ISSN 2618-1576 Vol. 4, Issue 3: 1-7, DOI: 10.25236/FSR.2022.040301

Research on Apparent Strain Measurement of Ankle Joint in Taekwondo Sports Using Data Mining Algorithm

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Abstract: *As a sport, Taekwondo has always attracted everyone's attention and love, but it is a very common phenomenon to have ankle injuries during sports. Therefore, the detection of ankle injuries has become a concern theme of scholars. It is of great significance to realize the ankle apparent strain measurement quickly and in colleges and universities. In this paper, a data mining algorithm-based approach to measuring the apparent strain of the ankle joint in Taekwondo sports is proposed. This paper first analyzes and integrates the research results of scholars, and then expounds from the two aspects of data mining and ankle apparent strain measurement. The method is introduced in detail, and the principle of apparent strain measurement is explained by the formula. The feasibility and robustness of the research scheme are then demonstrated through specific experimental data. The data showed that there was a difference between the boy group and the girl group in the time of jumping, kicking, and reaching the ground.*

Keywords: *data mining algorithms, Taekwondo sports, apparent strain measurement*

1. Introduction

Data mining technology can analyze and learn patterns and rules that are useful to users from a large amount of data. Using these learned patterns and rules, when new sample data is available, possible properties of sample data can be predicted based on existing patterns and rules. Aiming at the non-contact fast dynamic measurement of tissue mechanical properties under the condition of keeping the ankle joint relatively intact, the image processing technology is used to extract the dynamic ankle surface strain information, which is necessary for the comprehensive realization of non-contact dynamic ankle biomechanical properties rapid measurement. The attempt and development of the ankle joint provide an effective way for the basic research on the biomechanical properties of the ankle joint, and provide a powerful theoretical guidance for the clinical and rehabilitation of the ankle joint. However, the first and most critical problem in extracting strain is to extract the motion trajectory of the feature points in the ankle joint measurement area during the ankle flexion movement, that is, by calculating the relative displacement between the feature points to obtain the relative deformation variable and further deduce the strain variable. Therefore, it is necessary to study the extraction method of feature points, that is, how to check and extract the center of mass (coordinates) of feature points, the size (area) of feature points, and the shape of feature points.

2. Data mining algorithms

In fact, data mining is sometimes simply understood as "knowledge discovery", and its key steps are as follows:

(1) Data cleaning

(2) Data Integration

(3) Data selection

(4) Data transformation

(5) Data mining

(6) Model evaluation

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(7) Knowledge representation

Among them, the first four steps can be considered as the data preprocessing stage, the purpose is to prepare for the next data mining. Data mining is an extremely important step, as it undertakes the heavy task of uncovering hidden data patterns for evaluation [1-2].

The first stage of data mining is based on an independent system, using vector data, and only supports individual algorithms. The second stage is the combination of data mining and database, which can support multiple algorithms at the same time. The third stage of data mining is based on grid computing, and the prediction model is integrated in the data mining process, which can process Web data. The fourth stage is distributed data mining, which is a way of distributing multiple algorithms to execute on multiple nodes. The fifth stage is data mining based on cloud computing, which adopts the mode of distributed parallel processing and service to form a shared resource pool and allocate tasks on demand [3]. Data mining is a complete process (Figure 1).

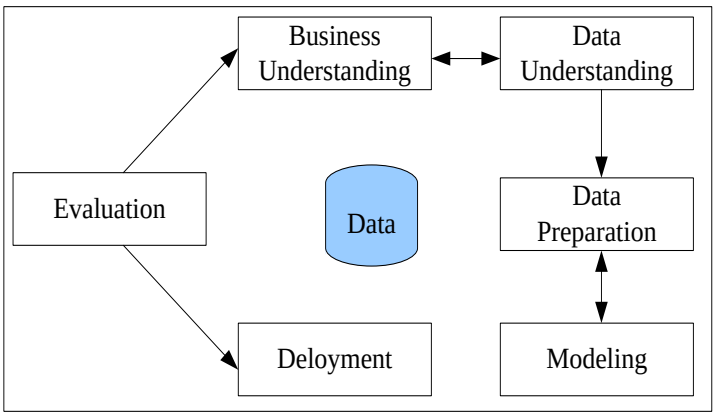

Figure 1: The process of data mining

The methods of data mining are as follows:

2.1 Prediction

Prediction is to establish a model based on the regularity of existing data, and predict the occurrence of future data through the analysis of the model. The typical prediction method is the regression analysis method, which is to obtain a nonlinear or linear regression equation based on the previous data, and to set a value for the independent variable to obtain a predicted value of the dependent variable, so as to achieve the purpose of information prediction [4-5].

2.2 Clustering

Clustering is a method for computers to recognize things, which can find the categories of things without human assistance. It usually divides the data/records in a data set into subsets with non-repetitive elements, that is, clusters. Because the machine discovers the category of things autonomously, the result of clustering is unpredictable. The cluster implementer can summarize the final clusters and find the characteristics of each cluster [6]. A good cluster analysis algorithm is to improve the similarity of objects within the same cluster as much as possible, and reduce the similarity between different clusters, and a suitable metric can be selected for the measure of similarity.

This paper briefly introduces the future research directions of data mining:

(1) Website-based mining: With the vigorous development of e-commerce websites, it is easy to build a website, but whether the website can attract customers to browse and re-consume is the key to the success of a website. A website generates a large amount of data every day. How to analyze customers' preferences, purchasing patterns, and purchasing power based on these existing data information, so as to make planned recommendations to customers, which requires data mining technology to achieve. For e-commerce websites, user data can be obtained mainly from three aspects. The first is the personal information registered by the user, the second is the user' s purchase record, and the third is the user' s website browsing record. Which e-commerce website can dig out more useful customer information, which will better understand customers, retain customers, and enhance their competitiveness [7].

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(2) Text-based data mining: Due to the numerous application points of text information mining, how to mine text data is also a research hotspot of data mining [8].

(3) Video-based data mining: The research on video data mining at home and abroad is in its infancy, and now it has attracted more and more scholars' attention. The video clips that may be of interest to you can be mined from a bunch of video clips through data mining algorithms. In terms of video surveillance, by comparing the difference between the target object and the video under normal conditions, it is judged whether it is an abnormal event, and an alarm is issued for the abnormal event .

The following expounds the model of the data mining method:

(1) The basic model of cluster analysis

The process of cluster analysis mainly includes data processing, design metrics and result evaluation, and its basic model is shown in Figure 2. The first is data preprocessing, which includes feature extraction from the original dataset and construction of feature vectors. The second is to select a suitable distance function according to a certain similarity measure to obtain the corresponding clustering results. Finally, the clustering results are evaluated and output, and certain knowledge information is obtained.

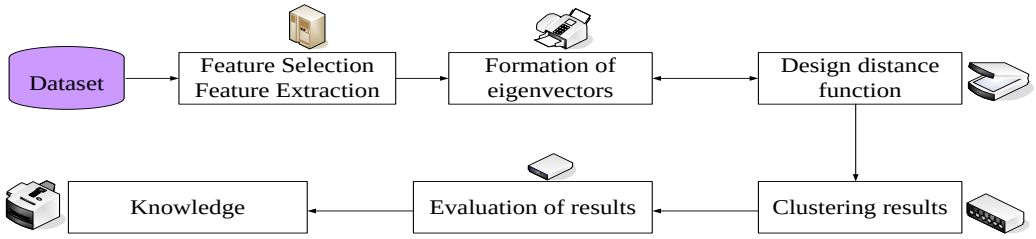

Figure 2: Cluster analysis basic model

(2) The basic model of association rule mining

The basic model of association rule mining is shown in Figure 3.

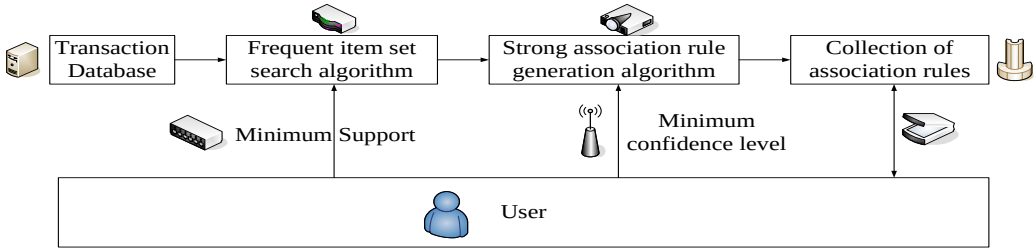

Figure 3: Basic model of association rule mining

3. Measurement of apparent strain of ankle joint in Taekwondo sports

This study took Taekwondo players as the basic research object, and screened out 10 athletes, 5 male and 5 male athletes. The basic information of the athletes is shown in Table 1.

Table 1: Basic information of Taekwondo players

Number	Age	Height (cm)	Weight (kg)
1	30	190	86
2	27	176	73
3	22	189	96
4	21	185	72
5	21	170	65
6	20	173	67
7	19	170	64
8	19	190	79
9	18	185	75
10	17	180	72

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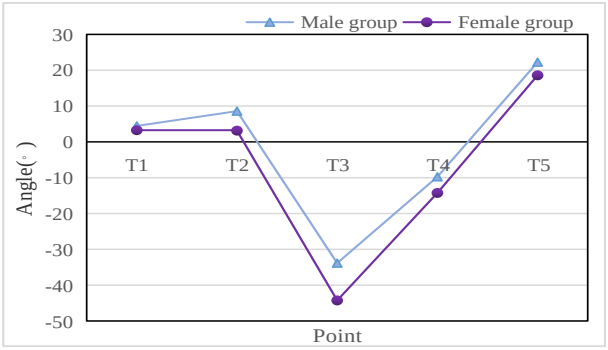
The sagittal peak torque and its appearance time are shown in Table 2.

Table 2: Sagittal peak moments and appearance time

	Male group		Female group	
Sagittal plane	Jumping Legs	swinging jumping legs	Jumping Legs	swinging jumping legs
First wave peak force distance	1.25	1.36	1.78	0.59
one time	1.15	0.28	1.35	0.86
Second wave peak force distance	0.75	0.84	1.46	1.98
two time	1.52	0.26	0.28	1.24

The angular features of the ankle socket in the sagittal plane of the athlete are shown in Figure 4.



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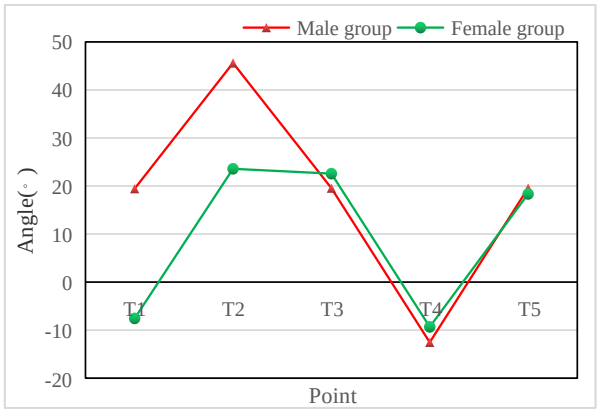

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Figure 4: Ankle joint sagittal plane angle characteristics

From Figure 4, it can be seen that the individual variability of the jumping and swinging legs of men and women is more obvious.

The peak torque and appearance time of frontal face are shown in Table 3.

Table 3: Frontal plane peak moment and appearance time

	Male group		Female group	
Frontal Plane	Jumping Legs	swinging jumping legs	Jumping Legs	swinging jumping legs
First wave peak force distance	1.48	0.57	1.39	2.14
One time	1.54	0.25	1.27	1.04
Second wave peak force distance (N m)	0.12	0.28	1.54	1.05
two time	2.31	1.28	2.14	0.49

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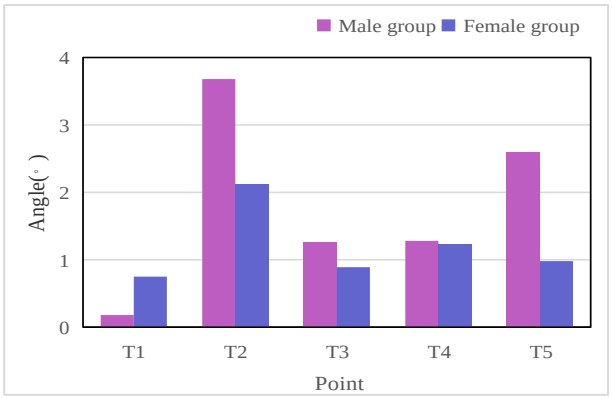
The angular feature of the anterior surface of the anterior ankle is shown in Figure 5.



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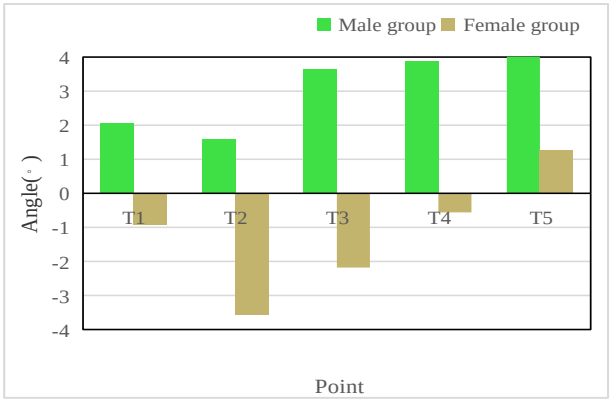

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Figure 5: Angular characteristics of the frontal plane of the ankle joint

It can be seen from Figure 5 that there was no significant difference in the ankle joint angle between the boys group and the girls group at five time points.

The peak moment on the horizontal plane and its occurrence time are shown in Table 4 and Table 5.

Table 4: Horizontal peak moment and emergence time

	Male group		Female group	
Horizontal plane	Jumping Legs	swinging jumping legs	Jumping Legs	swinging jumping legs
First wave peak force distance	1.15	0.25	0.14	0.79
One time	1.05	1.58	0.26	0.27
Second wave peak force distance (N m)	0.75	1.25	1.39	1.46
Two time	0.75	1.58	1.25	1.78

Table 5: Horizontal peak moment and emergence time

	Male group		Female group	
Horizontal plane	Jumping Legs	swinging jumping legs	Jumping Legs	swinging jumping legs
First wave peak force distance	1.25	0.58	1.26	1.52
One time	0.85	1.28	1.36	0.45
Second wave peak force distance (N m)	0.58	0.46	1.25	0.58
Two time	0.58	1.26	0.58	1.36

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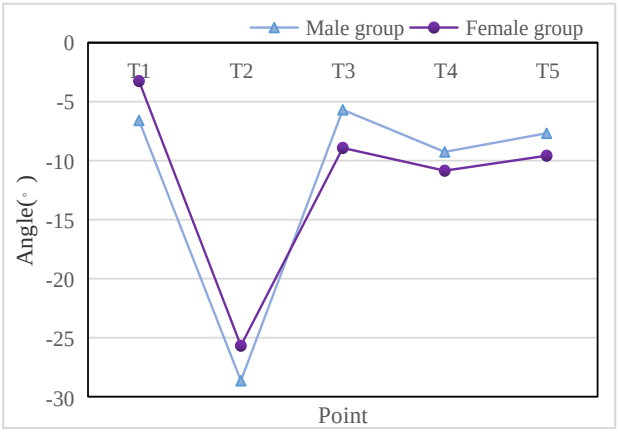
The angular profile of the horizontal plane of the ankle is shown in Figure 6.



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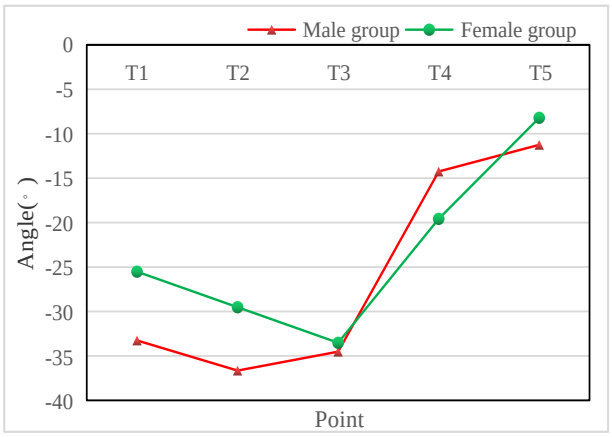

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Figure 6: Ankle joint horizontal plane angle characteristics

It can be seen from Figure 6 that the ankle joint of the take-off leg in the horizontal plane has the maximum external rotation at the moment of the maximum kick-off, and gradually adducts the ankle joint in the horizontal direction of the action. From the ankle joint of the swing leg, it can be seen that the ankle joint is always in different degrees of external rotation during the whole movement (from the step on the force platform to the landing buffer), but the degree of external rotation gradually decreases during the landing process.

4. Conclusion

Firstly, the basic knowledge of imaging equipment technology and image processing technology is roughly sorted out, and then, aiming at the significance of non-contact measurement of flexion angle in ankle flexion movement, a rapid non-contact measurement system of flexion angle based on image technology is designed. Furthermore, using the method of artificial marking, a feature point motion trajectory extraction system based on image technology is designed, and the corresponding calculation method of body surface deformation and strain is proposed. After comparing the performance parameters of the imaging technology, the hardware platform of the imaging system is determined. Through the understanding of image processing technology, as well as the research significance and technical path of the subject, a method for measuring buckling angle, extracting feature point trajectory and calculating related strain based on image technology is proposed. In terms of flexion angle measurement, on the one hand, non-contact measurement of flexion angle is adopted to overcome the theoretical error of the model loading and measurement of the flexion ankle circumference model. At the same time, the loading of the ankle joint by the loading system is more comprehensive and more in line with the physiological conditions to simulate the flexion movement of the ankle joint in vivo, and better feedback and more accurate physiological parameters are obtained in terms of exercise intensity and amplitude. On the other hand, in clinical and rehabilitation engineering, ankle joint loading system

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can be applied, that is, the ankle joint needs controlled movement after operation. It is necessary to control the speed, strength, amplitude, time length, etc. of the loading system in the process of ankle flexion movement, and to accurate flexion angle measurement is an indispensable task. In this project, a non-contact dynamic and fast measurement method of apparent strain of ankle flexion movement with high reliability, strong operability, easy popularization and data mining has been realized while keeping the ankle joint relatively intact. The basic research of the ankle joint provides an effective way, thus providing a new theoretical guidance for the clinical and rehabilitation of the ankle joint.

Acknowledgement

This work was supported by the 2019 School Level Scientific Research Project of Shaoguan University (NO.SY2019ZK10).

References

[1] Bonidia, R P, Brancher, J D andBusto, R M. Data Mining in Sports: A Systematic Review [J]. IEEE Latin America Transactions, 2018, 16(1):232-239.
[2] Meehan C L, Talebi M. A method for correcting field strain measurements to account for temperature effects [J]. Geotextiles and Geomembranes, 2017, 45(4):250-260.
[3] Zubaidi S L, Abdulkareem I H, Hashim K S, et al. Hybridised Artificial Neural Network Model with Slime Mould Algorithm: A Novel Methodology for Prediction of Urban Stochastic Water Demand [J]. Water, 2020, 12(10):1-18.
[4] Zcan E, Danan T, Yumuak R, et al. An artificial neural network model supported with multi criteria decision making approaches for maintenance planning in hydroelectric power plants [J]. Eksploatacja i Niezawodnosc - Maintenance and Reliability, 2020, 22(3):400-418.
[5] Raad N G, Isfahani N M. Ranking of building maintenance contractors using multi-criteria decision making methods and an artificial neural network model [J]. International Journal of Data and Network Science, 2020, 4(2):245-254.
[6] Yildiz O. Artificial Neural Network Model to Predict Anchored-Pile-Wall Displacements on Istanbul Greywackes [J]. Teknik Dergi, 2020, 31(4):1-20.
[7] Yu B, Kim D, Cho H, et al. A Nonlinear Autoregressive With Exogenous Inputs Artificial Neural Network Model for Building Thermal Load Prediction [J]. Journal of Energy Resources Technology, 2020, 142(5):050902.1-050902.9.
[8] Kfer P S , Rocha N , Diaz L R , et al. Artificial neural networks model based on remote sensing to retrieve evapotranspiration over the Brazilian Pampa[J]. Journal of Applied Remote Sensing, 2020, 14(3):38504-38501.