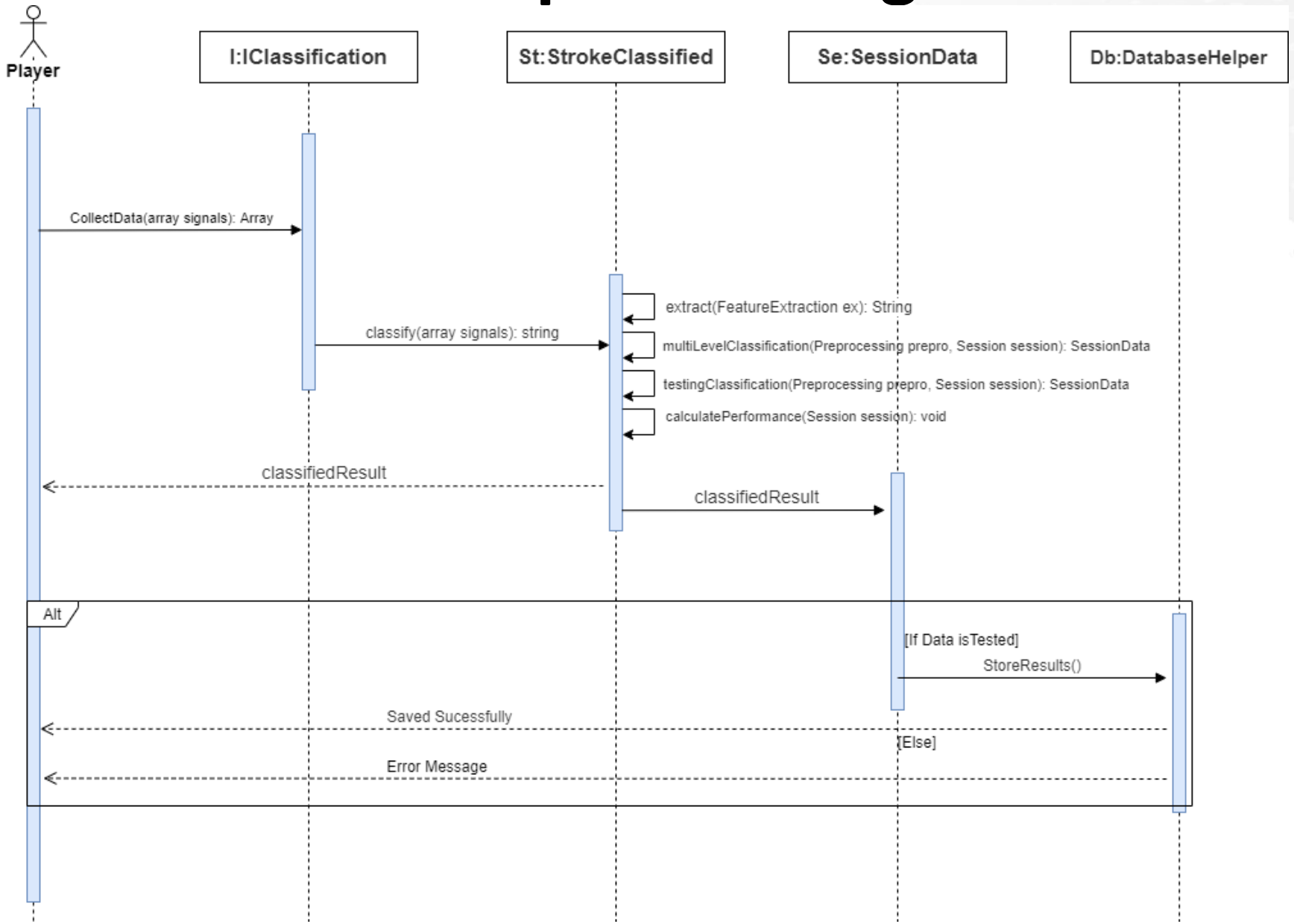




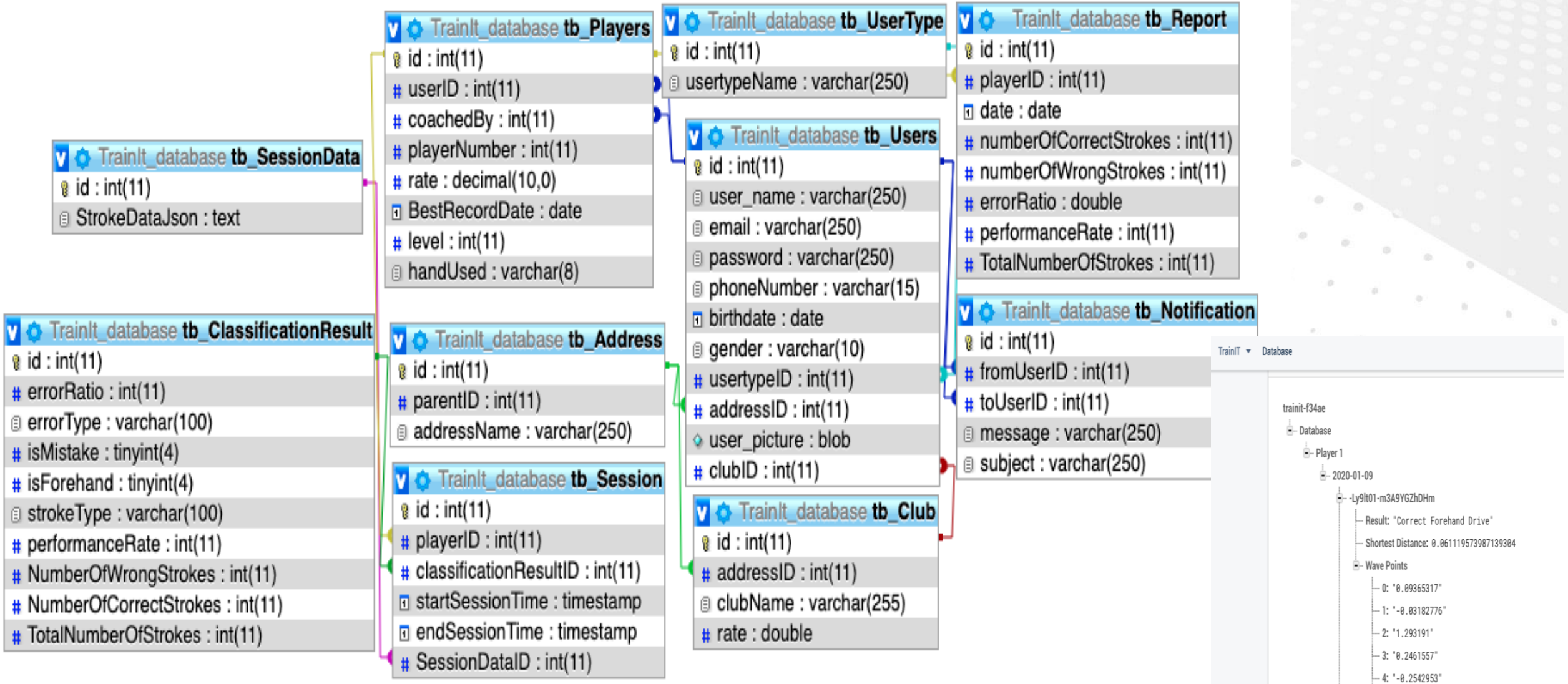
Problem definition

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.

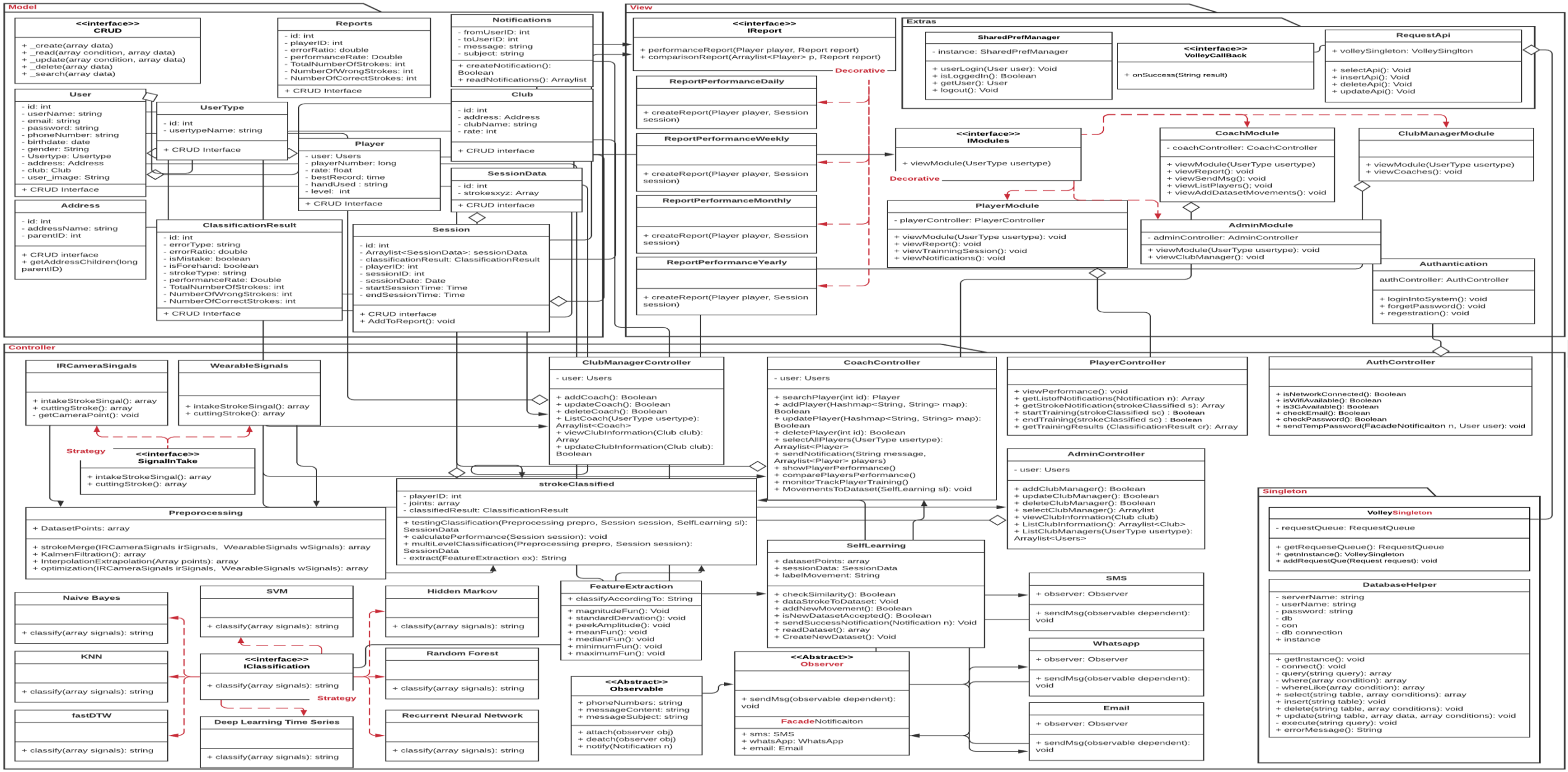
Main Sequence Diagram



Database and Firebase Schema



Class Diagram



Algorithms Choices (1/2)

Light Sport Exercise Detection Based on Smartwatch and Smartphone using k-Nearest Neighbor and Dynamic Time Warping Algorithm

- They proposes a light sport exercise activity detection system.
- They used **k-Nearest Neighbor algorithm.**
- Result: On the value of k =3, the accuracy of push up motion is 76.67%, then 80% for sit up, and 96.67% for squat jump activity.

Table 2. Result of Iteration 3 Data Training Process

Motion	Parameter	*k*=1 (%)	*k*=3 (%)	*k*=5 (%)	*k*=7 (%)
Push Up	Sensitivity	100	100	100	100
	Specificity	66.67	83.33	83.33	66.67
	Accuracy	77.78	88.89	88.89	77.78
Sit Up	Sensitivity	66.67	100	33.33	33.33
	Specificity	100	100	100	100
	Accuracy	88.89	100	77.78	77.78
Squat Jump	Sensitivity	66.67	66.67	100	100
	Specificity	100	100	83.33	100
	Accuracy	88.89	88.89	88.89	100

Nurwanto, F., Ardiyanto, I., Wibirama, S., 2016. Light sport exercise detection based on smartwatch and smartphone using k-nearest neighborand dynamic time warping algorithm, pp.

Algorithms Choices (2/2)

Toward accurate dynamic time warping in linear time and space

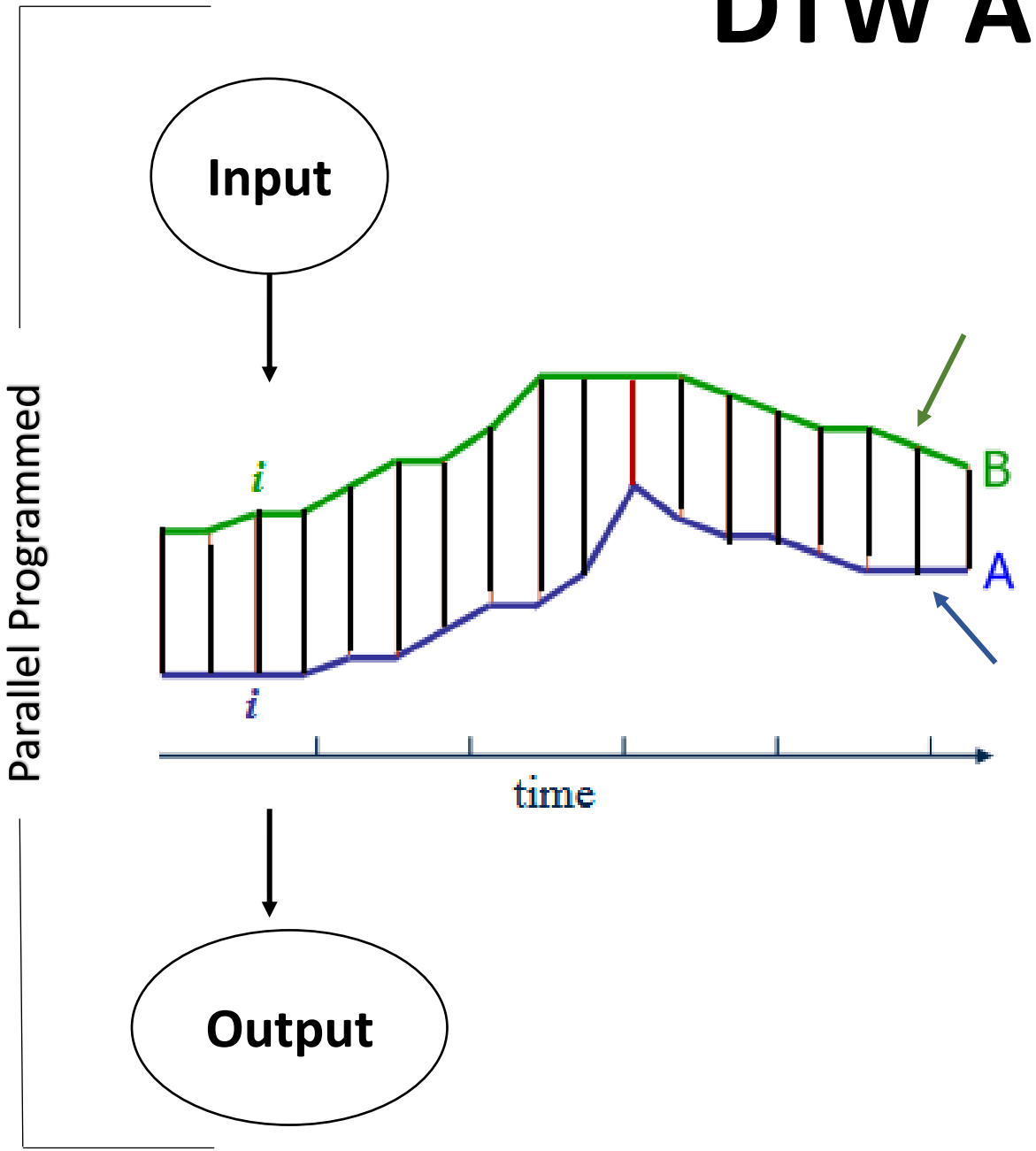
- They introduced **FastDTW Algorithm**, a linear and accurate approximation of dynamic time warping (DTW).
- Result: an average error of 8.6% with a radius of only 1, and increasing the radius to 20 lowered the error to under 1%.

Table 1
Average error of the three algorithms at selected radius values (errors of the 3 groups of data are averaged)

	Radius				
	0	1	10	20	30
FastDTW	19.2%	8.6%	1.5%	0.8%	0.6%
Abstraction	983.3%	547.9%	6.5%	2.8%	1.8%
Band	2749.2%	2385.7%	794.1%	136.8%	9.3%

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.

DTW Algorithm



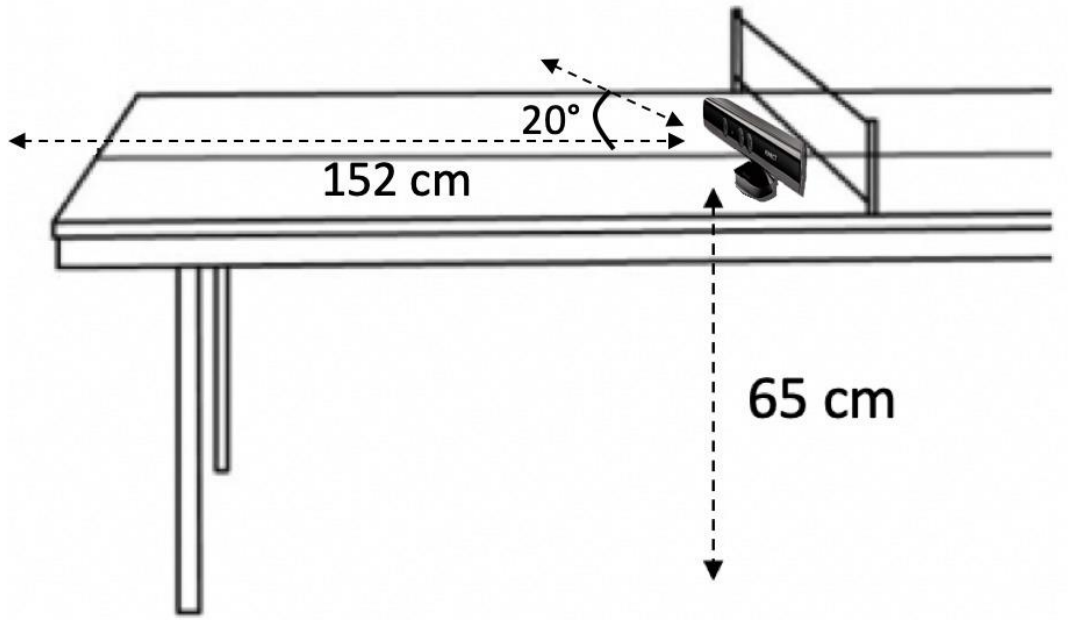
- 2 Arrays
  - 1- Each array from the dataset.
  - 2- Filtered array of stroke intake.

- The algorithm is able to find the optimal alignment between **the two time series**.
- It **finds the nearest optimal alignment** between the 2 arrays and compare them.
- FastDTW resolved the problem of quadratic time and space complexity which limits the use of small times series datasets.

- The shortest distance between the 2 waves.

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.

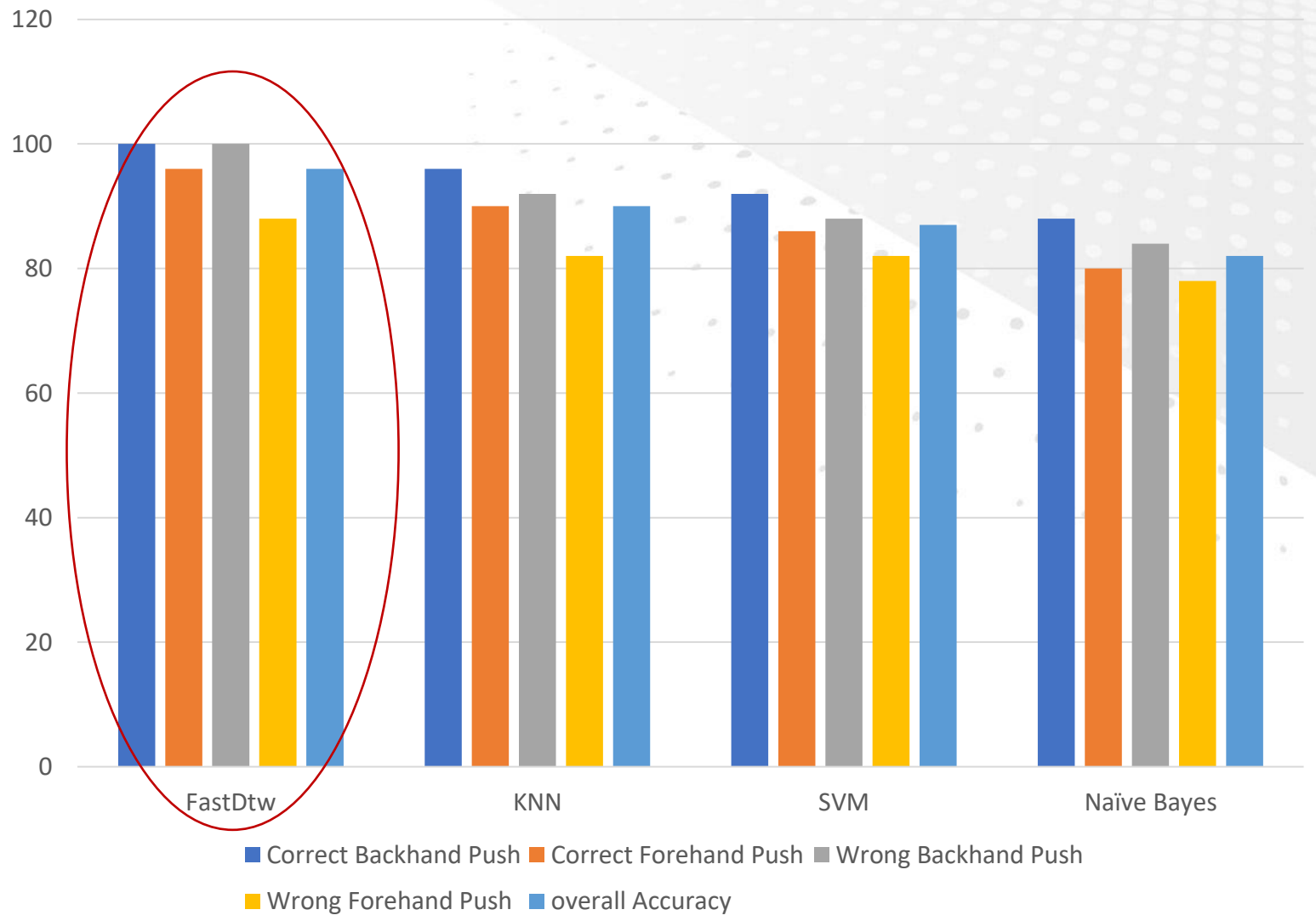


Results

Time complexity:

- FastDTW: O(N)
- KNN: O(n2)-O(n3)
- SVM (LibSVM): O(n3)
- Naïve Bayes: O(Nd)

N = number of training examples,
d = dimensionality of the features

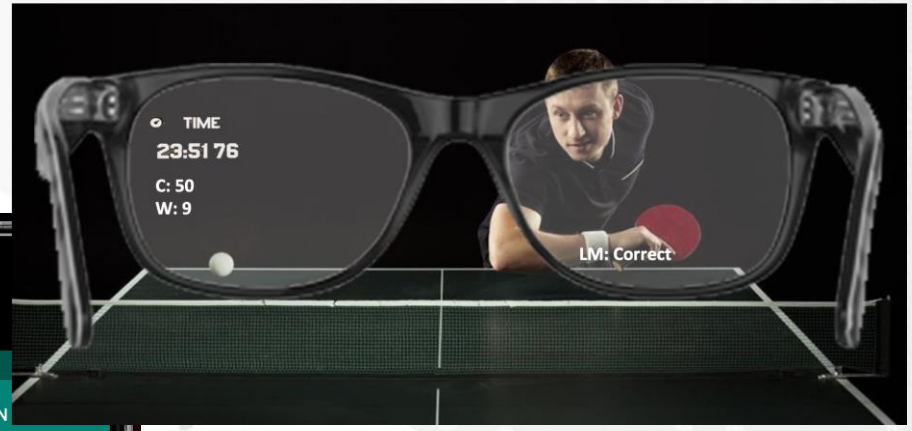


FastDTW achieved high accuracy

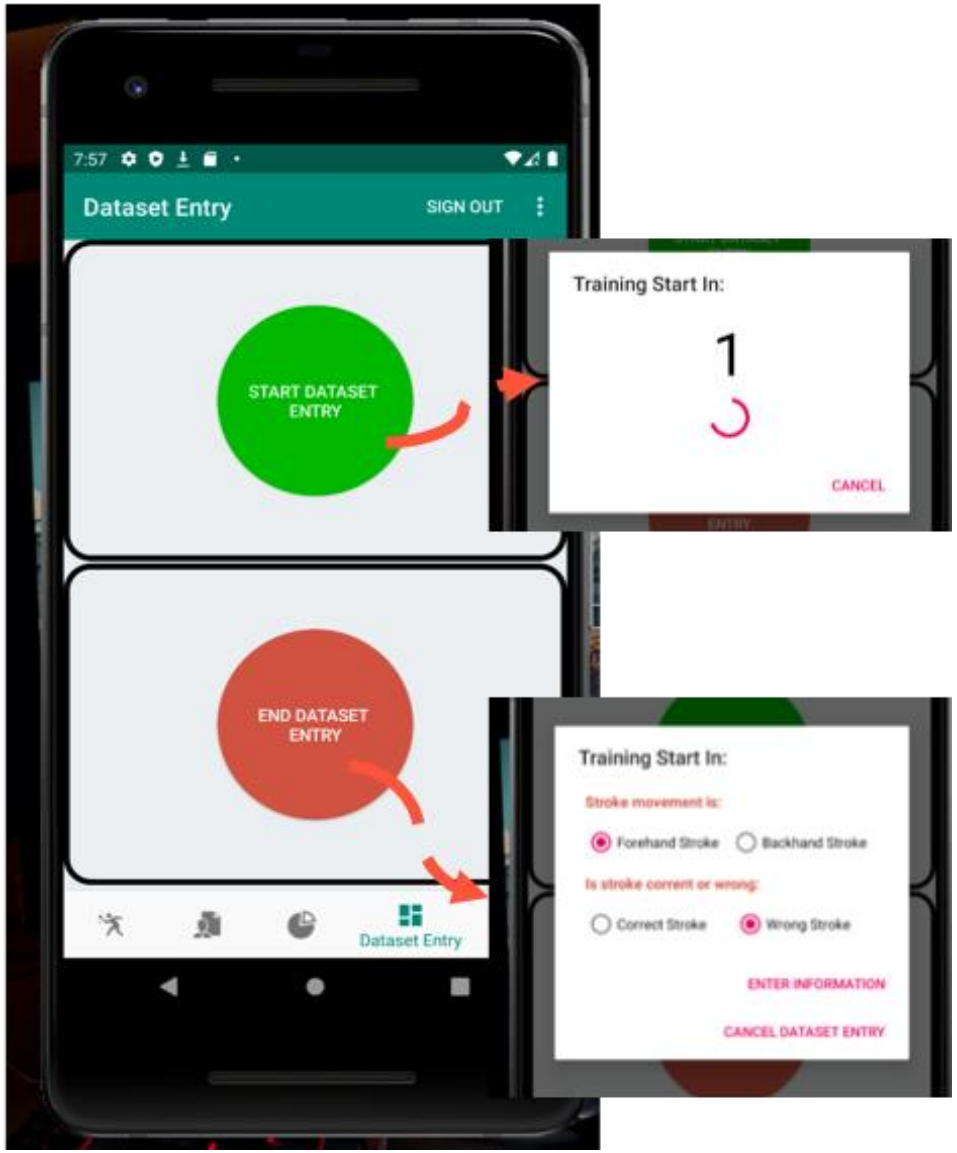
- The paper was **published** in (*The 11th International Conference on Ambient Systems, Networks and Technologies)* in Poland under the title of “Online detection and classification of in-corrected played strokes in table tennis using IR depth camera.”
- **Currently writing** a second paper (Journal) on the fusion between Kinect and other sensors helping increasing Table Tennis player performance.
- In collaboration with Al Ahly Club and Table Tennis Federation.

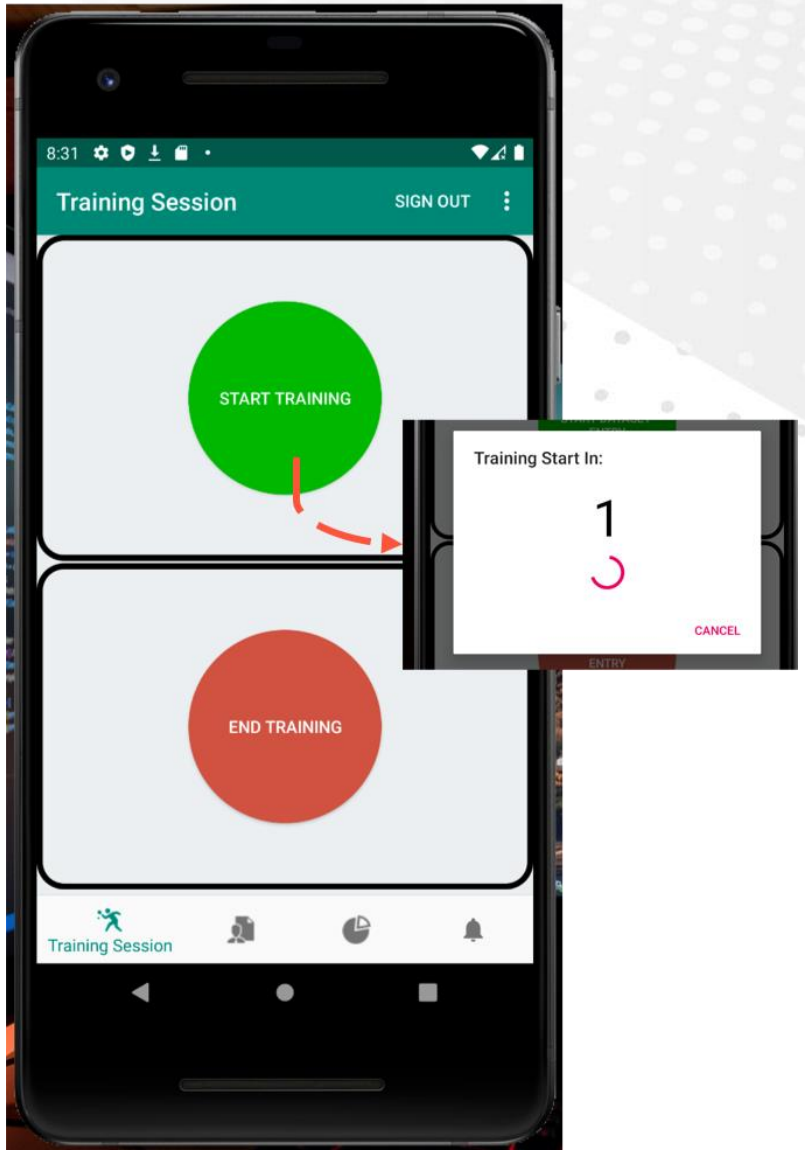
GUI Sample


8:31
Player Performance
SIGN OUT
Daily
Weekly
Monthly
Monday, 65%
Thursday, 99%
Friday, 55%
Sunday, 88%
Wednesday, 60%
Tuesday, 50%
Saturday, 33%
Dashboard
9:45
Player Performance
SIGN OUT
Daily
Weekly
Monthly
30.5%
35.2%
12.9%
21.5%
Dashboard
9:37
Player Performance
SIGN
Daily
Weekly
Monthly
Player Monthly Report
Jan
55 %
Feb
33 %
Mar
100 %
Apr
87 %
May
66 %
Jun
9 %
Jul
22 %
Aug
44 %
Sep
69 %
Dashboard


TIME
23:51 76
C: 50
W: 9
LM: Correct

GUI Sample


7:57
Dataset Entry
SIGN OUT
START DATASET ENTRY
END DATASET ENTRY
Dataset Entry
Training Start In:
1
CANCEL
Training Start In:
Stroke movement is:
Forehand Stroke
Backhand Stroke
Is stroke correct or wrong:
Correct Stroke
Wrong Stroke
ENTER INFORMATION
CANCEL DATASET ENTRY


8:31
Training Session
SIGN OUT
START TRAINING
END TRAINING
Training Session
Training Start In:
1
CANCEL

Demo

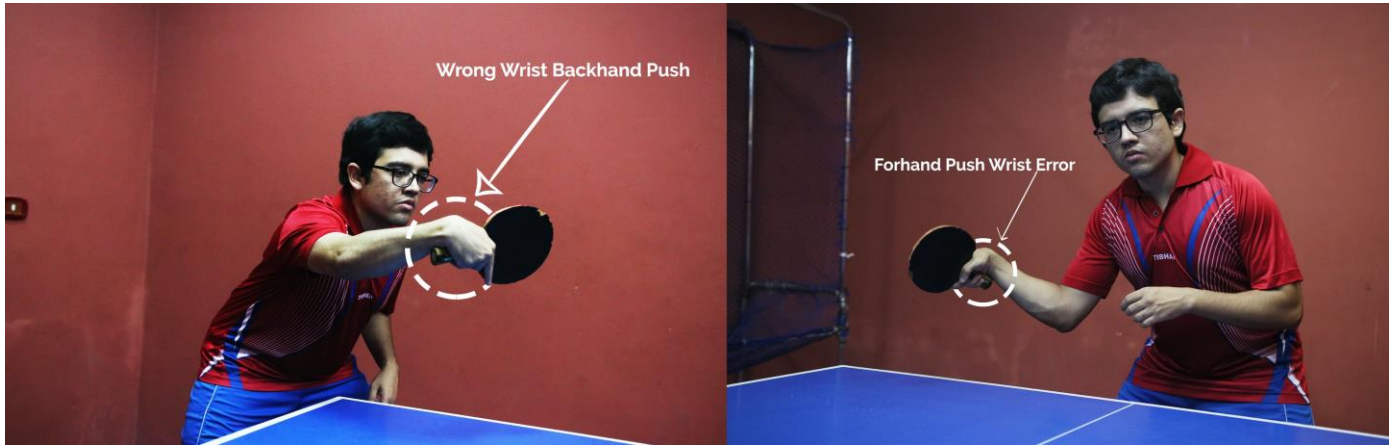
Video is Uploaded

THANK YOU!

Any Questions?

Common Mistakes

Common Mistakes in Push Stroke



Wrong wrist Movement

Wrong starting angle

Common Mistakes between strokes

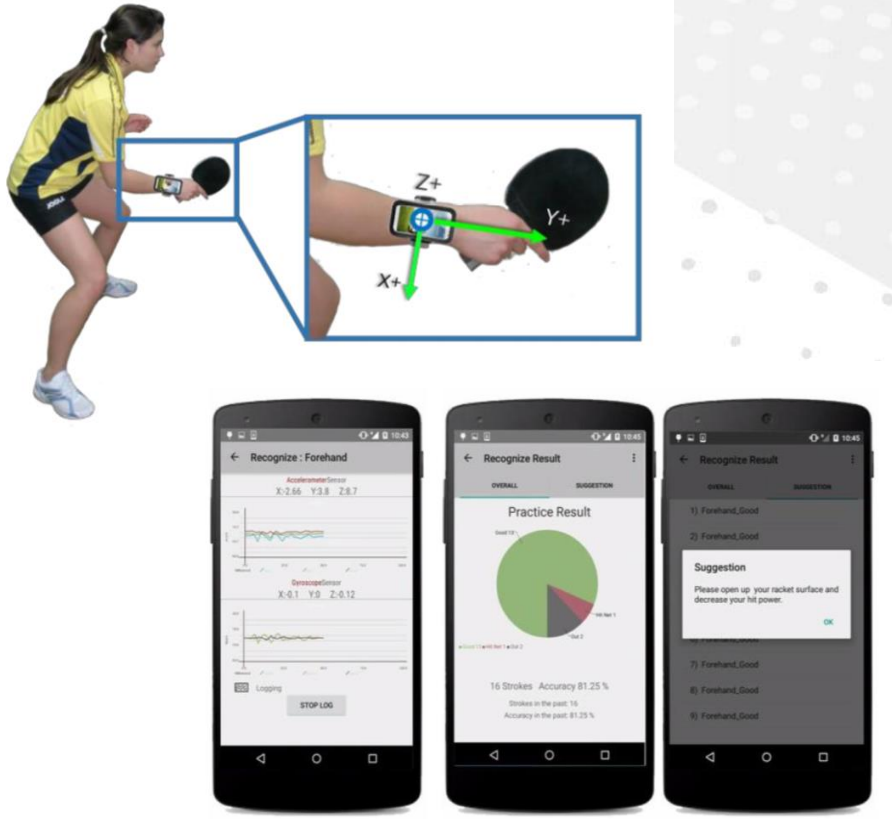
Elbow Extends

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.

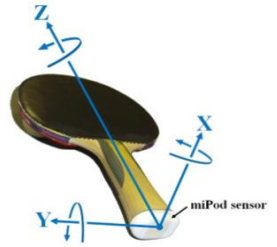


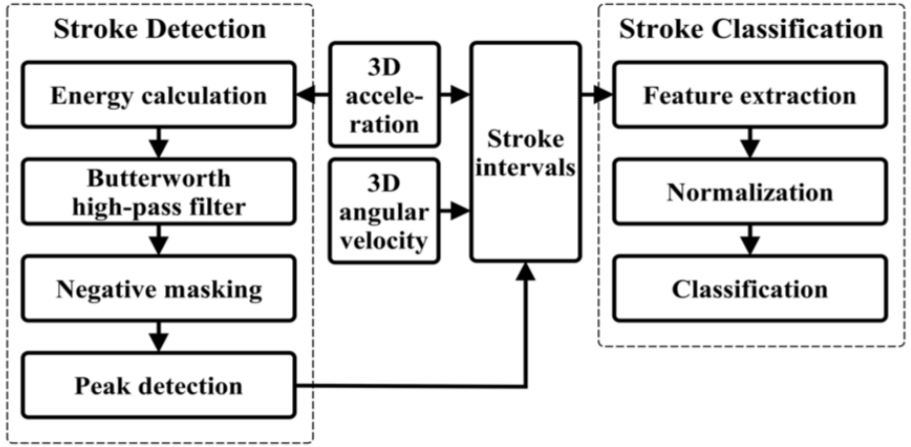
Viyanon, Waraporn & Kosasaeng, Vimvipa & Chatchawal, Sittichai & Komonpetch, Abhirat. (2016). SwingPong: analysis and suggestion based on motion data from mobile sensors for table tennis strokes using decision tree. 1-6. 10.1145/3028842.3028860.

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.

Algorithms Choices (1/2)

A Method for Hand Gesture Recognition

- They used Microsoft Kinect sensor.
- They used **Naïve Bayes classifier.**
- Result: They implemented and tested this algorithm for 15 images of each class, It gives a correct classification rate of 100 %.

TABLE II
CONFUSION MATRIX

a	b	c	d	e	<– – *classified as*
15	0	0	0	0	a=1
0	15	0	0	0	b=2
0	0	16	0	0	c=3
0	0	0	14	0	d=4
0	0	0	0	15	e=5

[2] Shukla, J., & Dwivedi, A. (2014). *A Method for Hand Gesture Recognition. 2014 Fourth International Conference on Communication Systems and Network Technologies.* doi:10.1109/csnt.2014.189

Algorithms Choices (2/2)

Human posture recognition using human skeleton provided by Kinect

- They proposed a method for human posture recognition using skeleton provided by Kinect device.
- They used **Support Vector Machine (SVM)** for classification.
- Result: The obtained results show this skeleton allows classifying well four postures.

TABLE I. RECOGNITION ACCURACY OF FOUR POSTURES FOR OFFLINE EVALUATION (%)

Accuracy / Posture	Ex1	Ex2	Ex3	Ex4	Ex5	Ex6	Ex7
Standing	100	89.67	100	88.93	100	81.18	100
Sitting	100	88.98	100	86.53	100	61.22	100
Lying	100	0	95.43	0	95.43	0	92.53
Bending	100	100	98.04	100	98.88	100	99.43
Average	100	73.43	98.38	72.71	98.65	65.26	98.20

[1] Le, T., Nguyen, M.Q., Nguyen, T.M., 2013. Human posture recognition using human skeleton provided by kinect. Doi.