Research Article

Application Research and Analysis of Intelligent Sensors in Tennis Serving Technical Correction Equipment

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The traditional tennis serving teaching correction method has been deeply rooted, and in the current teaching, the teaching method based on experience has been used for a long time, relying on the subjective consciousness of the coach to guide and supervise the technical movements of the athletes. It is said that to master the essentials of technical movements proficiently, it is necessary to carry out long-term and repetitive exercises according to the coach’s guidance. This situation seriously restricts the improvement of the level of teaching and training. To solve the above problems, the combined application of smart sensors and microsystem technology is used to Sensing identify and intelligently correct the player serve technology. This article in the presentation part initially sums up the movement catch innovation and tennis serve innovation and development; then, at that point, in the strategy part presents the objective following calculation and normal denoising handling calculation; and then, at that point, in the trial part presents the person choice, exploratory program, plan astute sensor handling framework, and trial examination. This article mainly introduces the application, research, and analysis of smart sensors in tennis server technology correction equipment, to reduce the burden on players and coaches. This article proposes target following calculations, normal denoising handling calculations, and so on, which are utilized to lead research investigating the use of savvy sensors in tennis server innovation adjustment hardware. The trial aftereffects of this paper show that the normal acknowledgment exactness of the savvy sensor is 91.14%, and the acknowledgment precision is high, which can be better applied to the tennis serve innovation revision hardware.

1. Introduction

Motion capture is a multidisciplinary research field that has emerged in recent years. It involves system design, communication technology, sensor measurement, navigation control, spatial positioning, information fusion, biological efficacy, and other disciplines. Generally speaking, the general process of motion capture is to set up sensors on the key parts of the moving object, capture the position of the tracking unit through the analysis of the motion data by the system, and then restore the coordinate data of the marking point in the three-dimensional space after calculation and processing. After being identified, it can be used in many fields. This technology has been identified and can be used in various fields.

Tennis serve technique is an important content of tennis technique course teaching. It is the focal point of helping and quite possibly the most troublesome strategy to dominate. These days, tennis educating primarily embraces conventional showing techniques in view of abstract judgment and experience. Mentors utilize emotional perceptions to direct, right, and equitably assess understudies’ specialized development. It is challenging to impart instructing content to understudies instinctively, distinctively, and clearly. Step-by-step instructions to investigate a bunch of training strategies appropriate for novices or nonproficient tennis aficionados and restorative techniques reasonable for instructors are significant exploration bearings for tennis educating laborers. The intelligent sensor technology is applied to the technical correction device of tennis services, so that players
can carry out technical correction and training scientifically and effectively.

Wu et al. proposed an intermittent assortment technique for exchanging capacitor DC-DC converters, which can accomplish super low-power utilization energy assortment. In this technique, shrewd sensor applications are added, depending on super low-power energy collectors to eliminate energy from different natural power levels and charge the battery. Wu et al. proposed a spasmodic savvy sensor procurement innovation that decouples the two efficiencies to acquire a superior compromise. The trial information recorded in this study are not many, which are not to the point of supporting the logical idea of the examination [1]. Li et al.’s examination observed that the remote shrewd sensor organization (WSSN) has minimal expense; higher adaptability; strong information, about the executives; and the capacity to give a superior comprehension of the underlying ways of behaving through a thick arrangement of sensors. Subsequently, it is utilized in underlying wellbeing observing (SHM), which shows an expansive possibility. At any rate, the execution of the far-off SHM structure brings numerous troubles, one of which is to ensure palatable synchronization of the accumulated data. Li et al. examined a one of a kind capacity and difficulty on/about simultaneous detecting in SHM applications and afterward led a mathematical report on the effect of nonlinear clock float on information synchronization exactness and proposed another sort of coordinated sensor that considers nonlinear clock float remuneration. Sense the system, and utilize two distinct execution strategies to meet different application prerequisites. This exploration step is muddled and not reasonable for advancement by and by [2]. Myers N, L purposed the body position in the recently settled 3D kinematics development examination study to foster an investigation instrument for noticing tennis serve. These are characterized as the place of the hubs corresponding to the successful power, age, and the least joint burden. The principle motivation behind the examination is to decide the dependability of the eyewitnesses at every hub between the two clinical experts who fostered the tennis serve investigation, and the second is to concentrate on the legitimacy of the tennis serve examination. To accomplish these objectives, Myers et al. directed two separate examinations. In the first place, they analyzed the recordings of 28 dynamic players; two clinical experts appraised every video and scored whether they got every hub; what is more, among tennis players, three tape records are utilized to pass judgment on the viability of the serve; the tennis serve investigation is utilized to score the assistance mechanics, and the players are partitioned into mechanics (≥5) and nonmechanics (≤4). This exploration interaction is long and not reasonable [3].

The conventional tennis serve specialized remedy strategy has low ID impact and off-base rectification technique, which needs further improvement and advancement. The innovations of this paper are as follows: (1) the Bayesian recursive channel strategy, Kalman channel technique, and expanded Kalman channel strategy are proposed for target following; (2) the restricting channel strategy, middle channel strategy, arithmetic normal separating technique, moving normal sifting strategy, and restricting moving normal separating strategy are utilized to denoise sensor information; and (3) the intelligent sensor processing system is designed.

2. Method of Application of Intelligent Sensor in Tennis Serving Technical Correction Equipment

2.1. Target Tracking Algorithm. The objective following the calculation is a course of investigating the video picture grouping to match each identified up-and-comer target district, finding the direction places of these objectives in the picture, and afterward acquiring a progression of ceaseless changes of a similar target. The target following calculation is quicker than the single-outline identification calculation, utilizing all known data (speed and area appearance highlights) to follow the focuses, saving framework resources. Method abundance limit channel strategy is otherwise called implanted channel technique or program judgment channel method. The computerized sifting technique concentrated here can more readily show excellent pictures.

2.1.1. Bayesian Recursive Filtering Method. Bayesian filtering refers to a type of filtering algorithm based on Bayes’ theorem, which is a method of recursive calculation based on the obtained observation data of the state’s posterior probability distribution, prior probability distribution, state estimated value, predicted value, etc. [4].

Offer the viewpoint arrangement \( z_{1:k} \) at time \( k \), and compute the likelihood that the objective state variable takes various qualities [5]. Build the likelihood thickness work \( p(x_k, z_{1:k}) \). In the event that there is an earlier \( p(x_0) \), the underlying likelihood thickness capacity of the objective state is known, the likelihood thickness work can be obtained in a recursive way [6]. The recursive cycle is for the most part isolated into two stages. The initial step is to anticipate: accepting that \( p(x_{k-1}, z_{1:k-1}) \) has been acquired, then, at that point, as indicated by the Chapman-Kolmogorov equation:

\[
p(x_k | z_{1:k-1}) = \int p(x_{k} | x_{k-1}, z_{1:k-1}) p(x_{k-1} | z_{1:k-1}) dx_{k-1}
\]

\[
= \int p(x_{k} | x_{k-1}) p(x_{k-1} | z_{1:k-1}) dx_{k-1}.
\]

After obtaining the observation value \( z_k \) at time \( k \), use it to update the prior probability density distribution of the state to obtain the posterior probability density distribution:

\[
p(x_k | z_{1:k}) = \frac{p(z_k | x_k) p(x_k | z_{1:k-1})}{p(z_k | z_{1:k-1})}.
\]

2.1.2. Kalman Filtering Method. In target tracking, Kalman filter makes full use of the latest state observations, previous observations, and state estimates at the previous moment and obtains the optimal state estimation at the current moment according to the principle of linear minimum
variance, which greatly improves the target dynamic tracking accuracy [7, 8]. Assuming that the posterior probability density function of the state at each time is Gaussian, the noise \( w_k, v_k \) obeys the Gaussian distribution, and \( f(x) \) and \( h(x) \) are known linear functions, then the state transition equation and observation equation are

\[
x_k = F_{k|k-1} x_{k-1} + w_k,
\]
\[
z_k = H_k x_k + v_k,
\]

where \( F_{k|k-1} \) is the linear state transition matrix and \( H_k \) is the linear observation matrix [9]. The autonomous interaction commotion \( w_k \) and perception clamor \( v_k \) are both zero-mean Gaussian background noise; the fluctuations are \( W_k \) and \( V_k \) individually [10]. The initial state \( x_0 \) is independent of observation noise and process noise, and the mean and variance are known, which are \( \Sigma_0 \) and \( P_0 \), respectively [11]. The main process and key equations of the Kalman filter algorithm are shown below.

Predicted state value

\[
\tilde{x}_{k|k-1} = E[x_k|z_{1:k-1}] = F_{k-1} \tilde{x}_{k-1|k-1}.
\]

Calculate the covariance of the predicted state:

\[
P_{k|k-1} = F_{k-1} P_{k-1|k-1} F_{k}^T + W_k.
\]

Predicted observations

\[
\tilde{z}_{k|k-1} = H_k \tilde{x}_{k|k-1}.
\]

Calculate innovation (residual):

\[
\gamma_k = z_k - \tilde{z}_{k|k-1}.
\]

Calculate the covariance of innovation:

\[
S_k = H_k P_{k|k-1} H_k^T + R_k.
\]

Calculate Kalman gain:

\[
K_k = P_{k|k-1} H_k^T S_k^{-1}.
\]

Update status:

\[
\tilde{x}_{k|k} = \tilde{x}_{k|k-1} + K_k \gamma_k.
\]

Covariance of update state

\[
P_{k|k} = P_{k|k-1} - K_k S_k K_k^T.
\]

Update time, let \( k = K + 1 \), and cycle the above process until the end [2, 12].

2.1.3. Extended Kalman Filter Method. To use filtering theory to achieve target tracking, the key is to construct an appropriate target state transition equation and observation equation [13]. For the target tracking problem in wireless sensor networks, even a very simple system is generally nonlinear. At this time, the standard Kalman filter algorithm cannot obtain the optimal state estimation, and certain techniques can be used to transform it into an approximate linear filtering problem [14]. The extended Kalman filtering method is a nonlinear filtering method. The principle is to approximate the nonlinear transfer function and the nonlinear observation function in the system model with the corresponding first-order Taylor series expansion, thereby obtaining the linearized system equation, and then, the Kalman filter algorithm is used to complete the state estimation [15].

For discrete nonlinear systems, suppose there are state transition equations and observation equations, where \( F \) is the nonlinear state transition matrix and \( H \) is the nonlinear observation matrix:

\[
x_k = F(k-1, x_{k-1}) + w_{k-1},
\]
\[
z_k = H(k, x_k) + v_k.
\]

The main process and key equations of the extended Kalman filter algorithm are as follows. Predicted state value

\[
\tilde{x}_{k|k-1} = E[x_k|z_{1:k-1}] = F(k-1, \tilde{x}_{k-1|k-1}) .
\]

Calculate the covariance of the predicted state:

\[
P_{k|k-1} = F_{k-1} P_{k-1|k-1} F_{k}^T + W_k .
\]

The Jacobian matrix of the nonlinear state transition matrix \( F \) is

\[
\tilde{F}_{k} = \frac{\partial F(k-1, x_{k-1})}{\partial x_{k-1}} \bigg|_{x_{k-1} = \tilde{x}_{k-1|k-1}} .
\]

Forecast observations

\[
\tilde{z}_{k|k-1} = H \left(k, \tilde{x}_{k|k-1} \right) .
\]

Calculate the covariance of innovation

\[
S_k = \tilde{H}_{k} P_{k|k-1} \tilde{H}_{k}^T + V_k .
\]

The Jacobian matrix of the nonlinear observation matrix \( H \) is

\[
\tilde{H}_{k} = \frac{\partial H(k, x_k)}{\partial x_k} \bigg|_{x_k = \tilde{x}_{k|k-1}} .
\]

Calculate Kalman gain:

\[
K_k = P_{k|k-1} \tilde{H}_{k}^T S_k^{-1} .
\]
Update status:

\[ \bar{x}_{k|k} = \bar{x}_{k|k-1} + K_k S_k. \] (20)

Update covariance:

\[ P_{k|k} = P_{k|k-1} - K_k S_k K_k^T. \] (21)

Update time, let \( k = K + 1 \), and cycle the above process until the end [16, 17].

The lengthy Kalman sifting strategy just purposes the principal request term in the Taylor series development of the nonlinear capacity, disregarding other higher request terms; assuming the higher request terms in the extension are held, the guess of the nonlinear capacity will be a lot higher, but the large amount of calculation that will increase with it may make the improvement more than the loss, and the scope of application is very limited [18].

Extended Kalman filter is a commonly used nonlinear filtering method. It has fast calculation speed and low storage capacity. It has obvious advantages in engineering applications. In the environment of low nonlinearity and Gaussian white noise, the algorithm tracking is stable, and it has good performance, fast convergence speed, and high estimation accuracy [19].

2.2. Common Denoising Processing Algorithms

2.2.1. Advanced Separating Technique to Manage Infrequent Enormous Impedance

(1) Limiting Filtering Method. The rule of the restricted channel technique is to set a deviation limit \( T \) in view of genuine tasks and exact decisions. Whenever the identified two nearby information surpass this edge, the ongoing estimation esteem is disposed of and the past estimation information is chosen to supplant [20]. This sifting strategy can successfully eliminate arbitrary impedance brought about by unintentional variables; however, it cannot be utilized in information perfection handling [21]. Its demeanor is

\[ \begin{cases} |Y(t_2) - Y(t_1)| \leq T, Y(t_2) = Y(t_2) \\ |Y(t_2) - Y(t_1)| > T, Y(t_2) = Y(t_1) \end{cases} \] (22)

(2) Median Filtering Method. The basic norm of center filtering is to spread out a sliding window, which contains various pixels, and take the center worth of this enormous number of pixels and use it as the new worth of the center characteristic of the window [22, 23]. The particular cycle is to initially decide a square (round, precious stone, straight, and so forth) region with a specific pixel as the middle. This area is for the most part called a window. Besides, the dim upsides of all pixels in the window are arranged and in the wake of arranging are finished, and the middle worth in the game plan is taken as the new worth of the dim worth of the middle pixel of this window. As of now, assuming that the quantity of pixels is odd, the middle worth is the center worth in the wake of arranging by size; on the chance that the quantity of pixels is even, the dark upsides of the two center pixels subsequent to arranging are arrived at the midpoint of the middle. In the image denoising process, the image sign can be seen as a two-layered signal, so the consequence of the center direct in the two-layered case can be conveyed as

\[ g(x,y) = \text{median}\{f(x-i, y-j)\} (i, j) \in W, \] (23)

where \( g(x,y) \) addresses the dark worth of the result pixel, \( f(x-i, y-j) \) addresses the dim worth of the information, and \( W \) is the format window.

2.2.2. Computerized Separating Strategy to Manage Little Variance in High Recurrence

(1) Arithmetic Average Filtering Method. Number-crunching normal sifting is to track down the normal worth in the wake of adding the information of \( N \) back-to-to-back examples. The accompanying equation exists:

\[ y = \frac{1}{N} \sum_{i=1}^{N} x_i. \] (24)

As \( N \) extends, the result is more exact, and the flawlessness of the data after the game plan increases, but the assessment time increases and the responsiveness reduces. In certified planning, the value of \( N \) is for the most part picked by unambiguous essentials to get the required isolating effect [24].

(2) Moving Average Filtering Method. There is a formula for moving ordinary filtering:

\[ y(n) = \frac{1}{\text{windowSize}}(x(n) + x(n-1) + \cdots + x(n - (\text{windowSize} - 1))). \] (25)

(3) Restricting Moving Normal Sifting Strategy. At the point when there is the impact of large heartbeat impedance, just utilizing the normal separating strategy will average the bigger heartbeat mistake into the sifting result, which will contort the separated information. The restricted moving normal sifting technique can eliminate large arbitrary obstructions based on guaranteeing the perfection of the handled information and make the separated information profoundly fit the credibility of the first information. The technique piece of this article utilizes the above strategy to concentrate on the utilization of brilliant sensors in tennis serve innovation adjustment gear. The particular interaction is displayed in Figure 1.

3. Application Research Experiment of Smart Sensor in Tennis Serve Technology Correction Equipment

3.1. Selection of Experimental Characters

3.1.1. Experimental Subjects. Throughout the analysis, this article haphazardly chooses a piece of youthful tip top tennis
players (second-level competitors or more) and the genuine information of serving in preparing and contest as the examination object. An aggregate of 16 male understudies in the tennis extraordinary class of the University of Physical Education were chosen as the exploration objects. The chosen understudies were haphazardly isolated into an exploratory gathering and a benchmark group. The experimental group used smart sensor correction equipment for training, and the control group used conventional teaching methods for training.

3.1.2. Interviewee. Select coaches and experts who have a certain degree of research in tennis, and experts who have been engaged in sensor technology, processing, and computer technology for a long time as interview subjects learn from their experience and ideas on tennis teaching and training, and listen carefully to their views on contemporary tennis. Explain the current situation of teaching and training, and ask how sensor technology can be used reasonably in corrective teaching and training of tennis serve.

3.2. Experiment Procedure

3.2.1. Experimental Data Collection. During the experiment, all players are required to stand 100 cm to the right of the intersection of the service line of the tennis court and the center line of the service area (that is, point T) and make a flat shot toward the opposite point T. In tennis singles, matches refer to the standard size of the court: length 2377 cm and width 823 cm. In the process of serving, players are required to make a flat serve with maximum speed and accuracy. To eliminate the interference of other factors on the experimental results, there is a warm-up time of 8 minutes before the start of the serve, and the athletes can rest for 6 minutes after every 12 servings. Each player makes 24 flat shots (12 low intensity, 6 intermediate intensity, and 6 high intensity), uses smart sensors to track and capture the course of the tennis serve, and simultaneously records the result of each serve, which is useful for an effective serve. It is recorded as a successful serve, otherwise it is recorded as a failed serve and stored in the computer together with the sensor data. In the process of recording the server, we will not give any feedback to the players, although they can see where the ball fell. Before the experiment started, all sports players had been informed of the purpose and arrangement of the experiment and emphasized the necessary precautions.

3.2.2. Analyze the Movement Trajectory. After fully and completely grasping the relevant sensor data of the player's serve, by connecting and tracking the movement trajectory of the important nodes in the movement process, a continuous movement trajectory diagram is obtained, and then, the technical analysis is performed to calculate the athlete the posture characteristics and movement rate during exercise, in-depth analysis, and correction of movement completion.

3.2.3. Information Feedback and Analysis. The basis of information feedback and analysis is the relevant data obtained.

Table 1: Some steps of the experiment in this article.

| Application research experiment of smart sensor in tennis server technology correction equipment |  |
|---|---|
| 3.1 Experimental character selection | 3.2 Experiment procedure | 3.3 Design a smart sensor processing system |
| 1 Test subject | 1 Experimental data collection | 1 Processing core |
| 2 Analyze movement trajectory information | 2 Software architecture |
| 3 Feedback and analysis | 3 Run task |
| 4 Comparative analysis |  |

Figure 1: Part of the technical process of this method.
through smart sensors, playing forward and backward at different rates, observing the complete server technical action or the action image of a certain link, and performing technical analysis according to the coach’s needs. Get the corresponding correction feedback information.

3.2.4. Comparative Analysis. The exploratory gathering and the benchmark group were analyzed; the expert tennis players were contrasted and the trial bunch and the benchmark group in the underlying phase of educating; the undeniable level tennis players were contrasted and the test bunch and the benchmark group in the last phase of instructing.

3.3. Design a Smart Sensor Processing System

3.3.1. Processing Core. This research selects the ARM core microcontroller. At present, the ARM core is divided into Cortex-A, Cortex-R, and Cortex-M according to application scenarios. Cortex-A series are mainly for multimedia applications and various application scenarios with large demand. Cortex-R is mainly used for dedicated hard real-time task scene. The Cortex-M series is specially optimized for mixed-signal equipment, with a good combination of power consumption and cost, and upward compatibility with the processor, which is very convenient for software reuse and transplantation, and is most suitable for the use of smart sensor processing platforms.

The final selected processing core is STM32F429ZI, with a 32-bit processor, and its data processing capability meets the design goal of resolution greater than or equal to 1 million digital requirements, the main frequency rate is 180 MHz, the processing speed is fast, and the core is embedded with FPU (floating point calculation unit); this unit improves the core digital processing capabilities and can accelerate the software filtering in the smart sensor processing platform and enhance the system’s computing capabilities.

| Average height (cm) | Average age | Average arm length (cm) | Average weight (kg) |
|--------------------|-------------|------------------------|---------------------|
| Test group         | 174.5       | 19.7                   | 73.3                | 67.3                |
| Control group      | 173.9       | 20.6                   | 72.5                | 65.4                |
| Professional athlete | 175.7    | 18.4                   | 74.1                | 66.2                |

Table 2: Examination of the normal state of bunch understudies, control bunch understudies, and expert competitors.

| Maximum height of the ball from the hand (m) | Height of hitting point (m) |
|---------------------------------------------|--------------------------------|
| X                                           | 1.81                          | 2.76 |
| Test group                                   | Max 1.92                      | 2.87 |
| Min 1.65                                     | 2.43 |
| X                                           | 1.68                          | 2.57 |
| Control group                                | Max 1.76                      | 2.62 |
| Min 1.59                                     | 2.29 |
| X                                           | 2.01                          | 3.12 |
| Professional athlete                         | Max 2.34                      | 3.54 |
| Min 1.89                                     | 2.77 |

Table 3: Average serve height of subjects.

Figure 2: Average serve height of subjects.

| Algorithm name                         | Mean value of RMSE (m) | Variance of RMSE |
|----------------------------------------|------------------------|------------------|
| 1 Bayesian recursive filtering method  | 0.2754                 | 0.0246           |
| 2 Kalman filtering method              | 0.2869                 | 0.0215           |
| 3 Extended Kalman filter               | 0.2041                 | 0.0159           |
| 4 Limiting filtering method median filter | 0.2649                | 0.0412           |
| 5 Arithmetic average filtering method  | 0.2517                 | 0.0325           |
| 6 Moving average filtering method      | 0.2942                 | 0.0274           |
| 7 Limiting moving average              | 0.3027                 | 0.0243           |
| 8 Filtering method                     | 0.2876                 | 0.0271           |

Table 4: Algorithm RMSE mean and variance comparison.

Figure 3: Algorithm RMSE mean and variance comparison.
3.3.2. Software Architecture

(1) The hardware interface layer, as the bottom layer directly related to the hardware. This time layer is mainly composed of various drivers, including ADS1261 analog-to-digital converter driver, serial port driver, SPI interface driver, and other peripherals and interface drivers. Moreover includes the MCU kernel driver

(2) The system layer. The middle layer is the operating system. In this intelligent sensor software system, the \( \mu \)/COS-III kernel will realize the management of various designed tasks and control the communication between data. It is used by the sensor processing platform. The realization of design functions and high-performance indicators assumes a supporting role

(3) The functional layer, that is, the application layer. This layer relies on the embedded operating system to realize various business function modules to be realized in the form of tasks and realize a function or part of a function through tasks, such as initialization tasks, AD module collection tasks, data processing, and calculation tasks

3.3.3. Run the Task

(1) ADS1261 Sampling Task. After the sampling task starts, request the semaphore, then start to access AD, obtain the output value, assign the global variable VALUE, calculate the voltage value VOLVALUE according to the voltage calculation formula, and then send the semaphore. VALUES and VOLVALUES can be used by other tasks. Use OSTimeDlyHMSM() to achieve delay. The purpose of delay is to provide a task switching point for the system, and the conversion of system tasks is operated by the task scheduler that is evoked by the delay. Similarly, when the task is suspended, OSTaskSuspend() and creation or deletion, that is, when the task state is changed, it can also be implemented to enter the scheduling point.

(2) Data Processing Tasks. The key point of the data processing task is to perform digital filtering after receiving the AD output value bound semaphore and calculate the filtered output value to convert it to the required value.

(3) LCD Task. After entering the task, first bind the semaphore, then call the relevant driver, pass the global variable VOLVALUE as a parameter to the function, call LCD_ShowString() to display and refresh the screen, and then unbind the switching task.

(4) Storage Task. The realization of the storage task enters the bound semaphore; first judges the com variable; performs a read operation or write operation according to the variable calls I2C_ReadData() and I2C_SendData(), respectively; reads and writes bytes; and then releases the semaphore. Enter the switch.

This part of the experiment puts forward the above steps for the application research experiment of smart sensors in tennis server technology correction equipment. The specific process is shown in Table 1.
4. Application Research and Analysis of Intelligent Sensors in Tennis Serve Technical Correction Equipment

4.1. Experimental Item Analysis

(1) The correlation of the normal state of the exploratory gathering understudies, the benchmark group understudies, and expert tennis players in the tennis exceptional class is displayed in Table 2. It very well may be seen from the information in the table that the normal tallness of the understudies in the trial gathering of tennis exceptional class is 174.5 cm; the normal age is 19.7 years; the normal manageable distance is 73.3 cm; the normal weight is 67.3 kg. The normal age of the benchmark group understudies in the tennis unique class was 20.6 years; the normal tallness was 173.9 cm; the normal weight was 65.4 kg; and the normal careful distance was 72.5 cm. The normal period of expert tennis players is 18.4 years; the normal tallness is 175.7 cm; the normal weight is 66.2 kg; the normal safe distance is 74.1 cm. There were no tremendous contrasts in the normal tallness, normal safe distance, and normal load of exploratory gathering, control gathering, and expert competitors.

(2) Serve technique is the focus of tennis teaching. First of all, the difficult part of the serve technique is reflected in the maximum height of the ball thrown away from the hand and the height of the hitting point. It not only affects the difficulty and accuracy of the shot when serving, but more importantly, it affects the rhythm of the entire server. In this study, the height of the ball thrown from the hand and the height of the hitting point of the subject in the serve movement were recorded with sensors, and the statistics were collected and sorted, as shown in Table 3 and Figure 2.

It tends to be seen from the outline that the normal greatest tallness of the ball tossed from the hands of the benchmark group understudies is 1.68 m, and the normal most extreme stature of the ball tossed from the hands of expert tennis players is 2.01 m, which is 0.33 m away from proficient tennis players. The average height of the hitting point of the students in the control group when serving is 2.57 m, and the average height of the hitting point when the professional athletes serve is 3.12 m, which is 0.55 m different from the high-level tennis players; the students in the experimental group throw away the ball when they serve The average maximum height of the hand is 1.81 m, and the average maximum height of the ball thrown from the hands of professional tennis players is 2.01 m, which is 0.20 m different from professional tennis players; the average height of the hitting point when the students in the experimental group serve the ball is 2.76 m, and the average height of the hit point when professional athletes serve is 3.12 m, which is 0.44 m away from high-level tennis players. As per the above information investigation, the stature of the ball in the hand and the tallness of the ball in the trial bunch are fundamentally better compared to those in the benchmark group, which is nearer to the information of expert competitors.
4.2. Experiment Analysis

(1) For target tracking in wireless sensor networks, it can generally be modeled as a nonlinear state estimation problem. The previous article introduces several filtering processing methods. Here, we use a system with nonlinear dynamic model and non-Gaussian noise to compare the effects of these algorithms in one-dimensional target tracking. The root mean square mistake (RMSE, Root Mean Square Error) is chosen as a list to assess the presentation of the calculation. The mean worth of RMSE is utilized to address the separating exactness of the calculation, and the difference of RMSE is utilized to quantify the dependability of the calculation, as shown in Figure 3 and Table 4.

For systems where the state transition equation and the observation equation are nonlinear equations and the process noise and observation noise are non-Gaussian distributions, the minimum RMSE of the extended Kalman filter method among several algorithms is 0.2041 m, which shows that the extended Kalman filter method has the highest estimation accuracy. And compared with the Gaussian noise case, the advantages of the extended Kalman filter method are more obvious. The variance of RMSE is slightly smaller than the other several algorithms by the extended Kalman filtering method, and the stability is stronger.

(2) FSIM measures the structural similarity between two images. It evaluates the underlying features of the image from the perspective of the human visual system. The nearer the worth is to 1, the more comparable the two pictures and the better the denoising impact. A few channel handling calculations are contrasted, and different assessment markers run multiple times, and the outcomes are arrived at the midpoint, as displayed in Table 5 and Figure 4.

It can be seen from the chart that the extended Kalman filter has a short running time and a better denoising effect. This paper selects the extended Kalman filter to denoise the collected sensor image sequence.

(3) Perform five experiments to analyze the recognition accuracy of the tennis server technology correction equipment based on smart sensors and plot the results on charts, as shown in Table 6 and Figure 5.

From the calculation of the data in the chart, it can be seen that the average recognition accuracy of the smart sensor in this paper is 91.14%, and the recognition accuracy is high. It can be better applied to the tennis serving technology to correct equipment and improve the efficiency of teaching and training.

(4) For the objective following and acknowledgment time, the framework broadens the Kalman target following and acknowledgment time to roughly 12.05 seconds. The Kalman target following and acknowledgment time is around 9.41 seconds. Bring what is
going on into a graph, as displayed in Table 7 and Figure 6.

After the Kalman development, the objective following and acknowledgment time is around 1.08 seconds, which is 10.97 seconds, not exactly the unadulterated programming execution. Consequently, after the extension speed increase, the objective acknowledgment time is decreased to 2.71 seconds, and the ongoing exhibition is fundamentally moved along.

### 4.3. Feedback Analysis

Count the feedback situation of the experimental subjects after receiving the test of the smart sensor-based tennis server technology to correct the equipment and organize and draw the graphs, as shown in Table 8 and Figure 7.

It very well may be clearly seen from the outline that by far, most of the subjects like tennis serve innovation revision hardware in light of shrewd sensors for preparing, representing 87.50%; most subjects accept that the utilization of this inventive savvy gadget can incredibly advance the learning of tennis serve innovation making it more clear and handle the central issues and troubles in the information learning process.

### 5. Conclusions

The quick advancement of science and innovation and the fiery ascent of data innovation have empowered the far and wide dispersal of current and logical tennis preparing innovation. The consolidated use of PC application innovation, correspondence innovation, and man-made reasoning innovation has been generally advanced in significant level tennis preparing. Serving is the basic technical action at the beginning of every ball in tennis, and it is also the most critical technical action in tennis. Long-term training practice shows that the mastering of serving technical actions requires repeated practice for a long time, which is relatively difficult to master.

With the persistent taking off of the degree of sports rivalry, the advancement of PC innovation, and shrewd detecting innovation, the utilization of machine vision to gather data gives more extravagant data to the mentors and can likewise record the information data of sports objectives. The athlete's technical movements make the originally inaccessible visual system have a more intuitive performance.

Movement investigation permits individuals to become familiar with the law of movement of the objective article and use it for examination and demonstrating. In the field of sports investigation, innovation can be utilized to recreate preparing, record competitors' development information, and contrast them with standard formats to produce revision data for examination and reference. In the teaching of segmented and decomposed tennis serve technology, the use of sensors to capture the serve movement and compare and correct wrong movements is helpful to find a variety of auxiliary teaching methods and comprehensively analyze the throwing, posture of the racket after throwing, bending knees, kicking, holding rotate the racket arm externally, relax, and follow the swing to establish a correct driving chain.

### Data Availability

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

### Conflicts of Interest

The authors declare that they have no conflicts of interest.

### References

[1] X. Wu, Y. Shi, S. Jeloka et al., “A 20-pW discontinuous switched-capacitor energy harvester for smart sensor applications,” IEEE Journal of Solid-State Circuits, vol. 52, no. 4, pp. 972–984, 2017.

[2] L. Jian, K. A. Mechitov, R. E. Kim, and B. F. Spencer Jr., “Efficient time synchronization for structural health monitoring using wireless smart sensor networks,” Structural Control and Health Monitoring, vol. 23, no. 3, pp. 470–486, 2016.

[3] N. L. Myers, W. B. Kibler, L. Lamborn et al., “Reliability and validity of a biomechanically based analysis method for the tennis serve,” International Journal of Sports Physical Therapy, vol. 12, no. 3, pp. 437–449, 2017.

[4] M. R. Garcia, M. L. Cabo, J. R. Herrera, G. Ramilo-Fernández, A. A. Alonso, and E. Balsa-Canto, “Smart sensor to predict retail fresh fish quality under ice storage,” Journal of Food Engineering, vol. 197, pp. 87–97, 2017.

[5] J. del Rio, D. M. Toma, E. Martinez et al., “A sensor web architecture for integrating smart oceanographic sensors into the semantic sensor web,” IEEE Journal of Oceanic Engineering, vol. 43, no. 4, pp. 830–842, 2018.

[6] G. C. Koutitas and L. Tassiulas, “Low cost disaggregation of smart meter sensor data,” IEEE Sensors Journal, vol. 16, no. 6, pp. 1665–1673, 2016.

[7] D. Simon, “Use smart hardware to improve IoT energy and sensor efficiency,” PACE - Process & Control Engineering, vol. 70, no. 1, pp. 26–27, 2017.

[8] S. Hwang, “Activity-aware sensor cycling for human activity monitoring in smart homes,” IEEE Communications Letters: A Publication of the IEEE Communications Society, vol. 21, no. 4, pp. 757–760, 2017.

[9] F. A. Egorov, V. V. Amelichev, S. S. Generalov, S. V. Nikiforov, S. V. Shamaeva, and Y. V. Goldberg, “Smart fiber-optical sensor of acoustic pressure with a possibility of distant correction of sensitivity,” Russian MicroElectronics, vol. 45, no. 6, pp. 442–445, 2016.

[10] R. Bie, G. Zhang, Y. Sun, S. Xu, Z. Li, and H. Song, “Smart assisted diagnosis solution with multi-sensor Holter,” Neurocomputing, vol. 220, pp. 67–75, 2017.

[11] D. He, S. Chan, and M. Guizani, “Cyber security analysis and protection of wireless sensor networks for smart grid monitoring,” IEEE Wireless Communications, vol. 24, no. 6, pp. 98–103, 2017.

[12] B. C. Csáji, Z. Kemény, G. Pedone, A. Kuti, and J. Vánca, “Wireless multi-sensor networks for smart cities: a prototype system with statistical data analysis,” IEEE Sensors Journal, vol. 17, no. 23, pp. 7667–7676, 2017.
[13] S. A. D. A. N. Dissanayake, H. Pasqual, and B. C. I. Athapattu, "Economical colorimetric smart sensor to measure water quality of drinking water in CKDu prevalence areas," IEEE Sensors Journal, vol. 17, no. 18, pp. 5885–5891, 2017.

[14] S. Rajasoundaran, A. V. Prabu, J. B. V. Subrahmanyam et al., "Secure watchdog selection using intelligent key management in wireless sensor networks," Materials Today: Proceedings, 2021.

[15] R. Edirisighe, "Digital skin of the construction site," Engineering Construction & Architectural Management, vol. 26, no. 2, pp. 184–223, 2019.

[16] C. Jaeik, N. Chilamkurti, and S. J. Wang, "Editorial of special section on enabling technologies for industrial and smart sensor internet of things systems," Journal of Supercomputing, vol. 74, no. 9, pp. 4171-4172, 2018.

[17] F. Dossena, C. Rossi, A. la Torre, and M. Bonato, "The role of lower limbs during tennis serve," The Journal of Sports Medicine and Physical Fitness, vol. 58, no. 3, pp. 210–215, 2018.

[18] J. Zappala, C. Orrego, E. Boe, H. Fechner, D. Salminen, and D. J. Cipriani, "Influence of posture-cuing shirt on tennis serve kinematics in division III tennis players," Journal of Chiropractic Medicine, vol. 16, no. 1, pp. 49–53, 2017.

[19] D. Cohen-Zada, A. Krummer, and O. M. Shapir, "Testing the effect of serve order in tennis tiebreak," Journal of Economic Behavior & Organization, vol. 146, no. Feb., pp. 106–115, 2018.

[20] S. A. Kovalchik and J. Albert, "A multilevel Bayesian approach for modeling the time-to-serve in professional tennis," Journal of Quantitative Analysis in Sports, vol. 13, no. 2, pp. 49–62, 2017.

[21] X. Liu, Y. Li, and Q. Wang, "Multi-view hierarchical bidirectional recurrent neural network for depth video sequence based action recognition," International Journal of Pattern Recognition and Artificial Intelligence, vol. 32, no. 10, article 1850033, 2018.

[22] G. Suryanarayana, K. Chandran, O. I. Khalaf, Y. Alotaibi, A. Alsufyani, and S. A. Alghamdi, "Accurate magnetic resonance image super-resolution using deep networks and Gaussian filtering in the stationary wavelet domain," IEEE Access, vol. 9, pp. 71406–71417, 2021.

[23] L. Chen, H. Sun, W. Zhao, and T. Yu, "Robotic arm control system based on AI wearable acceleration sensor," Mathematical Problems in Engineering, vol. 2021, Article ID 5544375, 13 pages, 2021.

[24] R. S. A. R. Abdullah, N. L. Saleh, S. M. S. Ahmad, A. A. Salah, and N. E. A. Rashid, "Ambiguity function analysis of human echolocator waveform by using gammatone filter processing," The Journal of Engineering, vol. 2019, no. 20, pp. 6935–6939, 2019.