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IMPROVING THE QUALITY OF INDIVIDUAL SPORT ACTIVITIES USING COMPUTER VISION TECHNOLOGY

The paper deals with the issues of comparing human movements using computer vision technology to ensure training quality during sports. The system is designed for devices with the iOS operating system, uses a smartphone camera. The ARKit library is used to recognize the position of a person. The development is aimed at use for strength training, gymnastics, etc.

Keywords: Computer Vision, ARKit, Swift, movement comparison, sports.

Relevance of the research topic. As well as Artificial Intelligence Computer Vision technology is developing very fast which is increasingly used in sports both to improve the spectator experience and to increase the effectiveness of training.

However, most of the existing sports systems are designed to train professional teams where user interfaces are complex, require the work of a coach and are too expensive for ordinary users.[1, 2, 3]

Target setting. For now there is no existing convenient systems designed for sports for ordinary users. That could provide feedback for the performed exercise without the participation of the trainer and the ability to add your own exercises.

Actual scientific researches and issues analysis. One of the most active technological fields today is an artificial intelligence, which is basic for Computer Vision technology, which is increasingly spread in our everyday life and sport industry.

This especially applies to sport professional part. We can recognize patterns between human body movements for classification and accuracy evaluation. With the help of this technology, it is possible to track the postures of several players and assess the situation on the field. Computer Vision programs are capable of detecting and classifying hits to analyze plays and further improve athletic skills. Computer vision-based sports video analytics helps reduce feedback time for time-constrained tasks. In addition, tracking is used to help newscasters and analysts interpret and analyze sports play and tactics more quickly. [1, 2, 3]

Uninvestigated parts of general matters defining. Most of the existing systems for sports, such as the training system from Stats Perform, which uses 3D sensing technology, are too expensive for the average user to use. In addition, most modern systems are designed for professional training, where user interfaces are complex and often require the work of a trainer.

Therefore, this work focuses on development the product for people who are not professionals in sports, who want to exercise correctly without harming their health. The program works with the use of the camera, without other means of recognizing the position of the body.

The research objective. Monitor the position of the human body during sports and compare with the exemplary exercise using the Computer Vision technology to improve the quality of individual sport activities. Create a user interface for visual feedback during sports training that will be accessible to everyone.

The statement of basic materials. The main tool for recognizing a person's position is the ARKit library, which includes motion capture technology. In this way, the movement of a person is tracked in real time. [4]

Movement tracking. In this paper we are tracking the position of 18 points [6]. These points are represent human joints. They are shown in the figure 1. These positions of the points are characterized by a Transformation matrix relative to the root joint (there is a hip joint) indicated by a black dotted arrow on the figure 2. [7, 8]

Therefore, the position of each point on the human body (x', y' z') is characterized by a matrix of transformations relative to the root joint, which is the origin of coordinates (x, y, z) in this case [5]:

$$[x'\ y'\ z'\ w'] = \left[a_1\ a_2\ a_2\ b_1\ a_4\ a_5\ a_6\ b_2\ a_7\ a_8\ a_9\ b_3\ 0\ 0\ 0\ 1\right][x\ y\ z\ 1]$$

Transformation matrix - numerical values that we can compare. So we can find the difference between two positions using this values.

Comparing with the largest possible difference we can find similarity of positions as a percentage for convenience.

Figure 1. Image of tracked joints.

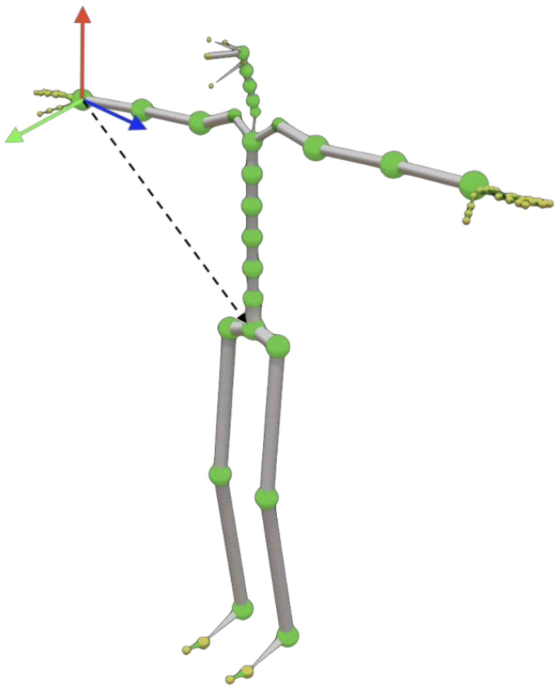

Figure 2. Location for the joint of the right hand relative to the root node of the skeleton.

Data comparison. So the movement can be detected by getting and comparing data from each frame of the video.

Movement detection. To analyze the performance of the exercise execution we need to be able to track Start and End of iteration.

To detect start of iteration for each updated frame, the system compares just received frame with the previous one. If the position has changed, the difference between the frames is large enough to be considered a movement, the movement is considered started, if the position has not changed, the system continues to compare frames.

It is possible to determine the end of the iteration if the half of the duration of the sample repetition is passed. The next step is to check the current position for similarity with the final one, and if the similarity is high enough, then we need to check whether the user has stopped in the final position. If all the described checks are successful, then the iteration is considered complete.

General system structure. The system consists of a mobile application containing the user interface with which the user interacts, an exercise recording module and a training module, here with the help of a camera and artificial intelligence programs built into ARKit, the video stream is processed to obtain data about the position of the human body during the exercise, the data of the user's movements are processed and analyzed with the help of developed algorithms. Processing results are displayed in the user interface or, using a service for interacting with the database, sent to the database.

The next part is a database with storage that is necessary for storing and downloading data and media materials from various devices. Figure 3 illustrates system main components.

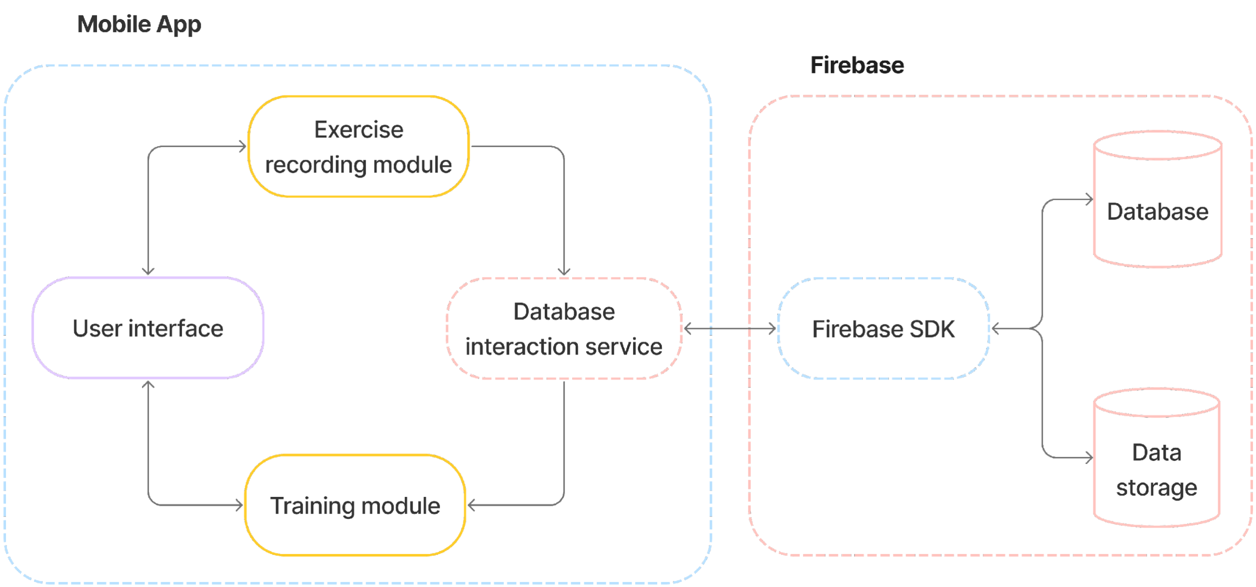

Figure 3. System main components.

Conclusions. As a result, an application for sports which allows the user to add a variety of exercises and gives feedback of the correctness of performance in a user-friendly form has been implemented. That improves a quality of individual sport activities and at the same time does not require the presence of a coach. It can be concluded that the goal was achieved.

Areas for further improvements:

- Display tracked points during recording (so user can understand that system detects his body correct).
- Use an AR model to explore the exemplary exercise from different sides and angles.
- Provide more accurate information about the results (for example, that the position of the hands was not correct).
- Create a setting for adding an exercise (for example, trainer can specify whether you need to follow the same speed or not).

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