ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24SEP239

Athletic Runners Injury Prediction using Support Vector machines (SVM)

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Abstract:- Concerns about predicting sports-related injuries, like those experienced while practicing soccer or running, have grown recently due to the use of machine learning techniques for this purpose.

The proposed injury prediction framework is based on SVM and an artificial neural network. The proposed model's architecture aids in the runners' injury prediction. The model's creators gathered the datasets of 24 runners. The model was implemented in MATLAB and evaluated with the help of gathered data. Lastly, a comparative analysis has been done between the model and previous attempts. Furthermore, the gathered dataset was used to assess the model's correctness. By now, the accuracy was 93.7%. The writers plan to provide more information in the future, such as the runners' ages and gender.

Keywords:- *Machine Learning, SVM , Injury, Runner.*

I. INTRODUCTION

Recently, there has been an increasing concern about using machine learning algorithms to predict injuries in sports, including soccer and running. In recent years, concern over applying machine learning algorithms to forecast sports-related injuries, such as those sustained in running and soccer, has grown(Van Eetvelde, Mendonça, Ley, Seil, & Tischer, 2021). Several studies have demonstrated machine learning's ability to accurately predict injuries by analyzing pre-season data and identifying risk factors. For instance, machine learning algorithms have shown higher sensitivity in predicting injuries than traditional statistical methods(Santos, Dias, & Amado, 2022), as evidenced by studies conducted on professional and youth soccer players. Additionally, using pressure plate measurements combined with machine learning models has successfully identified individuals at risk of lower extremity overuse injuries in physically active populations (Mohamed &Rasha ,2024).

These developments highlight the importance of injury prediction and the capability of machine learning algorithms in this domain. Remaining injury-free is crucial for sporting achievement. New technologies and data science applications may offer valuable insights despite the difficulty in predicting injuries.(Lövdal, Den Hartigh, & Azzopardi, 2021).

This study aims to develop a machine learning framework, more specifically using a Support Vector Machine (SVM), that can forecast injuries for runners. This objective aligns with the growing awareness of using machine learning to expect injuries in sports, as evidenced by previous studies in soccer that have successfully utilized machine learning algorithms to forecast injury occurrence.

Being healthy and avoiding injuries is crucial for achieving peak sports performance. Thus, academics and professionals from various sports have gathered statistics on athletes' training loads and injury rates for decades.

In recent years, sports data-driven advice has been enhanced with the introduction of machine-learning applications and new technologies. These tools can forecast future performance and injuries.

Injuries in both individual and team sports are frequently shared and can seriously affect one's physical, mental, and financial well-being.

The current research seeks to apply similar principles to the context of competitive running, leveraging SVM to analyze running patterns and biomechanical data to predict the risk of injuries.

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II. LITERATURE REVIEW

A forecasting model with average areas under the curves of 0.724 and 0.678 was discovered using bagged XGBoost machine learning for injury prediction in competitive runners. In particular, the day approach results show a high likelihood that our method accurately predicts injuries from new technologies.(Lövdal et al., 2021).

Additionally, predicting football injuries with machine learning is very new but growing quickly. Machine learning techniques produce accurate injury forecasts, helping new technologies better understand the comparative influence of several (psychological and physical) properties of training load on injury risk. (Majumdar, Bakirov, Hodges, Scott, & Rees, 2022).

Similarly, Rossi and author authors studied injuries.954 data records were gathered by the authors. The dataset consists of twenty-six Italian professional male players. The data is automatically collected using GPS data and then used to select features and predictions using machine learning. (Rossi et al., 2018)Another project was also found to create and evaluate a hierarchical machine learning predictive system that can use athletic load data to identify injuries in players early and accurately. The model was experimented on 21 soccer players, who were collected from various sources containing inner data, like heart rate, and exterior data, like the number of jumps.(Naglah et al., 2018). Likewise, A model based on a decision tree is used for injury forecasting in soccer using feature selection and GPS. The model accuracy is 76%(Rossi et al., 2018). Another prediction system built by SmoteBoost presented 75% accuracy. This model can identify professional soccer and handball players who are sensitive to lower extremity muscle injuries (MUSINJ). The prediction model facilitates injury prevention decision-making.(López-Valenciano et al., 2018). Also, the decision tree model was used to improve the identification of injury risk features and forecast injury in a group of elite male youth football. The model accuracy was 66%(Oliver et al., 2020).

III. METHODOLOGY

Developing the suggested machine learning SVM injury prediction model for competitive runners' injury avoidance involved several crucial phases.

- Firstly, Stating the theoretical foundation: In this stage, a deep reading, understanding, and analysis of the prediction system of injury, the injuries for runners, and the related works that were done in this field will performed to form a clear orientation of the theoretical framework for the work
- Secondly, Specifies the requirements and features of the proposed model.
- Thirdly, Design the suggested framework: In this stage, the model of the prediction system of injury will be clear. Initially, data collection included gathering running-related measurements, such as heart rate, speed, and impact force. The collected data was preprocessed to ensure the data quality and consistency. Then, the level of the feature selection process and engineering were performed to identify the most relevant features that can be used for the injury prediction decision. Lastly, using Support Vector Machines (SVM) as the machine learning algorithm for injury prediction was a central aspect of the methodology, leveraging its ability to handle complex, high-dimensional data and find optimal separating hyperplanes as shown in figure1 .
- Fourthly, Build the suggested framework: In this stage, the model is developed by using match string algorithms applied by MATLAB.
- Finaly , Evaluate the suggested framework : In this stage, the model will be tested

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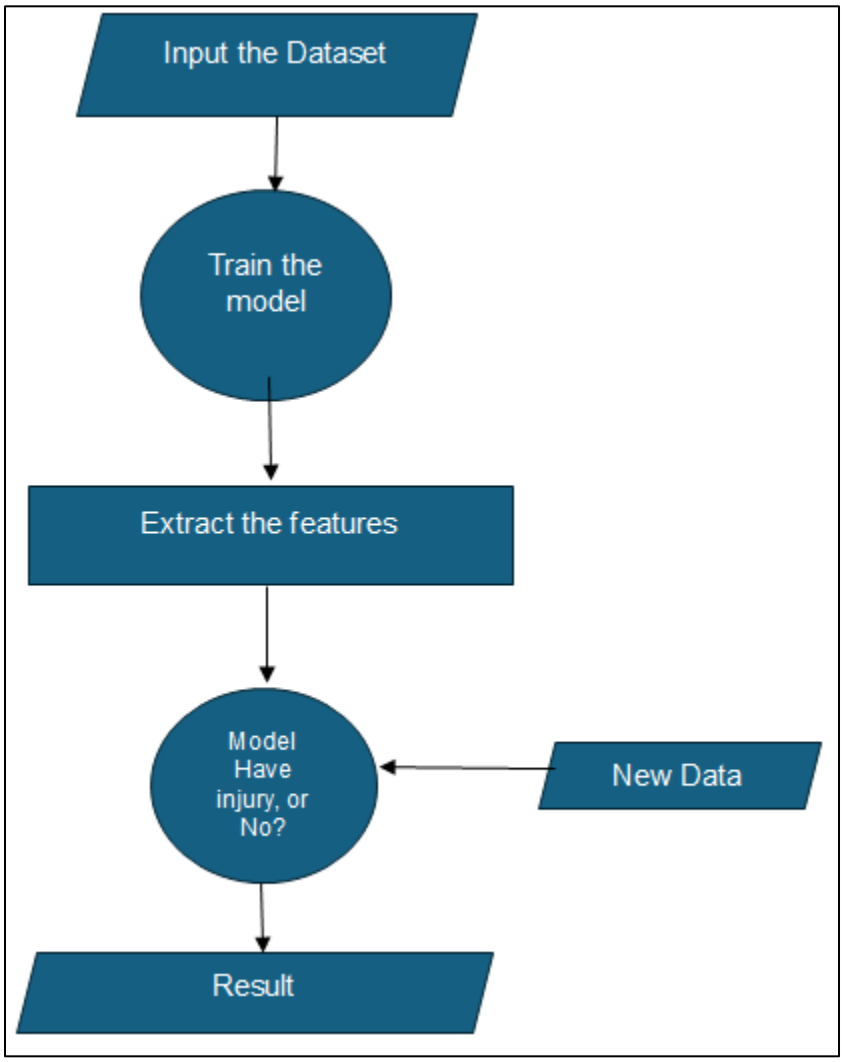

Fig 1: Proposed Injury Prediction Model based on SVM

IV. DATASET

The dataset was collected from 24 runners, from Marvel Gym at port said in Egypt. The dataset was collected from 20 males and 4 females, and the age between 19 to 35 years. The collected dataset has a unique feature. Table 1 describes the datasets used in this evaluation stage. The dataset measures the heart rate, speed, and impact force for two months.

Table1: Collected Dataset

Gender	Heart Rate	Speed	Impact Force	Injury Status
Female	150	8	200	0
Female	161	7	180	1
Female	145	8	190	1
Female	155	9	205	1
Male	150	8	200	0
Male	168	7	180	1
Male	145	8	190	1
Male	155	9	205	1
Male	150	8	200	0

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Male	170	7	180	1
Male	145	8	190	1
Male	155	9	205	1
Male	150	8	200	0
Male	160	7	180	1
Male	145	8	190	1
Male	155	9	205	1
Male	150	8	200	0
Male	160	7	180	1
Male	145	8	190	1
Male	155	9	205	1
Male	150	8	200	0
Male	165	7	180	1
Male	145	8	190	1
Male	155	9	205	1

V. RESULT AND DISCUSSION

This section aims to validate the suggested framework, which was constructed using the MATLAB programming language. Based on the authors' gathered data, this research evaluates the framework's accuracy for injury prediction in competitive runners using machine learning SVM.

This research uses a novel, proposed framework to determine the runner's injury prediction. This section on the test displays the proposed framework's accomplishments. The evaluation phase shows how effective the suggested framework is. Ten iterations of the framework were run.

By applying the runner data to the suggested framework, the Confusion Matrices for collected data were computed, as shown in Table 2.

False Negative Rate = FN/ (TP + FN) = 2/ (22 + 2) = 0.083
Accuracy = (TP+TN) / (TP+TN+FP+FN) = (45)/ (22+23+2+1) = 0.937.
Precision = TP / (TP + FP) = 22/(22+1) = 0.956.
Sensitivity = TP / (TP + FN) = 22/(22+2)=0.916.
Specificity = 23/ (23 + 1) =0.958.
False Positive Rate = FP / (FP + TN) == 1/(1+23)= 0.041.

Table 2: Calculate the Confusion Matrices to predict injury

Actual	**No injury**	**Injury**
No injury	22	2
Injury	1	23

From the data shown in Table2, the accuracy becomes 93.7% at predicting injury, and precision is 95.6%

- *Comparing the Result of the Suggested Framework with Former Models*

This part shows the accuracy evaluation of the suggested framework with former models, as shown in Table 3.

Table 3: Comparing the result between the new framework and the previous works

Paper	**Methods**	**Database**	**Accuracy**
Oliver et al., 2020	Decision tree	Collected male	66%
.(López-Valenciano et al., 2018)	SmoteBoost	Collected	75%
Suggested framework	SVM	Collected	93.7%

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VI. CONCLUSION

The proposed framework for injury prediction is based on machine learning using SVM. This proposed model architecture helps predict runners' injuries. The model's authors collected the runners' datasets from 24 runners. The model was implemented in MATLAB and evaluated with the gathered data. Lastly, a comparative analysis has been done between the model and previous works. Furthermore, the gathered dataset was used to assess the model's accuracy. The accuracy improved to 93.7 %. In the Future, the authors will add more data, such as the gender and age of the runners.

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