iKarate: Improving Karate Kata

Bassel Emad, Omar Atef, Yehya Shams, Ahmed El-Kerdany
Supervised By: Dr. Ayman Ezzat, Dr. Ayman Nabil
and Eng. Nada Ayman

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Abstract

Karate is a martial art that can be practiced using hands and feet to deliver and block strikes. However, moves must be done in a certain way, many wrong moves are done in the training itself. The system helps in capturing and analyzing the moves giving live feedback to the player and the coach to know exactly where the wrong move was done and how to improve it and make it better, all this is done using Kinect sensor(s) and machine learning algorithms, and displaying the feedback on a web page, either the move was done correctly or needs improvement.

1 Introduction

1.1 Background

Karate moves are combination of successive moves. Kids nowadays may find difficulties learning those moves at a young age, since the training may consist of a large number of players, the trainer himself may not be able to focus on every detail of every player's move, which may result in taking more time for learning the move or to be precious to master it or it may lead to learning that move in a wrong way from the beginning. The main goal of this project is to capture the moves of the players, analyse those moves and give the players a feedback to enhance their technique or alert them if they are playing in a wrong way.

1.2 Motivation

Despite the importance of the sports field and improving it, not many people focus on working in the Karate sport, so as a team we saw a good opportunity to continue researching in the Karate sport, by improving and adding some features that might make a difference. We also found that kids playing Karate at the beginning don't have the attention needed from the coach who should focus on the little mistakes made by the kids.

1.3 Problem Definitions

There is the problem of the real-time feedback, giving the player a feedback on his/her moves whether it was right or not in a couple of minutes is essential after he/she finishes the move, the feedback should have high-accuracy. The feedback contains tips on how to execute the move correctly. Moreover, each player has different body proportions than the other players.

2 Project Description

Karate training assisting system that detects Karate moves and analyze them to detect the mistakes and to present a feedback in an interface to the user, showing the recognized moves and explaining whether there was a mistake or not in a certain position.

2.1 Objective

The project aims to improve Karate coaching with the assistance of motion capture technologies and algorithms.

2.2 Scope

The system is designed to cover multiple things:

1. Help Karate players who don't have Karate coaches.
2. Assist Karate coaches.
3. Extract body position mistakes that could be hard to be noticed by a coach.
4. User data can be recorded and analyzed, thus improving the player's experience and training.

2.3 Project Overview

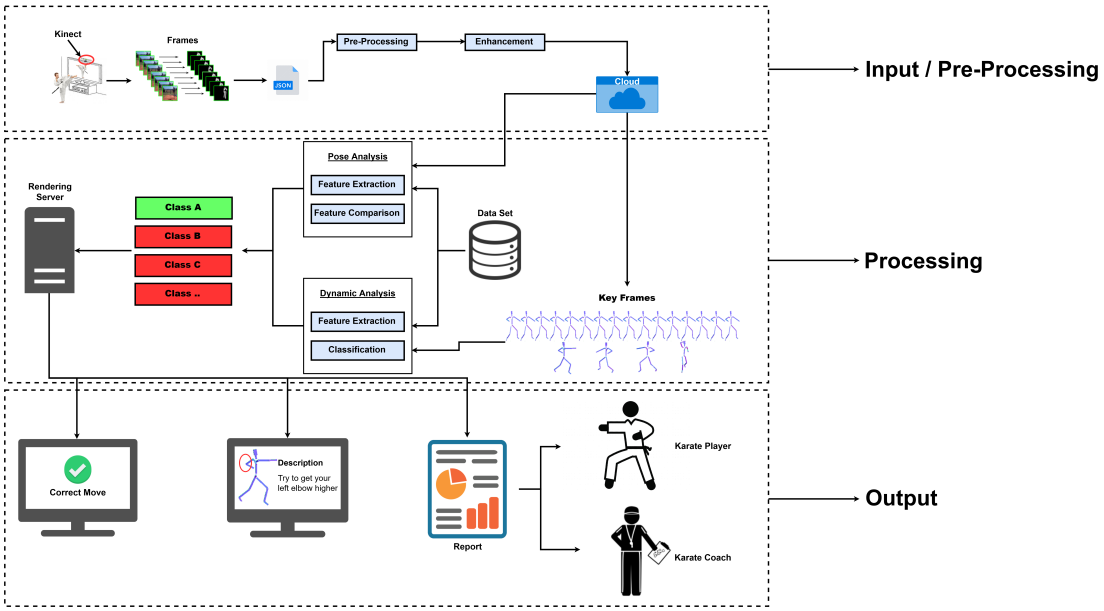


Figure 1: System Overview

As shown in figure 1, the system is composed of one or multiple Kinects. The Kinect(s) is facing the user while he/she performs a sequence of moves, then the frames and the skeleton are extracted from the Kinect and the analysis process begins, which consists of pre-processing, enhancement, saving data on the cloud, computing the key frames, feature extraction and finally the classification. According to the classification, the system is going to determine whether the move is correct or not and show the feedback and the report to the user.

3 Similar System Information

- T. Hachaj, et. el in [1] proposed statistical comparison between Kinect 1 and Kinect 2 recognition in some of the Karate movements. This research is done to evaluate effectiveness of Kinect 1 and Kinect 2 for Karate motion recognition. Their Motivation was different types of Kinect sensors, made them start this research to find the best suited sensor for Karate. They had proved in all cases that Kinect 2 is more reliable than Kinect 1 due to more accurate calculation of legs joints positions. It is important to us to make it clear that Kinect 2 will give us more accuracy and will improve our recognition rather than Kinect 1.
- T. Hachaj, et. el in [2] proposed evaluation and visualization technique

for the advanced human motion analysis. This paper is to evaluate the method for comparison, analysis and visualization of similarities and differences between 3D trajectories of body joints in Karate movements. They were interested in investigating what are the differences in the movements, due to imperfect imitation problem. This paper is important since they touched an important problem that might face us, which is imperfect imitation problem.

- E. Escobedo-Cardenas and G. Camara-Chave in [3] proposed an approach for dynamic hand gesture recognition using Kinect. They wanted to Overcome the problems of hand gesture recognition using Sensor and Video based tools. They came up with better recognition compared to the methods that uses visual information only with 88.38% accuracy. Their approach can be used to improve our accuracy and get the exact hand gestures, which could benefit our system.

- T. Hachaj, et. el in [4] proposed actions descriptions with maximally three key-frames. Their aim was to make motion recognition in low-dimensional feature space and selection of proper features to model a set of multiple human actions. They were able to reach recognition rate of level of 88%. Their selection of proper features set to model human actions in low-dimensional space could help us prioritise our features selection for better recognition.

- P. Alborno, et. el in [5] proposed a method to compute the measurement of Karate movement quality. Analysis of human full body movements to evaluate movement qualities is an important problem. They reached a solution by studying how much the limbs are synchronized during relevant motion phases. They proved that there is a way to measure the quality of Karate movements, that we can use to deliver a complete system.

- Y. Choubik and A. Mahmoudi in [6] was able to make a real-time human poses classification technique. Poses recognition is important in many situations, and their problem was to apply machine learning algorithms to classify real-time poses. Finally, they were able to classify user's poses whatever his size and his position in the scene, which will help us to classify the pose, which is a part of the Karate movements.

- N. T. Thanh, et. el in [7] made a program that applies the depth data of images to human performance scoring system. Their aim was to make a standardized modeling system that can be used around the world for Vietnamese Traditional martial arts. They used Data analysis on the Kinect's motion capture, which will guide us.

- A. D. Calin, in [8] compared the efficiency of several classifiers, trained and tested on a data-set obtained from Kinect v1 and v2. Their aim was to Evaluate the accuracy of the two Kinect Sensors and Analyse the variation of the gesture recognition accuracy of several classifiers. He reached an

accuracy of 99.0874% by Multilayer Perceptron and Kinect 2 data. This will help us in choosing our data-set and the classifiers wisely.

- T. Hachaj, et. el in [9] made a video annotation method that enables both numerical and categorical features calculation. Their aim was to create efficient system for learning Karate. Since most of the up-to-date videos data are amateur films which are not reliable for self-learning. This system is very close to our system, which we could benefit from knowing the methods and techniques they used.

- T. Hachaj, et. el in [10] proposed a calibration procedure of three Kinect sensors that integrates the data into one skeleton. Their problem was to find a way to increase Karate motion recognition accuracy and effectiveness of the fusion of the body joints gathered from different sensors. They reached a positioning of the three sensors to improve the non-classified techniques with 48%. In case of using GDL (Gesture Description Language) and more than one Kinect this paper will help us to increase our accuracy.

3.1 Similar System Description

- A system that was proposed by Mitsuhashi, el. in [11] presents a support system of body motion based on three-dimensional bio mechanism evaluation. The most important problem they face was imperfect imitation problem, that human cannot attain the perfect copy or imitation of the referenced motion because of skeleton size, each skeleton has different size from the other skeletons.

- The system made by Wennrich, el. in [12] is different because they didn't involve any Kinects in Video/Motion capture setups. The system they built is a game, were the player should learn and repeat different Karate movements to increase the progress and reach the next level. They also, used "HTC VIVE" to build this Virtual Reality game.

3.2 Comparison with Proposed Project

Our proposed project is a hybrid system, that will take Karate movements classification, measurements of quality and grading system to a better level. We will also propose another approaches and methods to enhance the movements classification. We will be combining all of these features to deliver a coaching and judgment system with all the requirements needed to reach high-quality performance in Karate (Kata style).

3.3 Screen Shots from previous systems

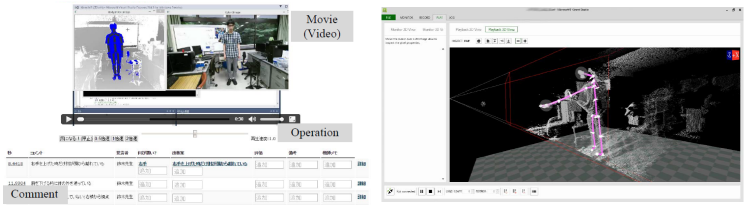
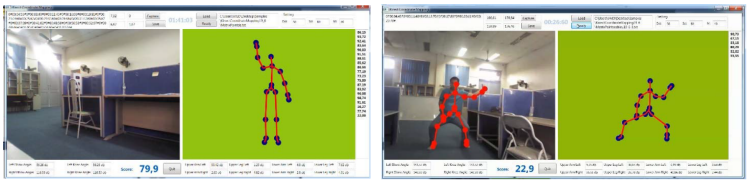


Figure 2: This System is taken from [11]



(a) First test on the system (b) Second test on the system

Figure 3: This System is taken from [7]

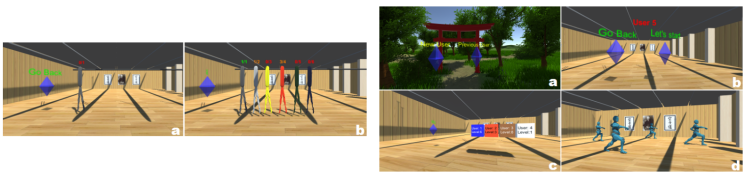


Figure 4: This system is taken from [12]

4 Project Management and Deliverables

4.1 Tasks and Time Plan

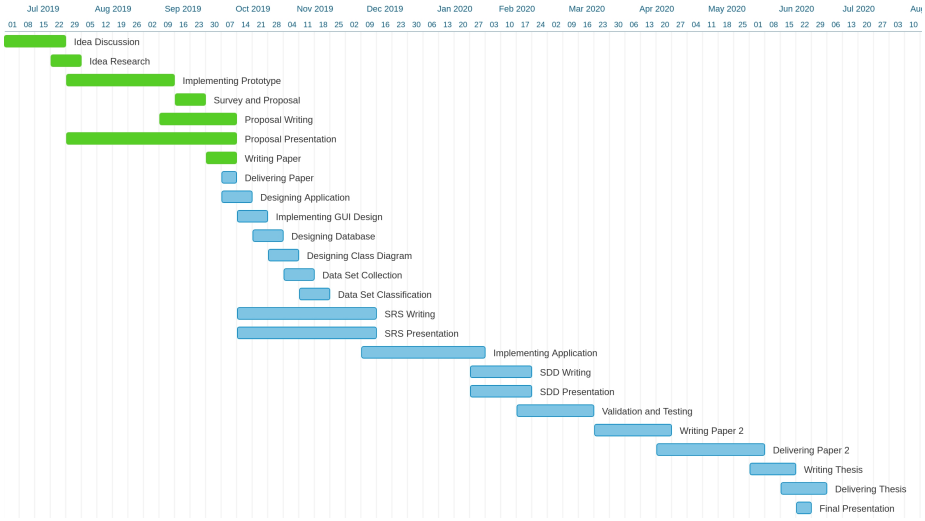


Figure 5: Tasks And Time Plan

4.2 Budget and Resource Costs

1. Microsoft Xbox One Kinect Sensor: 300$.
2. Microsoft Xbox One Kinect Sensor Adapter For Windows: 25$.
3. A Server To Process The Data: 160$/Month.
4. A Cloud To Store The Data: 20$/Year.

4.3 Supportive Documents

Asking for help in Karate and GDL Papers Inbox ×

Omar Omar Atef Hashem Ahmed <omar1603910@miuegypt.edu.eg> Wed, Aug 21, 10:04 PM

to tomekhachaj, mogiela, marcin.piekarczyk, kkoptyra

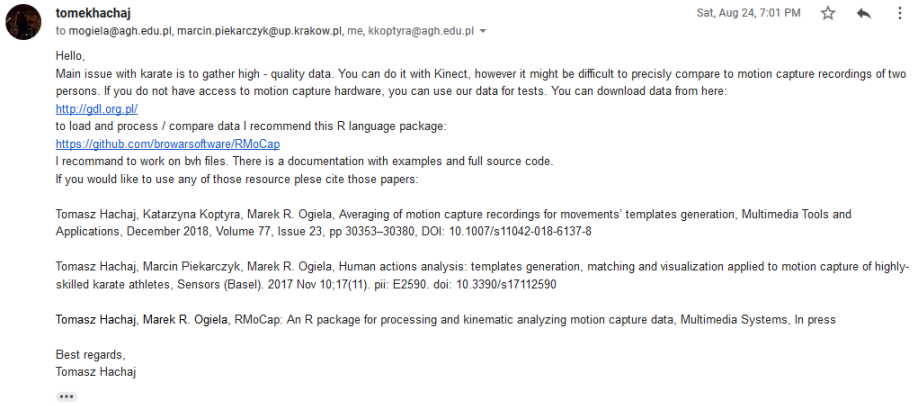
Hello,

My name is Omar Atef, I am a Computer Science Student, who studies in Egypt at Misr International University (MIU). Currently a senior and working on my Graduation Project with 3 other friends. Our project subject is about Karate, and developing a system using Kinect that could help learners get more professional and adjusting their skill motion. This system could be able to recognize the performed movement and give a fair feedback about how correct it was and giving hints to improve his skills.

I am sending this mail asking for your help, Since i read about your published papers in IEEE and knew that you are an expert in this field. So if you could allow me to ask you some questions and giving me some hints and guidance to complete my project I would really appreciate it.

best regards.

Figure 6: Data-Set 1/2



tomekhachaj Sat, Aug 24, 7:01 PM

to mogiela@agh.edu.pl, marcin.piekarczyk@up.krakow.pl, me, kkoptyra@agh.edu.pl

Hello,
Main issue with karate is to gather high - quality data. You can do it with Kinect, however it might be difficult to precisly compare to motion capture recordings of two persons. If you do not have access to motion capture hardware, you can use our data for tests. You can download data from here:
http://gdl.org.pl/
to load and process / compare data I recommend this R language package:
https://github.com/browarsoftware/RMoCap
I recommand to work on bvh files. There is a documentation with examples and full source code.
If you would like to use any of those resource plese cite those papers:

Tomasz Hachaj, Katarzyna Koptyra, Marek R. Ogiela, Averaging of motion capture recordings for movements' templates generation, Multimedia Tools and Applications, December 2018, Volume 77, Issue 23, pp 30353–30380, DOI: 10.1007/s11042-018-6137-8

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Best regards,
Tomasz Hachaj

Figure 7: Data-Set 2/2

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