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Analysis of boxing Performances using machine learning algorithm

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Abstract: *This study focuses on a scientific and experimental way of employing thera band and reflex ball training to improve punching accuracy in amateur boxing, and a revolutionary strategy is modeled. A group of athletes from various categories were chosen to put this idea to the test, with pre- and post-training data recorded and compared to see how Boxer performance, accuracy, and stability changed. Machine learning is a strong data categorization method that has been used to categorize recorded movement data. Furthermore, supervised machine learning models should be built on sparring data to evaluate if high accuracy can be maintained in a competitive context.*

Key Word: *Sensor, Machine learning; sport; boxing.*

I. INTRODUCTION

Athletes nowadays are larger, quicker, and stronger. Science is progressing at an alarming rate. Kickboxing is a fast-paced, anaerobic sport. Throwing punches round after round while fighting an assaulting opponent is a difficult undertaking. Boxing is possibly the most physically demanding sport. A boxer's motions and responses must be split second in order to punch, slide, and block. A boxer should be prepared to battle with vigor round after round. Boxing is anaerobic in nature. If a boxer wants to be effective in the ring, he must turn in a precise way. The vast majority of boxers still run 4 or 5 kilometers every day.

Boxing has evolved into an intriguing sport in recent years. Boxing is popular and well-liked all [2]around the world. Maintaining peak performances are difficult in boxing. Physical, physiological, and psychological fitness are all significant factors in producing elite boxing performances. A variety of elements impact boxing players' performance, some of which may be predicted and adjusted, including as food, physical fitness, the player's mental toughness, mental capacity, inventiveness, and brain functions.

One of the most essential traits of a boxer is his or her punch speed; the ability to punch rapidly and unexpectedly nearly always defines the course of the fight and delivers victory. As a result, coaches work ceaselessly on the development of players' speed attributes, which has resulted in a high level of activity among scientists in this field.

To develop the speed of a boxer's punch, it is required not only to put in the appropriate training time, but also to regularly check the development. As a result, the athlete's progress is closely monitored by the coach, because it is hard to comprehend whether the training approach and tactics are appropriate without tracking the dynamics of change. Constant control is connected with a significant number of punch speed and acceleration data. This places a significant load on coaches, who must train dozens of athletes.

As a result, the objective of this research was to create an automated system for collecting and analysing data on parameters (punches, endurance, speed, and resistance) in amateur boxing.

II. RELATED WORKS

Hristovski R, Davids K, and Arajo D. (2006) investigated the effects of participant-target distance and perceived hand striking efficiency on emergent behavior in boxing, discovering affordance-controlled nonlinear dynamical effects (i.e. bifurcations) inside the participant—target system. The findings demonstrated the existence of key scaled distance values for the formation of first time excitations and annihilations of a broad range of boxing actions, namely the appearance and dissolution of jabs, hooks, and uppercuts. There were two reasons for the action diversity: (a) topological discontinuities (bifurcations) in the number of feasible hand strikes, i.e. motor solutions to the hitting task; and (b) fine alteration of probability of development of striking patterns. Boxers' use of a 'strike ability' affordance in scaled distance-to-target information resulted in a variety of emergent behaviors via a cascade of bifurcations in the task perceptual-motor work space. According to the data, perceived efficiency (E) of an action varied as a function of scaled distance (D) and was connected with the frequency of occurrence of action patterns (P), with the following dependency P = P(E(D)). The consequence is that the probability of occurrence (P) is affected by efficiency (E), which is affected by scaled distance (D) to the target. As a result, scaled distance-dependent perceived efficiency appears to be a suitable choice for a contextual (control) component in boxing to characterize the nonlinear dynamics of striking movements.

Shoepe, Ramirez, and Almstedt (2010) measured the length vs. tension parameters of a variety of regularly used elastic bands in order to calculate the resistance that would be imparted to free-weight plus elastic bench presses (BP) and squats (SQ). An overhead support beam was fitted with five elastic bands of varied thicknesses. Dumbbells of varied weights were gradually added to the free end, and the linear deformation was measured with each weight increase. The resistance was displayed as a factor of linear deformation, and the data was then matched to the best-fit nonlinear logarithmic regression equations. It was determined that load disparities exist as a function of elastic band thickness, attachment technique, and kind of activity done.

Spori Goran, Harasin Drazen, Bok Daniel, Matika Dario, and Vuleta Dinko (2012) studied the impact of special operations battalion (SOB) training on soldiers' fitness measures. The study included 25 members of the Croatian Armed Forces for SOB (mean SD: age 27.93 5.12 years, height 178.64 6.91 cm, body mass 81.42 9.18 kg) separated into control and experimental groups. The SOB basic training lasted 62 days in total. The variable set includes 12 tests for assessing fitness traits, 2 tests for functional capacity, and 18 morphological measurements. Morphological parameters were measured in accordance with the International Biological Program's guidelines.

III. PROBLEM STATEMENT

Boxing movements are complicated, and as can be seen in the works of other writers in this subject, mostly single blows struck outside of a genuine fight are investigated.

The structure of human movement is complicated. The kinematic structure of movement encompasses spatial, temporal, rhythmic, and phase aspects. Power, energy, and inertial characteristics reflect the dynamic structure of movement. The human musculoskeletal system determines the anatomical structure of movement. Sensory and psychological aspects influence the control structure. It is extremely difficult to create a mathematical model that describes human movement while taking into consideration the interplay of all of these components, which are also highly individual for various persons. Tensometry, accelerometers and gyroscopes, and electromyography, which provide data on the speed, acceleration, and rotation angles of body segments; electrical activity of muscles; support reaction forces; and movement trajectory, are currently well-developed and used to build a biomechanical model. However, integrating this massive amount of data into a coherent image of movement remains challenging.

Machine learning methods provide an alternate approach for analysing human motions. The Long Short Term Memory (LSTM) offers several potential for data analysis in sports and boosting athlete movement efficiency.

IV METHODOLOGY

The focus of this research was to compare the impact of Thera band and Reflex ball training on boxing performance measures.Two distinct groups participated in the experiments. One group receives thera band and reflex ball training, whereas the other group does not receive thera band and reflex ball training. Boxers threw a series of punches on a Boxing pad that was used to measure punch force. The IMU was mounted to the wrist of each boxer's hand, measuring the acceleration and angular velocity of each blow. The punch force, acceleration, and angular velocity were therefore monitored for each punch. The punches with the best indications of speed and strength were chosen from among all of them.

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From the data collection we can able to find out the,
1) punch counts
2) endurance
3) speed
4) Resistance

V. DATA COLLECTION

The Experiment included two types of volunteer boxers from the Boxing Sports Club.

One group receives thera band and reflex ball training, whereas the other group does not receive thera band and reflex ball training. Boxers threw a series of punches on a Boxing pad that was used to measure punch force. The IMU was mounted to the wrist of each boxer's hand, measuring the acceleration and angular velocity of each blow. The punch force, acceleration, and angular velocity were therefore monitored for each punch. The punches with the best indications [6]of speed and strength were chosen from among all of them. These punches were combined to create a data set for training the artificial neural network.

To obtain data for training the LSTM, each boxer used single punches in each category (straight, hook, and uppercut) and performed motions that mimicked Amateur Boxing without strikes. The punches were not distinguished by whether they were delivered with the right or left hand. Each fighter in each group delivered 100 blows with each arm before taking a break.

VI. DESIGN OF EXPERIMENT

The boxer punches a boxing pad during the testing. Only single punches (jab, cross) were analyzed (no punch combos). The wall-mounted boxing pad has a punch force measurement feature as well as an Internet of Things module for transferring data with a computer.

The boxer's wrists were fitted with fixed inertial measuring units that included a gyroscope and an accelerometer to detect the rotational and translational motions of the hands. Along with the IMUs, wireless transmitters were mounted on the wrist, which sent data to a computer through an IOT.

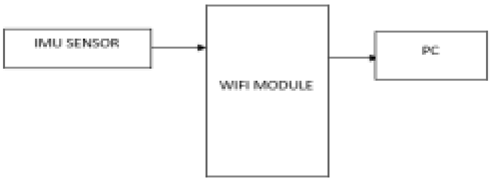


Figure 1: *Block Diagram*

The box containing the fitted IMU and microprocessor was tiny enough to fit comfortably within a boxing glove.

1. The obtained data for training (dataset) was randomly jumbled.
2. The dataset is separated into k sample groups (k = 50 in this study).
3. for each distinct sample:
    - the remaining groups are used to train the model;
    - the model is tested on a test sample;
    - the model score is kept, and the next selection is moved on.
4. The model quality parameters are generalized based on the sample model estimations.

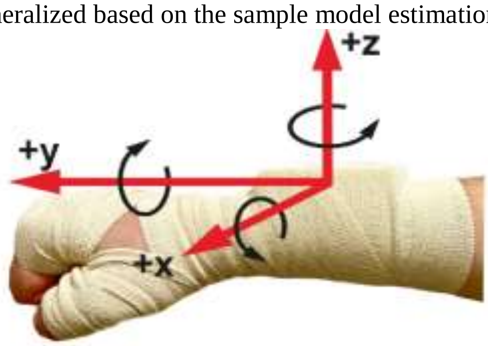


Figure 2: Measuring module attached to the arm with a boxing hand wrap

VII. MACHINE LEARNING ALGORITHM

A recurrent neural network is Long Short Term Memory. The output of the previous step is fed into the current step in RNN. Hoch Reiter & Schmidhuber created LSTM. It addressed the issue of RNN long-term dependency, in which the RNN cannot predict words stored in long-term memory but can make more accurate predictions based on current input. RNN does not provide efficient performance as the gap length rises. By default, LSTM can save the information for a long time. It is used for time-series data processing, prediction, and classification.

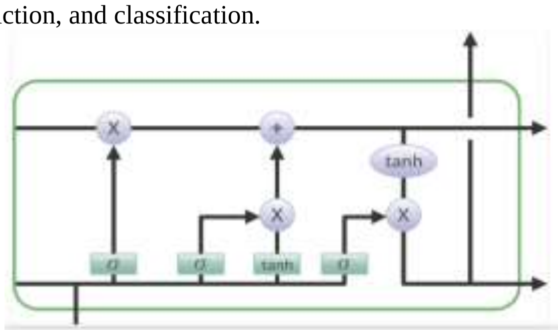


Figure 3: Lstm Algorithm

Figure 3 shows LSTM's chain structure, which includes four neural networks and several memory units known as cells.

VIII. RESULT AND DISCUSSION

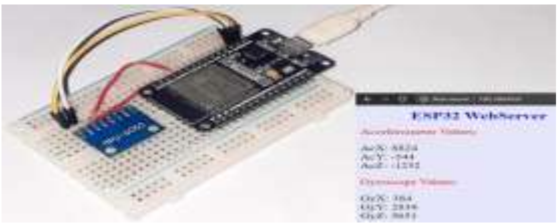


Figure 4: - Prototype

Above Figure shows the prototype model of the design experiment.

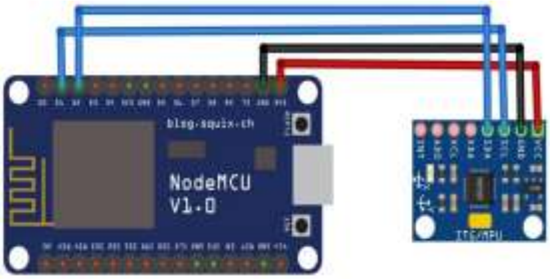
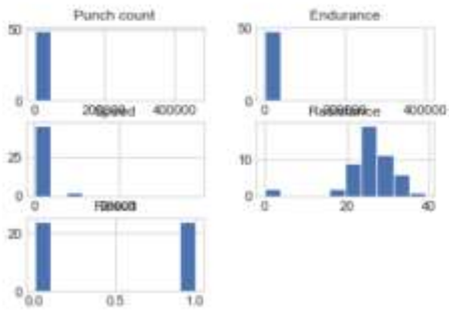
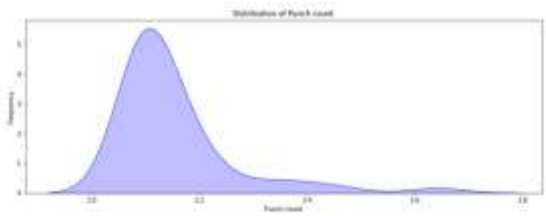


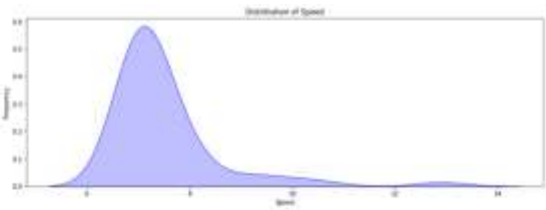
Figure 5: - Circuit diagram

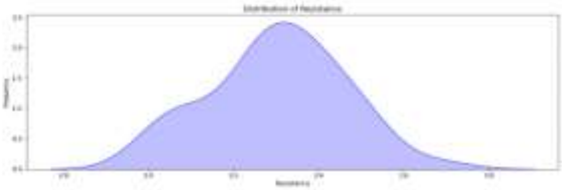
After producing a complete dataset, the models were trained for each group of boxers.
MLP training took no more than 10 min on a computer with the following parameters:
CPU—Intel Core i7; RAM—16 GB; and CPU frequency—3.2 GHz.



Overall characteristics (speed, punch count, endurance, and resistance) were enhanced, was shown in this figure as compared to untrained groups.







Boxers who trained with the Thera Band and reflex ball improved their speed, punches, and resistance, according to the findings.

IX. CONCLUSION

Experiments have demonstrated that using LSTM in the form of MLP considerably simplifies data collecting on the kinetic features of boxer punches, allowing this procedure to be automated. During shadow boxing, punch metrics such as speed and acceleration may be calculated, as well as the type of punch and its properties. It is well recognised that the qualities of a punch in a fight differ from those of a boxer striking outside of a fight. With recent technological advancements, measuring the dimensions of a punch during a fight is not difficult, but identifying punches requires specific video capture of motions, which is a time-consuming and expensive technique that is nearly impossible to carry out for several dozen boxers. However, with the advancement of technology, video capture may take the lead in detecting motions in martial arts in the future.

Machine learning frequently employs a data augmentation approach to greatly enhance the variety of data available for training models. The "repetition without repetition" strategy was utilized in this experiment; that is, boxers were told to administer each punch differently without changing the kind of punch. Simultaneously, data augmentation was used, which boosted the efficiency of the produced model.

Experiments were carried out on a second set of entry-level boxers of comparable age and weight to the first. We investigated the notion that the better the punch method, the closer its parameters are to the ideal, model ones in this experiment. To compare punches, a single metric called the quality of the punch was devised, which is equal to the product of the punch's effective force and velocity. The effective punch force is a property that is proportional to punch power. As a consequence of the trial, a link was discovered between the quality of the punch and the degree of model conformity. This dependency turns out to be almost linear.

Raw IMUs data was utilized as a dataset in the experiments, and pre-processing of the data is planned for future investigations (normalization, reduction of the dimension of the input dataset.).

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