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Construction of equestrian trainer competency evaluation index system based on big data background

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Abstract

A professional coaching team is an important factor in learning equestrian sports, and their competency level in the process of training and competition directly affects the achievement of the team's competition results. This paper uses research methods such as hierarchical analysis and mathematical statistics to construct an equestrian coaches' competency evaluation index system and determine the weights of each index based on theories related to equestrian coaches' competency characteristics, equestrian sport-specific characteristics and coaching characteristics. By proposing a quaternion-driven skeletal vectorized human motion reconstruction method, a mechanism model conforming to the kinematic characteristics of human body was established to realize the three-dimensional posture reconstruction of motion posture in the process of equestrian evaluation. The results show that the competency evaluation indexes of 5 primary indicators, 13 secondary indicators and 30 tertiary indicators can effectively evaluate equestrian coaches in a more detailed and comprehensive way. And the empirical analysis also verified that the detection of coach B was 0.515 in the first period and 0.785 at the end of the second period, which was consistent with the actual results. The competency evaluation index system of equestrian coaches proposed in this paper provides a reference basis for practical activities such as selection, employment and qualification of equestrian coaches, and promotes the improvement of Chinese equestrian competition level.

Keywords: *competency evaluation index, equestrian trainer, human kinematics, quaternion, three-dimensional posture reconstruction*

Introduction

Nowadays, the development of competitive sports programs is advancing rapidly and the competition is becoming more and more intense, gradually developing into an all-round, three-dimensional and multifaceted competitive system (Salma & Meyers, 2019)-(Blakeslee & Goff, 2007). The coaches of competitive sports are the fundamental facilitators of the development of the project, and the role played by professional coaches is becoming increasingly important (Kuhl, Ritchie, Taveira-Dick, Hoefling, & Russo, 2014)-(Cannella, King, & Keller, 2015). The influence of the equestrian program in the world is growing, and although it has been introduced to China not long ago, its influence has been unparalleled. From the initial introduction to the

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present development, equestrianism has spread to various cities across the country, which is inseparable from the promotion of professional equestrian coaches, fully reflecting the key role of coaches (Winfield, Williams, & Dixon, 2013) (F, 2018).

The competence of coaches largely determines the level of development of the program, which is determined by the series of competitive tasks they perform, such as selection, training and competition (Choi & Kim, 2020).

The literature (Cui et al., 2022) considers competency as an individual characteristic that distinguishes deep-seated characteristics of an individual performing a job, any individual characteristic that can be measured or calculated and that clearly distinguishes excellent from average performance.

The literature (Kao, Tsai, & Schinke, 2021) argues that competencies can distinguish outstanding achievers from average performers in a job through personal, underlying, deep-seated characteristics. The literature (Deng Z H 2015) considers that in the field of competencies for excellent performance, a comprehensive set of competencies that can be directly used to achieve a purpose, work habits and personal skills that contribute to the achievement of task goals and can be measured.

The evaluation indicators are the basic elements that reflect the development of the evaluated object (Pulido et al., 2020)-(Sawatsky, Huffman, & Hafferty, 2020), which are linked to many elements and form a unified, orderly and open system as a whole.

The literature [(González-Ponce et al., 2018) points out that modern equestrianism is the use of the athlete's body in a sitting position to manipulate the horse, to help the hand and leg with each other, to control the horse's turn, to adjust the pace, to drive the horse to jump obstacles and to finish the race in the shortest time. In the literature [(Silva et al., 2020), the physical ability of athletes emphasizes the training of leg strength and the control of the horse with the reins and feet, and the practical practice of obstacle training and the training of psychological level of athletes in the competition.

This paper firstly constructs the evaluation system of equestrian coaches from the perspective of ability, and constructs the evaluation index system of equestrian coaches' competency by taking the competency characteristics and relevant competency theories and methods, combining the professional characteristics, special characteristics and coaching characteristics of equestrian coaches.

Secondly, the inertial motion measurement method is used for the quantitative evaluation of equestrian competency, and on the basis of analyzing human kinematics, the rigid body dynamics model is established by equestrian instructors in the training process.

From the perspective of three-dimensional kinematics, a set of quantitative research methods that can be used for the evaluation of the trainer's meta-horseback movement posture is constructed.

Finally, through empirical evidence the purpose of the coach selection evaluation system is to evaluate whether the athletes are competent to teach and train the sport, and to screen out excellent coaches with the characteristics of the sport.

Equestrian trainer competency evaluation index system

Evaluation Objectives and Targets

This study takes the equestrian program as the research object to evaluate the riding technique level by designing the equestrian riding technique. By summarizing the equestrian coaching arrangement of the modern pentathlon national team and consulting with the head coach of the equestrian program, Benny, a foreign coach, the evaluation process of equestrian riding technique was designed in five stages as shown in Figure 1.

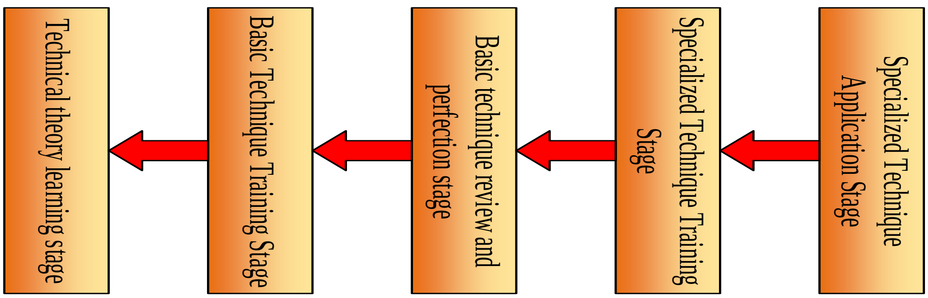

Figure 1: Evaluation process of equestrian riding technique

The evaluation of equestrian coaches' competency follows the construction of diversified evaluation, which can be three evaluation subjects: athletes' evaluation of coaches, coaches' self-evaluation and experts' evaluation of coaches, and advocates the combination of coaches' self-evaluation and other evaluation.

It can only reflect the respect for individual coaches and promote the improvement of coaches' enthusiasm for their own lack of competence, and at the same time, it can improve the interaction and exchange of opinions between coaches and evaluation subjects. This is a human-oriented evaluation method, and the diversified evaluation subjects can make the evaluees accept the evaluation results more easily. Therefore, the role of evaluation is played more effectively.

The goal of competency evaluation is to help coaches find out where the problems are in the training process and solve and correct them in time.

The evaluation of college equestrian drill coaches' competence can not only find out the shortcomings in the training process, but also provide reference for the improvement of coaches, so that the overall training level can be improved to strive for the realization of training goals. It helps coaches to reflect on their own competency and provide guidance for the strengthening of training techniques in advance to produce significant training effects.

Selection of evaluation indicators

This paper collects relevant information on coaches' competency, quality structure, evaluation indexes and understands the degree of progress and problems of existing research on coaches' competency of other individual specialties. The paper combines the comprehensive analysis of the intersection of sports selection, sports training, sports competition, competitive participation, sports physiology, sports research methods and coaching. Then, according to the characteristics of equestrian coaches' competence, the characteristics of equestrian sports and coaching, as well as the relevant connotations, a total of five first-level indicators are designed according to the principle of system construction, which are selection strategy, training setting, special experience, competition guidance and sports team management as shown in Table 1.

Table 1: Evaluation indexes for the primary selection of equestrian trainer competency level 1

Serial number	Evaluation Indicators
1	Material selection strategy
2	Training setting
3	Specialized experience
4	Coaching
5	Sports Team Management

Subdividing the five first-level indicators into equestrian coaches' selection strategy is composed of two parts: selection theory and selection method; training setting includes training content arrangement, sports load selection, training method application and training organization and arrangement. Specialized experience is composed of special ability, teaching experience and competition experience. Participation guidance includes preparation for participation, pre-competition training and participation summary and evaluation. The management of sports teams includes training competition management and training system management, and a total of 14 secondary indicators are set up as shown in Table 2.

Table 2: Evaluation indexes of equestrian trainer's competency primary selection level 2

Serial number	Evaluation Indicators	Serial number	Evaluation Indicators
1	Theory of material selection	8	Teaching Experience
2	Material selection methods	9	Training Experience
3	Training content arrangement	10	Competition Preparation
4	Exercise load selection	11	Pre-Competition Training
5	Training method application	12	Competition Summary and Evaluation
6	Training organization and arrangement	13	Training Competition Management
7	Specialized ability	14	Training System Management

On the basis of the construction of the second-level indexes by combining relevant literature, books and my years of training experience, we further decomposed and screened them, and initially formulated the content of the third-level indexes of the equestrian drill instructor competency evaluation index system, with a total of 30 items as shown in Table 3.

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Table 3: Evaluation indexes of equestrian trainer's competency in the initial selection of Level 3

Serial number	Evaluation Indicators	Serial number	Evaluation Indicators
1	Physical Form	16	Load weight
2	Athletic quality	17	Competition training method
3	Skill Performance	18	Cycle training method
4	Mental quality	19	Music training method
5	Experience Selection	20	Movement demonstration
6	Scientific selection	21	Movement creation
7	School-wide selection	22	Formation design
8	Physical selection	23	Articulation of difficult movements
9	Morphological selection	24	Basic hand position training
10	Skill selection	25	Optimization of teaching mechanism
11	Psychological selection	26	Movement behavior reinforcement
12	Load quantity Load intensity	27	Experience sharing
13	Number of exercises	28	Relationship management with players
14	Displacement distance	29	Daily training management
15	Team Cohesion Building	30	Team Culture Building

The coach competency evaluation index system is the concrete implementation of the evaluation guidelines for equestrian coaches. The design of each index system and the selection of evaluation indexes must be scientific and can objectively and comprehensively reflect the true relationship between the indexes. It is a collection of evaluation indicators with linkage and independence. Generally speaking, it contains many first-level indicators, second-level indicators and even third-level indicators, the first-level indicators are the abstraction and generalization of the second-level indicators, and the second-level indicators are the refinement of specific indicators. The construction of the indicator system is hierarchical, top-down, from macro to micro layer by layer, forming an indivisible evaluation system. After the above steps of hierarchical relationship, the final evaluation index system of equestrian trainers' competency is established.

Determination of the weights of equestrian trainer competency evaluation indexes

Steps and methods of weight assignment

The key to AHP is to establish a hierarchical structure model to hierarchize and organize the study, so the analysis of system factors and their levels must be done in view of the methods of system analysis, and then design models that can represent the hierarchical structure of the system. The general hierarchy is divided as follows. (1) Highest level: also called the goal level, the analysis of the purpose of dealing with the problem and the problem to be solved, that is, the ultimate goal to be achieved by conducting hierarchical analysis.

(2) Intermediate level: also known as strategy level, criterion level and program level, which can be multiple levels to constitute the intermediate level, indicating the factors and criteria

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considered in decision making, the core aspects that ripple through certain methods, plans and policies used in order to reach the intended overall goal. (A, B)

(3) The bottom layer: also called the program layer, indicator layer, measure layer, etc., indicates the alternative to some policies, measures and programs, etc. in dealing with the problem. (C)

(4) Connecting lines: indicates the correlation between the indicators of the upper layer and the indicators of the lower layer. And the form of block diagram is used to explain the recursive layout of levels and the subordination of indicators. The number of levels in the hierarchical model is closely related to the complexity of the problem and is related to the level of detail of the content to be analyzed, and the number of levels is generally unlimited. The importance of each element at each level is measured and judged, and the judgment matrix is further constructed by quantifying the scaled values, which is the key step of AHP. A is the target, u_i and $u_j (i, j = 1, 2, ..., n)$ are the factors, compare them two by two, and u_{ij} indicates the relative importance value of u_i to u_j. And the judgment matrix P composed by u_{ij} is:

$$P = \begin{bmatrix} u_{11} & u_{12} & \cdots & u_{1n} \\ u_{21} & u_{22} & \cdots & u_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ u_{n1} & u_{n2} & \cdots & u_{nn} \end{bmatrix} \quad (1)$$

The solution scheme is derived from the normalization of the feature vector W, that is, the ranking of the importance of each evaluation factor (i.e., weight distribution).

The original weight matrix: Table 4 shows the derivation steps of the first level of the equestrian gymnastics instructor competency evaluation index system (direct matrix solving).

Table 4: Competence evaluation index weights of equestrian gymnastics coaches

Tier 1 Indicators	A1 Material Selection Strategy	A2 Training design	A3 Coaching Skills	A4 Competition Guidance	A5 Sports Team Management
A1 Material Selection Strategy	1	1	1/3	1/5	1
A2 Training design	1	1	1	1/4	2
A3 Coaching Skills	4	1/5	1	1/2	3
A4 Competition Guidance	3	1/4	1/5	1	2
A5 Sports Team Management	1	1	1/4	1/3	1

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Competency evaluation index weights determination

Finally, the weights of all the indicators in the equestrian trainer competency evaluation index system were obtained by comparing the judgment values of the indicators at all levels by 10 experts as shown in Table 5.

Table 5: Equestrian trainer competency evaluation index weights

G	Secondary Indicators	Three-level indicators
Material selection strategy 0.1225014	B1 Material selection basis 0.05982142	C1 Athletic quality 0.02164
		C2 Music literacy 0.0131
		C3 Skill performance 0.00851
	B2 Material selection method 0.0626424	C4 Experience selection 0.0422
		C5 Physical selection 0.01812
		C6 Morphological selection 0.01141
A2 Training design 0.1010086	B3 Training plan development 0.261655	C7 Skill selection training 0.01375
		C8 Basic technical training 0.024711
		C9 Difficult Technique Training 0.02142
	B4 Training method selection 0.0452014	C10 Specialized physical training 0.02974
		C11 Musicianship training 0.01175
		C12 Set movement training 0.013782
	B5 Training organization 0.082571	C13 Decomposition training method 0.02551
		C14 Competition training method 0.01875
		C15 Circuit training method 0.014123
		C16 Innovative training methods 0.0235174
A3 Coaching skills 0.315245	B6 Specialized knowledge ability 0.14253	C17 Ideological education work 0.02342
		C18 Professional literacy planning 0.020971
	B7 Teaching and training experience 0.167892	C19 Creative ability 0.024341
		C20 Spirit of Inquiry 0.0121783
		C21 Use of scientific research 0.014876
A5 Participation Guidance 0.1173242	B8 Pre-tournament preparation and instruction 0.0542634	C22 Music selection 0.0305147
		C23 Movement creation 0.0347541
		C24 Formation design 0.018142
	B9 Summary and evaluation of participation 0.0576374	C25 Difficult movement articulation 0.01174
		C26 Optimization of combined movements 0.02534
A6 Sports team management 0.1835142	B10 Training and competition management 0.1004253	C27 Reserve team building 0.0229111
		C28 Fund preparation and use 0.02427524
	B11 Organizational system management 0.0825641	C29 Team cohesion building 0.02102177
		C30 Team culture building 0.0144651

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Equestrian three-dimensional posture reconstruction and evaluation of posture maintenance and balance ability

Research on quantitative evaluation of equestrian ability using inertial motion measurement methods is very scarce, so in the face of the current research gap, it is necessary to establish a set of analytical methods and theoretical frameworks to regulate the development of related research theories. This chapter mainly combines the measurement characteristics of wearable inertial sensors, and constructs a set of quantitative research methods that can be used for the evaluation of the equestrian trainer's posture on horseback from the perspective of three-dimensional kinematics by establishing a rigid body dynamics model of equestrian trainers in the training process on the basis of the analysis of human kinematics.

Human kinematic modeling and 3D pose reconstruction

Human kinematic modeling based on skeletal vectorization and its 3D pose reconstruction method

In the current study, a distinction is made from previous modeling approaches in order to conduct an in-depth study of the human-horse interaction. To analyze and reveal the principle of the influence of equestrian ability on the evaluation of trainers' competence, this paper establishes a vectorized bar kinematic model of human skeleton based on quaternion drive from the perspective of human physiology and anatomy.

The structure of this kinematic model is shown in Figure 2. The model is characterized by abstracting each skeleton as a segment of rigid body with fixed length, and the original joint chain between each skeleton is abstracted as a spherical connection point, which connects each skeleton rigid body segment together. And using the pelvis as the Root node, the kinematic chain covering the whole body parts is established by means of hierarchical traversal, and the reconstruction of the three-dimensional motion posture of the human body is realized by means of quaternion drive [(Al Hilali, Al Mughairi, Kian, & Karim, 2020).

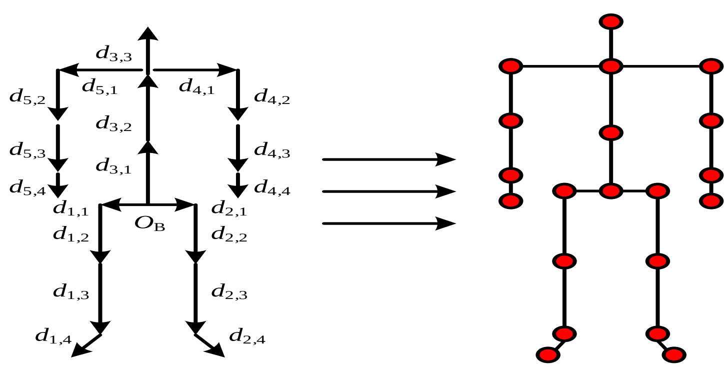

Figure 2: Vector model based on biomechanical structure

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The bar vector corresponding to each skeletal segment, BO denotes the root node, and the individual skeletal vectors can be expressed as:

$$d_{\eta,\gamma}^{B} = l_{\eta,\gamma} v_{\eta,\gamma} \in R^3 \quad (2)$$

Where γ and η denote the number of the bone and the segment number of the corresponding bone: $d_{\eta,\gamma}^{B}$ denotes the vector of the corresponding limb segment under BCS. $I_{\eta,\gamma} \in R$ denotes the length of a rod-like limb segment and $v_{\eta,\gamma}$ denotes the corresponding unit vector, then the pose of each skeletal segment under SCS can be expressed as:

$$d_{\eta,\gamma}^{n}(t) = \hat{q}_{b,\eta,\gamma}^{n}(t) d_{\eta,\gamma}^{b} \quad (3)$$

Where $d_{\eta,\gamma}^{n}(t)$ denotes the pose of a limb vector at moment t corresponding to the navigation coordinate system. $\hat{q}_{b,\eta,\gamma}^{n}(t)$ denotes the quaternion of rotation of the corresponding limb segment at moment t with respect to the body coordinate system under the navigation coordinate system. Then the position of each segment under the navigation coordinate system at this moment can be expressed as:

$$P_{\eta,\gamma}^{n}(t) = \sum_{t=0}^{n} d_{\eta,\gamma}^{b}(t) + O_N(t) \quad (4)$$

The $P_{\eta,\gamma}^{n}(t)$ indicates the position of the two connected joints between the skeletal segments with corresponding numbers η, γ and $\eta+1$, $\gamma+1$, respectively, and the $O_N(t) \in R$ indicates the position of the pelvic center point in the navigation coordinate system at the t moment. At this point, since the orientation and position of each skeletal segment are known, the interplay between the rider's limbs under the action of the horse's back can be visualized in the kinematic model during the equestrian evaluation.

3D Horizontal Attitude Alignment

Because of the need to validate the proposed kinetic model, optical motion capture systems are generally considered the gold standard for such comparative experiments. However, optical systems in general have their own set of model building standards, which tend to vary widely from system to system.

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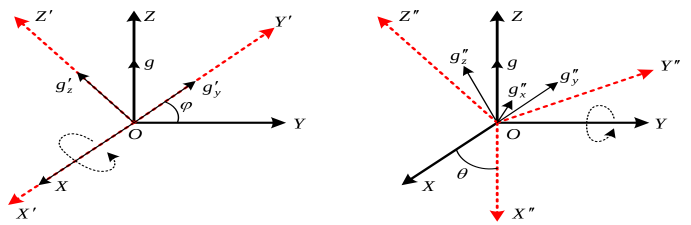
Horizontal attitude alignment refers to the attitude calibration relative to the horizontal plane, which mainly involves the calculation of the cross-roll angle and pitch angle. The principle is to use the projection of gravity in the sagittal and coronal planes to calculate the corresponding pitch and roll angles by trigonometric functions, as shown in Figure 3.



(a) Calculation of the cross-roll angle using the gravity component
(b) Pitch angle calculation using gravity component

Figure 3: Calculation of pitch and roll using gravity components

When the sensor is at rest, ignoring noise interference, the measurement value of the accelerometer is approximated as a gravitational acceleration. Using the measured value at this time, the gravitational components of gravity in the sagittal and coronal planes at rest can be calculated respectively, and then the pitch and roll angles can be calculated by trigonometric changes. Figure 3(a) depicts the method of using gravitational acceleration to calculate the cross-roll angle $\phi^{roll}(0)$. Figure 3(b) demonstrates the process of using gravitational acceleration to calculate the pitch angle $\theta^{pitch}(0)$. The specific calculation method is:

$$\begin{cases} \phi^{roll}(0) = \arctan\left(\hat{\alpha}_y, \hat{\alpha}_z\right) \\ \theta^{pitch}(0) = \arctan\left(-\hat{\alpha}_x, \hat{\alpha}_y \sin\phi^{roll}(0) + \hat{\alpha}_z \cos\phi^{roll}(0)\right) \end{cases} \quad (5)$$

Where $\hat{\alpha}_x$, $\hat{\alpha}_y$, and $\hat{\alpha}_z$ are the accelerometer measurements corresponding to the X, Y, and Z axes, respectively.

Quaternion representation of spatial poses

A quaternion is a supercomplex concept developed on the basis of complex numbers, which in mathematical concepts are generally formed by combining real and imaginary numbers by adding them together. Similarly, a quaternion is formed by adding two imaginary numbers to a complex number. The general quaternion q can be expressed as:

$$q = w + q_0\vec{i} + q_1\vec{j} + q_2\vec{k} \quad (6)$$

Where w, q_0, q_1, q_2 are real numbers; $\vec{i}$, $\vec{j}$, $\vec{k}$ are three complex numbers representing standard orthogonal bases in three spaces and satisfy the following relations:

$$\vec{i}^{\,2} = \vec{j}^{\,2} = \vec{k}^{\,2} = -1 \qquad (7)$$

To facilitate the description, other representations of quaternions are introduced, and the four-dimensional vector of the defined equation here is:

$$p = \left(p_w, p_x, p_y, p_z \right) \qquad (8)$$

Where p_w is the real scalar of the quaternion, p_x, p_y, p_z are imaginary vectors, which can be abbreviated as $\vec{p}$. for the common calculation of quaternion, mainly quaternion multiplication, which is expressed as

$$kp = \left(kp_w, kp_x, kp_y, kp_z \right) \qquad (9)$$

The multiplication of two quaternions is similar in principle to the multiplication of two vectors:

$$p_1 \otimes p_2 = p_{w1} + p_{w2} - \vec{p}_1 \cdot \vec{p}_2 + p_{w1} \cdot \vec{p}_2 + p_{w2} \cdot \vec{p}_1 + \vec{p}_1 \times \vec{p}_2 \qquad (10)$$

Where, denotes quaternion multiplication, $\otimes$ denotes vector inner product, and $\times$ denotes vector multiplication. According to the operation of vectors, the above equation can be rewritten as:

$$\begin{aligned} p_1 \otimes p_2 &= \begin{bmatrix} p_{w2} & -p_{x2} & -p_{y2} & -p_{z2} \\ p_{x2} & p_{w2} & p_{z2} & p_{y2} \\ p_{y2} & p_{z2} & p_{w2} & -p_{x2} \\ p_{z2} & -p_{y2} & p_{x2} & p_{w2} \end{bmatrix} \begin{bmatrix} p_{w1} \\ p_{x1} \\ p_{y1} \\ p_{z1} \end{bmatrix} = p_2^L p_1 \\ &= \begin{bmatrix} p_{w1} & -p_{x1} & -p_{y1} & -p_{z1} \\ p_{x1} & p_{w1} & p_{z1} & p_{y1} \\ p_{y1} & p_{z1} & p_{w1} & -p_{x1} \\ p_{z1} & -p_{y1} & p_{x1} & p_{w1} \end{bmatrix} \begin{bmatrix} p_{w2} \\ p_{x2} \\ p_{y2} \\ p_{z2} \end{bmatrix} = p_1^R p_2 \end{aligned} \qquad (11)$$

The conjugate of a quaternion can be expressed as:

$$p^* = \left(p_w - \vec{p}^T \right)^T \qquad (12)$$

The inverse of the quaternion can be expressed as:

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$$p^{-1}=\frac{p^{*}}{\|p\|^{2}} \qquad (13)$$

Azimuth alignment is generally referred to in navigation as the calculation of yaw angle, which is mainly used to determine the relative orientation reference of the system carrier. The basic principle of calculating the initial yaw angle using ground information is shown in Figure 4. In Fig. 4(a), M_e indicates the local magnetic field strength.

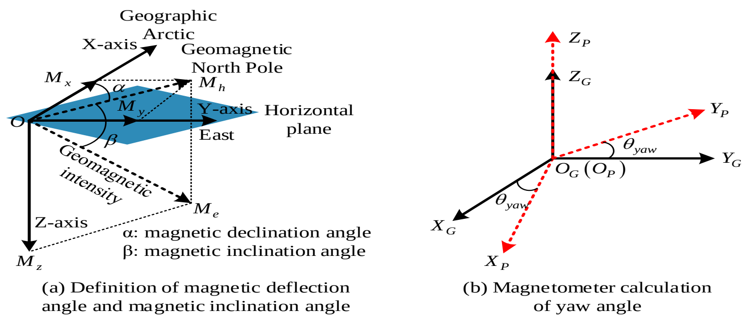

Figure 4: Calculation principle of yaw angle by magnetometer

From the corrected acceleration and magnetic field strength data, the pitch and roll angles can be calculated as:

$$\gamma=\arcsin\left(\frac{\hat{a}_y}{|\vec{g}|}\right) \qquad (14)$$

$$\varphi=\arcsin\left(\frac{\hat{a}_x}{|\vec{g}|}\right) \qquad (15)$$

Where $\hat{a}_x$ and $\hat{a}_y$ denote the acceleration values of the x and y axes after filtering.

However, since the gyroscope's own bias can cause errors, the accelerometer and magnetometer are needed to compensate for this, so that the system can be stabilized and eventually converge. The compensation equation is:

$$\hat{\Phi}(t)=\lambda\cdot\vec{\hat{\Phi}}_{gwo}(t)+(1-\lambda)\vec{\Phi}(t) \qquad (16)$$

Empirical results and analysis

The purpose of this paper through the empirical coaching staff selection and evaluation system is to assess whether the athletes are competent to teach and train in the sport and to select the best coaches with the characteristics of the sport. The selection of coaches is based on the evaluation of the state and form of the athletic ability of the selected coaches and the prediction of the upper limit of their athletic potential. Therefore, the construction of the coach selection system should be closely focused on the athletic ability characteristics of the sport, and the evaluation system should reflect the dominant factors affecting the athletic ability of the sport. The study of the competency evaluation system of equestrian athletes for coaches is the focus of this study, and the selection of coaches should be based on indicators with high heritability such as physical form, physical fitness and athletic ability, and psychological personality traits.

Comprehensive evaluation methods and criteria for equestrian trainer selection

Comprehensive evaluation criteria

In this paper, the weights of morphological length factor, morphological width factor, morphological circumference factor, comprehensive quality factor, agility strength factor, coaches' rating factor and neurotypical factor were further determined by expert evaluation method, i.e. Delphi method. Three senior equestrian coaches were invited as experimental subjects to listen carefully to the opinions of experts and coaches, collate their suggestions, and have them orderly concentrate and re-screen the initial screening indexes, and finally determine the selection evaluation system and corresponding weights of youth equestrian athletes. Through factor analysis, the cumulative variance contribution rate of the five main factors in this study was 87.522%, i.e., the total weight was 88.654%, and the coaches' evaluation factor and the neural type factor were assigned the remaining weight of 12.351% on average, i.e., the weight accounted for by each was 5.145%. The results of the three senior equestrian trainers' selection index levels are shown in Table 6. Because the scientific selection is to choose the best and most talented athletes, this paper sets the score of excellent at 90 or above and divides the grade standard into five levels: 90 or above is excellent, with equal score of 5. 90-70 is good, with score of 4. 70-50 is average, with score of 3. 50-30 is poor, with score of 2. 30 or below is very poor, with score of 0. The score of 50-30 is poor, with 2 points. 30 points is very poor, with 0 points.

Table 6: Test for normal distribution of the results of each test index for equestrian trainers

Test Metrics	Kolmogorov-Smirnova		
	Statistics	df	Sig.
Medial width	0.269578	18.28005	0.076503
BMI	0.216918	9.799915	0.160865
Standing forward bend	0.194976	5.10394	0.155447
Combined reaction time	0.266627	20.44135	0.063847
Calf length A	0.253391	8.011094	0.125665
Lower limb length A	0.112599	11.28238	0.05713

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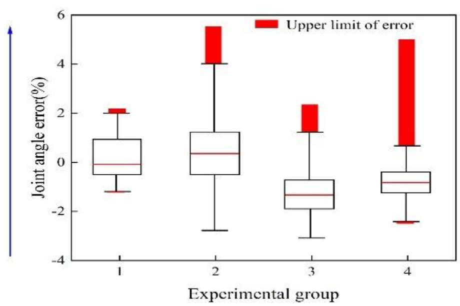
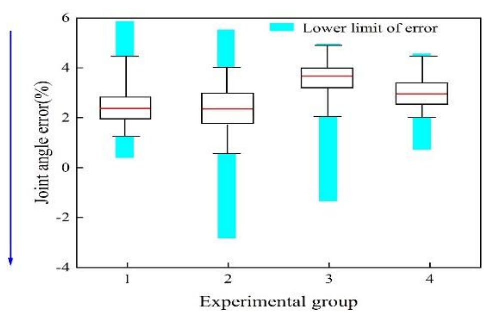
Shoulder width	0.342573	15.27483	0.07476
Thigh circumference	0.284675	12.08706	0.083848
Pelvis width	0.130541	12.7927	0.167939
Stand-ups	0.261767	6.26216	0.189809
Body weight height	0.198824	19.39508	0.050656
Finger Span	0.340172	6.630269	0.093436

Equestrian skill joint angle error analysis

We also compare our proposed method EID-EKF with some more established algorithms such as extended Kalman filter based on maneuver detection, gradient descent method, complementary filtering and quaternion-based Kalman filtering. The results of comparing the root mean square error and correlation coefficient of several methods are listed. Meanwhile, in order to verify the generalization of the algorithm, we counted the joint angle errors during four equestrian skill experiments, and the box plots of the joint angle errors during the four experiments are given in Fig. (5), where 1, 2, 3, and 4 denote joint angles α, β, γ, and δ, respectively. where Fig. 5(a) shows the upper limit of joint angle errors and Fig. 5(b) shows the lower limit of joint angle errors. It can be found that the overall errors are basically within 2 degrees after removing the singularities. The above experimental results show that, compared with other algorithms, our proposed data fusion method has high accuracy and can achieve accurate tracking of human posture during equestrian training.



(a) Upper limit of error



(b) Lower limit of error

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Figure 5: Box plots for the errors of joint angle in four experiments

It can be seen that the algorithm proposed in this paper also has some limitations. First of all, the running time of the program is considered in terms of the execution time of the algorithm is compared. The time index is the average value of the algorithm after 10,000 executions, and it can be found that the motion time of the algorithm proposed in this paper is about 2.1521ms, which is slightly lower than the extended Kalman filter fusion method based on the maneuvering method, but the algorithm running time is slightly higher compared to GDA, CF and KF. Therefore, relatively speaking, the running time of the algorithm will be sacrificed to some extent while achieving higher accuracy. In addition, this paper only distinguishes two motion states for low-speed motion and high-speed motion. However, in practice, the high-speed motion state can still continue to be subdivided, so as to further optimize the parameters for several different motion states.

Analysis of the results of equestrian riding skills training

Analysis of jumping obstacle movement pattern

The variation values of ankle, knee and hip joint angles of athletes, and elbow, front flying joint, knee and rear flying joint angles of horses were selected to analyze the characteristics of joint motion patterns of the lower limbs of athletes and horses during the jumping and landing phases of the jumping obstacle. The movement forms of the ankle, knee and hip joints of the athletes' lower limbs during the jumping and landing phases are shown in Table 7.

Table 7: Forms of lower limb joint movements of athletes during jumping

Coaching Staff	Phase I			Phase II		
	Ankle	Knee	Medulla	Ankle	Knee	Medulla
A	Flat	Flat	Flexion	Extension	Flexion	Flat
B	Flat	Extension	Extension	Flexion	Extension	Flexion
C	Flexion	Flexion	Flat	Flat	Flat	Flat
D	Flat	Flat	Flexion	Extension	Extension	Extension
E	Extension	Extension	Flexion	Flat	Flexion	Flat
F	Flexion	Flat	Extension	Flexion	Flat	Extension

The form of movement of the joints of the rider's lower limbs (flexion, extension or flat) at the moment of jumping and landing is examined, focusing on the way the joints move at that moment and in the 0.3 seconds before and after. Due to the individual riding habits of the athlete, the cooperation of the horse (training and competition require random horse pairing), the venue, and the time constraints of training (jumping exercises are only performed at the end of the period), the athlete needs to adjust the movement pattern of the lower limb joints according to the specific situation of jumping. The two phases of jumping training were not sufficient to produce a more consistent movement pattern of the lower limb joints for jumping and landing, but the movement of the ankle and knee angles during jumping in the second phase of training showed some consistency.

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Analysis of equine lower limb joint skills

The angle change of the post-flying joint in the jump phase is: small-large-small, the angle curve is upwardly raised arc knee joint and the post-flying joint are similar, the angle change of the pre-flying joint in the landing phase is also small-large-small, but the angle curve is inverted "V" shape as shown in Figure 6, there are sharp peaks. Some of the peaks are ahead or behind the moment of jump or landing, while the elbow joint angle does not change significantly.

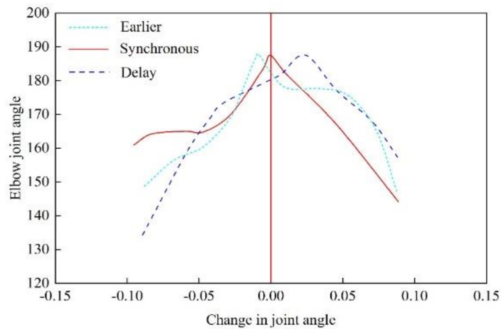

Figure 6: Peak angle curve of horse front flying node during landing stage

The correlation coefficient value of trainer B's human-horse center of gravity gradually increased from 0.515 ($p<0.01$) (moderate correlation) at the beginning of training period 1 to 0.785 ($p<0.01$) (high correlation) at the end of training period 2, indicating that his coordination with the horse's movement became better and his technical movement level was steadily improving. The ankle, knee and medullary joint angles were 91.3°, 97.5° and 115.3°, respectively, and the amplitude of ankle, knee and joint movements were 36.1°, 35.4° and 51.5°, respectively, when riding at a light fast trot better. It can be seen that trainer B had better ankle flexibility during light and fast pace riding and could adapt to the need for a larger ankle range of motion, but the joint range of motion was too large and the upper body posture should be kept stable and the thighs should not be stretched too low during light and fast pace riding. It means that trainer B scores the highest and is the most competent under the evaluation system proposed in this paper.

Conclusion

This paper constructs a competence evaluation index system for equestrian coaches based on the characteristics and technical features of equestrian projects and the content related to the basic theory, technical skills and knowledge system of equestrian coaches, combined with the opinions of authoritative experts in the equestrian field. By establishing a rigid body dynamics model for equestrian coaches in the training process, a set of quantitative research methods for the evaluation of coaches' horseback movement posture was constructed. Finally, through empirical analysis, it was concluded that the competency testing of coach B was 0.515 in the first period and 0.785 at the end of the second period, which was consistent with the actual results and verified the effectiveness of the proposed competency evaluation index system. In this paper, the weight ranking of the equestrian coaches' competency evaluation index system is derived as follows:

(1) The weighting of the first-level indexes are, in descending order, coaching skills, training design, sports team management, selection strategy, and competition guidance.

(2) The secondary indexes in descending order of weight are special knowledge and ability, teaching and training experience, training and competition management, training plan development, training method selection, organizational system management, etc.

(3) The five indicators with higher weight order are training coaching skills, movement creation, sports quality, music selection, participation program development and implementation, special physical training, etc.

References

Al Hilali, K. S., Al Mughairi, B. M., Kian, M. W., & Karim, A. M. (2020). Coaching and mentoring. Concepts and practices in development of competencies: A theoretical perspective. *International Journal of Academic Research in Accounting, Finance and Management Sciences, 10*(1), 41-54.

Blakeslee, M. L., & Goff, D. M. (2007). The effects of a mental skills training package on equestrians. *The Sport Psychologist, 21*(3), 288-301.

Cannella, S., King, D. L., & Keller, B. (2015). *Absorption of Impact Forces by Three Types of Equestrian Protective Vests.* Paper presented at the International Journal of Exercise Science: Conference Proceedings.

Choi, S., & Kim, J. (2020). The Relationship among Coaching Competence Perceived by High School Soccer Players, Trust in Instructor, and Athletic Performance. *The Korean Journal of Physical Education, 59*(5), 207-219.

Cui, L., He, A., Wang, X., Wang, Y., Huang, X., & Ni, Z. (2022). Development and validation of a competency evaluation model for hospital infection prevention and control practitioners in the post-pandemic era: a mixed methods study. *Journal of Hospital Infection, 119*, 132-140.

Deng Z H , D. W. J., University K (2015). Study on the Core Competitive Power of Competitive Sports in Germany. *Journal of Guangzhou Sport University.*

F, T. J. (2018). Discussion on Contemporary Value and Development Strategy of Equestrian. *Sports Culture Guide.*

González-Ponce, I., Leo, F., Jiménez, R., Sánchez-Oliva, D., Sarmento, H., Figueiredo, A., & García-Calvo, T. (2018). Athletes' perceptions of coaching competency and team conflict in sport teams: A multilevel analysis. *European journal of sport science, 18*(6), 851-860.

Kao, S.-F., Tsai, C.-Y., & Schinke, R. (2021). Investigation of the interaction between coach transformational leadership and coaching competency change over time. *International Journal of Sports Science & Coaching, 16*(1), 44-53.

Kuhl, H. N., Ritchie, D., Taveira-Dick, A. C., Hoefling, K. A., & Russo, S. A. (2014). Concussion history and knowledge base in competitive equestrian athletes. *Sports Health, 6*(2), 136-138.

Pulido, J. J., García-Calvo, T., Leo, F. M., Figueiredo, A. J., Sarmento, H., & Sánchez-Oliva, D. (2020). Perceived coach interpersonal style and basic psychological needs as antecedents of athlete-perceived coaching competency and satisfaction with the coach: A multi-level analysis. *Sport, Exercise, and Performance Psychology, 9*(1), 16.

Salma, C. L., & Meyers, M. C. (2019). Athletic and Pain Coping Skills of Competitive Female Equestrian Athletes. *Journal of Sport Behavior, 42*(1).

Sawatsky, A. P., Huffman, B. M., & Hafferty, F. W. (2020). Coaching versus competency to facilitate professional identity formation. *Academic Medicine, 95*(10), 1511-1514.

Silva, E. J. D., Evans, M. B., Lefebvre, J. S., Allan, V., Côté, J., & Palmeira, A. (2020). A systematic review of intrapersonal coach development programs: Examining the development and evaluation of programs to elicit coach reflection. *International Journal of Sports Science & Coaching, 15*(5-6), 818-837.

Winfield, J., Williams, J., & Dixon, M. (2013). The use of reflective practice to support mentoring of elite equestrian coaches. *International Journal of Evidence Based Coaching & Mentoring, 11*(1).