Still Rings Movements Recognition in Gymnastics Sport Based on Deep Learning

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Abstract— The methods of detecting objects and tracking their movements are among the methods that are relied upon in many fields, whether medical or industrial, and others. One of these areas that will rely on deep learning methods in discovering and distinguishing the player's movements is the sports field and is very useful in games in which the player's degree depends on the accuracy of the performance of the movement, such as the gymnastics game, where it was applied to the static ring gymnastics game, where the distinction of movements was discovered the stability in this game is based on a convolutional neural network. Models. The neural network was trained on five of the most important stability movements in this game after creating the data set based on a set of videos of tournaments held in the period from 2016-2022, where an average of 1500 images were obtained for each stability movement, which was divided into 80% for training and 20 % for testing, after training the convolutional neural network model, it was applied to a group of video clips for different tournaments. Many criteria were adopted to measure the efficiency of the model after training and practical application, which showed the efficiency of the proposed system.

Keywords—Deep Learning ,YOLOV7,Object Detection , gymnastics sports

1.Introduction

The gymnastics game is one of the games in which the player must possess many characteristics, including strength and flexibility, as well as the ability to balance, because most of the movements of this game need these characteristics, including what depends on strength such as stability movements, as well as there are movements that require high flexibility by the player, especially In backward somersaults, the arbitration process in this game and giving points to the player depends largely on the accuracy of performing these movements and the sequence of movements[1].

The process of analyzing the movements of the gymnastics player is one of the topics of great importance, which can be benefited from the process of analyzing these movements in clarifying the weaknesses in the player in addition to avoiding some movements that may cause injuries to the player, as the traditional methods rely on the

use of sensors that are placed in different places From the player's body, from which the values of these sensors are calculated, and thus the player's performance is measured[2].

The results obtained from the application of deep learning algorithms in the process of detecting objects within video clips as well as images, and after that the process of distinguishing these objects was of high accuracy and was used in different fields, it became possible to rely on these techniques in the mathematical field in the process of discovering the player inside Video clips and then analyzing the movement of this player will be less expensive than relying on sensors[3]. A method was presented in this article that detects and distinguishes the most important stability movements in the ring game in gymnastics, where the five most important stability movements are distinguished, which are considered the most important movements that the player can evaluate on the basis of these movements. One of the convolutional neural network models, YOLOV7, was relied upon. It is considered one of the rapid models in the process of discovering objects, which are in one stage. The research is divided into seven sections, where the first section provides a general introduction to the game of gymnastics and the importance of relying on deep learning. The second section presents a group of articles that have been relied on deep learning techniques to distinguish The sports movements in the games are different. As for the third section, it presented general concepts about deep learning. As for the proposed system and the analysis of the results obtained, it was presented in the fourth and fifth paragraphs, respectively. Finally, in the sixth paragraph, the most important conclusions that were reached were explained.

2- Related Work:

Due to the importance of deep learning and the accuracy of the results that can be reached in the process of discovering the movements of the player or the ball inside the stadium, which helps in the arbitration process or can also be used in the training process or tracking the ball and locating it, the researchers presented many articles in the process of using these techniques in different sports We will present a collection of them.

Ahmed s. Abdullah and Khalil I. alsaif in 2023 , the deep learning algorithms were relied upon to detect the backfilp movement of the gymnast, which is considered one of the most important and complex movements that need high accuracy by the player as well as the referees to measure the accuracy of this movement, where it was relied on yolov7 as well as yolov5 after he divided the data into two parts 80 % for training and 20% for testing, and better results were obtained by relying on the seventh version[3].

Nur Anis in 2019 ,introduced a technique for distinguishing a badminton player on the court by utilizing one of the faster R-CNN convolutional brain network models, subsequent to gathering a data set of badminton player pictures through recordings posted on YouTube for three unique competitions, two of which are badminton competitions for men's singles and the third It's a men's pairs game. Where the video cut was changed over into a frams, where 100 pictures were taken from every video cut,

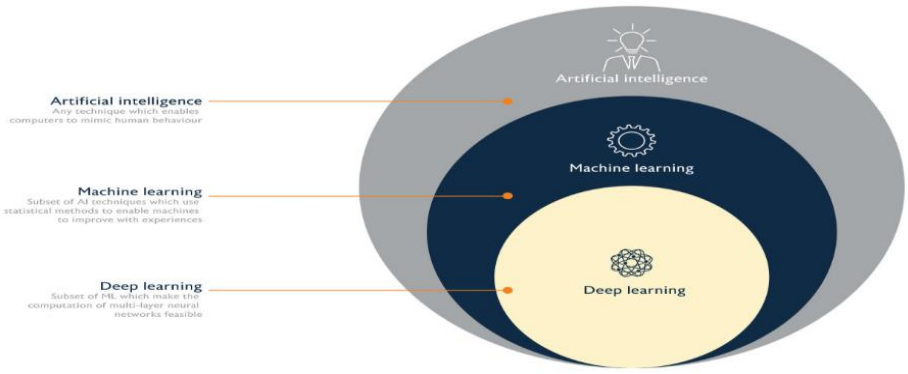
and hence we will have 300 pictures, however separated into three data sets, where the preparation of the proposed model was partitioned into 6 techniques, where the model was prepared in the initial three strategies on every One rule, concerning the fourth strategy, the profound learning model utilized was prepared on two bases, one of them is badminton for the single men, and the subsequent rule is for the sets of men. The dependence on preparing utilizing three data sets was better since every one of the models in the data sets were prepared on[4].

In 2020, Yip Zi Ying and others presented a method to distinguish the Badminton Smash movement, as it relied on three techniques (ResNet-18, VGG-16, and GoogleNet). These models were trained on the data of this movement from three positions: backhand, jump, and forehand, where the Data to 75% for training and 25% for testing. After training these models on this data, ResNet-18 was the best, as the accuracy in the training process was 97.51%, while the accuracy in the testing process was 98.86%[5].

Keerthana Rangasamy, et al. in 2020. Four moves were distinguished from the game of cricket, namely Long Corner, Free Hit, Goal, and Penalty Corner, after collecting the dataset through clips on YouTube, due to the lack of available dataset. This was cut into clips into 400 frames, which were divided into 100 for each move. VGG16 trained, 98% accuracy obtained[6].

3-Deep Learning

Artificial intelligence is all technologies that try to simulate human behavior and human thinking, such as planning, problem solving and education, and therefore it tries to make these programs able to deal and solve these problems without human intervention. Figure (1) shows the relationship between deep learning and artificial intelligence[3,7].



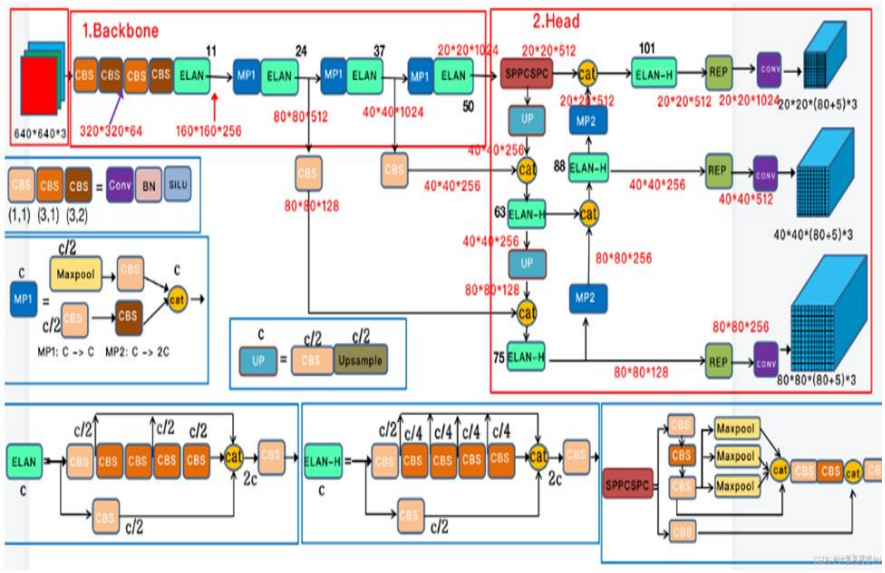
. **fig(1). AI and Deep learning**

As shown by the figure above, deep learning is one of the branches of machine learning that is within artificial intelligence. The reason for the emergence of deep learning applications clearly in the current period is due to the amount of data that exists at the present time because deep learning needs a large amount of data. In addition to the progress made in the hardware, especially the speed, because the operations within the deep learning algorithm are complex and need a group of operations, so speed will be required[8-10].

Deep Learning (DL) varies from standard AI (ML) in that it utilizes various layers to give more reflection and vigorous speculation. The usage of brain networks requires the extraction of qualities to bring down the organization's computational burden. In the event that brain networks consolidate qualities, they should be wiped out. This will request a huge organization with the capacity to give clear bearings. Subsequently, the chance of preparing achievement was slight or nonexistent. Taking into account the accessible handling power and memory, as well as late headways in registering power and memory limit, it is currently doable to prepare huge organizations effectively[11-12].

The most accurate and quick real-time object detection model for computer vision jobs is YOLOv7. In general, YOLOv7 provides a faster and more reliable network architecture with better feature integration, more accurate object detection, a more reliable loss function, and improved label assignment and model training effectiveness. Yolov7's expanded efficient layer aggregation networks are built on a foundation of efficient layer aggregation networks, which are characterized by large parameter sets and high computational densities. According to the VovNet and CSPVNet models, the input/output channel ratio and element-wise operation have an effect on the speed of network inference (CNN aims to make DenseNet more efficient by integrating all features just once in the last feature map). E-ELAN, as designated by YOLO v7, after expanding ELAN, dubbed The ability to better learn and create a deeper network by managing the gradient path was the primary advantage of ELAN (Efficient Layer Aggregation Networks)[20,21].

To improve the YOLOv7, a compound model scaling approach can be used. In this instance, breadth and depth are scaled coherently for concatenation-based models. Re-parameterization is a technique used to improve the model after training. model. Despite the longer training time, better judgment results are achieved. Model level and module level ensemble re-parameterization are both used to finish models. Re-parameterizing models at the model level is possible using either of these two techniques. With the same settings and various training sets, train multiple models. to the weights. The weights of a model are spread over many epochs. Recent study has seen a huge increase in the use of re-parameterization at the module level. Using this method, the model training process is divided into a number of stages. The outputs are simulated to build the final model. RepConv is used in the re-parameterized convolution design in YOLOv7 without identity connection (RepConvN). When re-parameterized convolution is used to swap out a convolution layer for residual or concatenation, the intention is to avoid identity links figure (2) show the architecture of YOLOV7 [20,21] .



Fig(2) : YOLOV7 Architecture

4. Proposed System

In this paragraph we will discuss the steps that were followed in this article:

a-Data collection and preprocessing.

The video clips on YouTube were relied upon in the process of creating the dataset, due to the fact that they were not available in an available format, as it relied on 100 video clips for different tournaments and focused only on the game of throat in gymnastics. These clips were converted into a set of frames, where 7500 images were created, divided into 1500 for each Classified, this image has been processed through digital image processing techniques to improve the contrast in the image by using histogram equalization [17-19].as well as re-sizing it,figure (3) shows a sample of the dataset.

Fig(3). Samples of Dataset

b.- train yolov7 and testing

One of the convolutional neural network models was used, where yolov7 was used, where the data was divided into 80% for training, 20% for testing, where Google Colab was relied on to implement the training process because it provides an environment containing the GPU. after that, the network was tested on a group of video clips of gymnastics players to measure its efficiency in the process of discovering and distinguishing the movements of the players.

c.- Evaluate the performance

A set of criteria was relied upon to measure the efficiency of the algorithm in training and testing, where the following was used[13,16]:

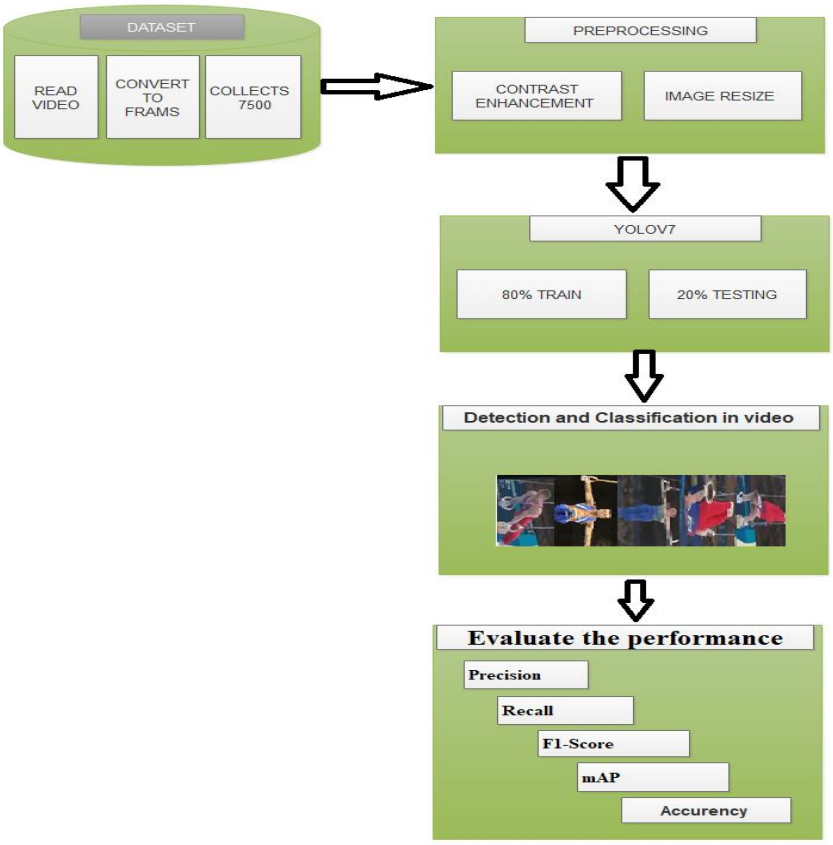
$$\boldsymbol{precision} = \frac{Tr\ Posiyive}{True\ Positive + False\ Positive} * 100\% \dots\dots\dots\dots\dots\dots\dots\dots (1)$$

$$Recall = \frac{True\ Posiyive}{True\ Positive + False\ Nagative} * 100\% \dots\dots\dots\dots\dots\dots\dots\dots (2)$$

$$F1 - Score = \frac{precision * recall}{precision + recall} * 2 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3)$$

$$Mean\ Average\ Precision = \frac{1}{number\ of\ classes} \sum_{k=1}^{k=n} The\ Average\ Precision, of\ class\ k. \quad (4)$$

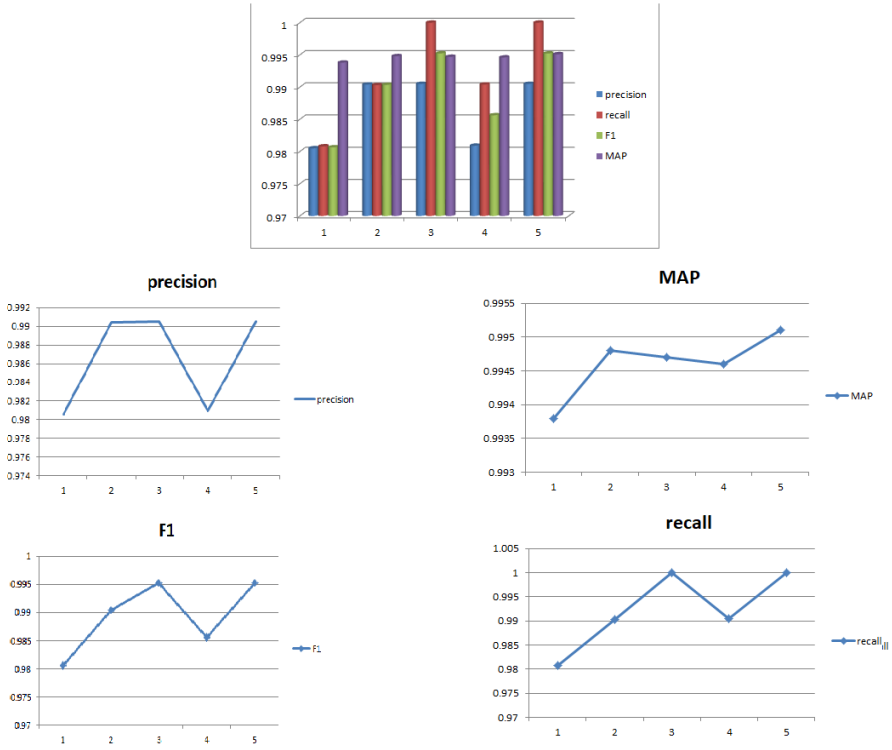
Figure (3) shows the flowchart of the proposed system



Fig(4) . proposed system

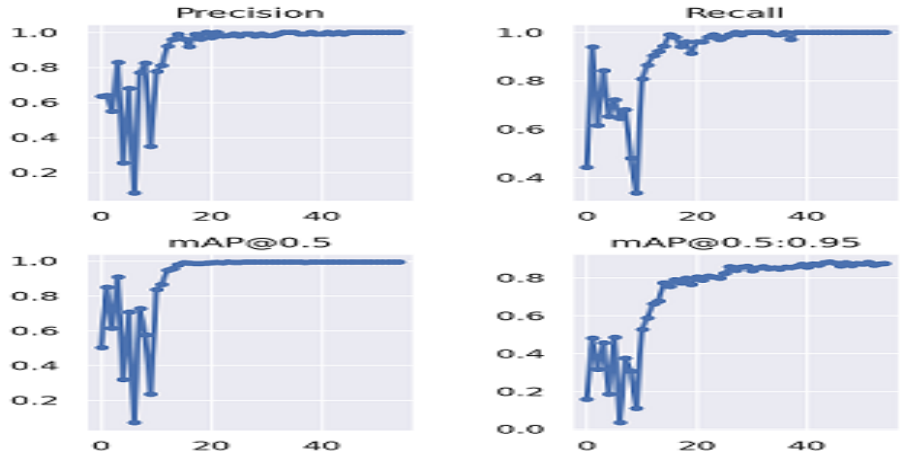
5- Result

After training the convolutional neural network models on five of the most important throat movements in gymnastics, the test is done on a group of videos. Figure (4) shows some of the results obtained from applying the proposed system to the video clips.



Fig(5).Evaluate the performance for train

Where it is noted from the obtained results that the system is able to detect the movements of stability, the basic five in the gymnastic throat game, where it is noted that the system was able to distinguish these movements with a high correct rate, and therefore the accuracy was very high, the slight difference between the results between distinguishing these movements due to The nature of the movement differs. In some movements, the hands are joined to the body, and therefore the results of discrimination were high. As for other movements, the hand is open, the results are less accurate. Figure (6) shows the graph of the convolutional neural network training process.



Fig(6).YOLOV7 training

6- conclusion

Relying on computer vision systems and deep learning techniques in the process of detecting and distinguishing the player's movements in different sports games, especially games in which the player's evaluation depends on the accuracy of the performance in which the player presents a specific movement, such as the gymnastics game, which is considered one of the games in which it is difficult in the arbitration process. It is possible to rely on computer vision systems that are able to evaluate movement more accurately than humans, as we note that the results obtained through the application of the proposed system, which was based on one of the yolov7 convolutional neural network models, showed high accuracy in detecting movement and distinguishing it through segments Therefore, it would be better to rely on it in the arbitration process after adding some arbitration rules to the proposed model.

7-References

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