Embedded design of intelligent vision in sports performance accuracy verification devices

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ABSTRACT

To address the issue of insufficient accuracy in the embedded design of traditional sports performance verification devices, this study innovatively proposes an embedded design scheme for a sports performance accuracy verification system based on intelligent vision technology. In terms of hardware configuration, a high-efficiency Advanced RISC Machines (ARM) processor is selected to replace the original bulky computing unit, outdated embedded controllers, and complex independent power modules. This significantly enhances the system's integration and energy efficiency. On the software level, advanced intelligent vision technology is ingeniously integrated. Through the meticulously constructed reverse vision model design, the system not only achieves fine classification and evaluation of sports performance but also optimizes the execution efficiency of the underlying code, ensuring the standardized and regulated operation of the model. This model is customized for high-precision performance determination and can adapt to the scoring rules of various sports events. To verify the practical effectiveness of this system, simulated application scenarios were constructed, and detailed simulation tests were conducted. The analysis of the experimental data shows that the embedded sports performance verification system based on intelligent vision significantly improves the accuracy and efficiency of performance evaluation. It also demonstrates excellent stability and versatility, thus strongly confirming the effectiveness and innovative value of this design.

Keywords: Intelligent vision, sports performance, embedded design, integration, energy efficiency ratio

1. INTRODUCTION

With the wave of technological advancements, sports events are gradually incorporating cutting-edge technology to ensure fairness and accuracy in judging, providing strong technical support for athlete training. Traditionally, sports performance verification systems mostly rely on optical sensing systems for monitoring. While adept at capturing light changes, these systems can lead to misjudgments in high-speed dynamic scenarios due to threshold settings, particularly in competitions with similar speeds, potentially mistaking multiple objects for a single one and thus affecting judgment accuracy[1].

In this context, integrating intelligent vision technology into performance verification has brought about a revolution. This technology, which incorporates the latest algorithms and design concepts, significantly enhances the accuracy of performance evaluation through highly precise image recognition and analysis capabilities. Therefore, this paper proposes an innovative approach to applying intelligent vision technology to sports performance accuracy verification systems, aiming to address the limitations of traditional verification systems.

The core of the system design lies in adopting a high-performance ARM processor to replace the previously bulky computing units. This not only reduces the device size but also improves processing efficiency. The system integrates an embedded control unit and an efficient power management module, ensuring hardware compactness and high energy utilization. On the software side, a meticulously designed artificial vision reverse assembly model is employed to achieve fine classification and standard evaluation of sports performance. This model optimizes memory usage, accelerates computation processes, and establishes strict standards to ensure the standardization and accuracy of verification results.

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To validate the effectiveness of the new system design, a series of simulation experiments were conducted. Experimental data show that the embedded verification system based on intelligent vision can quickly and accurately complete sports performance corrections, significantly improving judgment efficiency and reliability. This fully demonstrates the innovative value and practical significance of the design.

2. HARDWARE DESIGN

The embedded design of intelligent vision in sports performance accuracy verification proposed in this paper achieves a high degree of integration and optimization in the hardware architecture, specifically including the following core components:

(1) Embedded Memory: Used for storing program code, vision model parameters, and temporary data, ensuring fast data access required for system operation.

(2) Operation Manager: Responsible for scheduling system resources, including task allocation and process management, to ensure efficient system operation.

(3) ARM Processor: Serving as the brain of the system, an advanced ARM architecture processor replaces traditional large processors, providing high-performance and low-power computing capabilities. This is key to achieving rapid performance verification.

(4) Embedded Switch: Used for network communication and data transmission, ensuring efficient and stable interconnection between systems.

(5) Integrated Power Management Module: Optimizes power distribution, ensuring stable power supply under different loads and improving energy utilization.

(6) Control System: Integrates the control logic of various sensors and actuators, enabling precise control of external devices.

Through the close cooperation of these components, especially the high-efficiency computing capability and integrated design of the ARM processor, the system can achieve high-speed, precise performance verification while maintaining a compact size. Figure 1 illustrates the hardware structure layout of this innovative design, intuitively reflecting the connections and interactions between each part. This demonstrates the compactness and functionality of the design, providing a solid technical foundation for more fair and efficient sports competition judging.

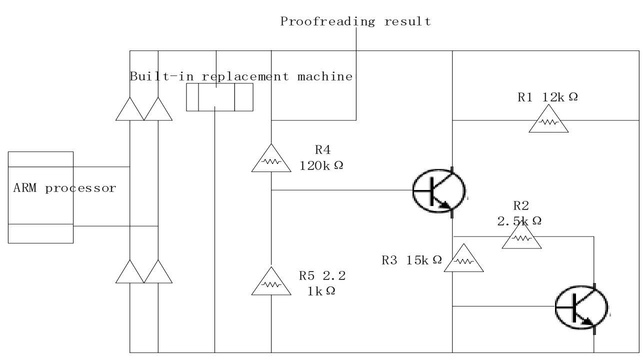

Figure 1. Hardware configuration.

3. SOFTWARE DESIGN

3.1 Reverse engineering intelligent vision model design

This study proposes an innovative approach utilizing intelligent vision technology embedded in systems to standardize equipment for verifying sports performance. The core of this system lies in adopting an optimized visual processing strategy, referred to as the reverse engineering vision model. This model represents a further evolution of traditional intelligent vision technology, aiming to accomplish the task of sports performance verification with high efficiency and precision. The initial work in constructing this reverse engineering vision model involves implementing a standardized adjustment process for sports performance, detailed as follows:

$$\mathrm{TRU}_{\mathrm{er}}=\frac{\ln\left(H_{\mathrm{er}}^{T}-\mathrm{f}_{\mathrm{er}}^{T}\right)\left(\mathrm{U}_{\mathrm{er}}^{2}\text{-}\mathrm{U}_{\mathrm{er}}\text{-}1\right)}{2\Delta\mathrm{d}\left[\ln H_{\mathrm{er}}^{T}\text{-}\ln H_{\mathrm{er}}^{T}\text{-}1\right]+\left(\ln H_{\mathrm{er}}^{T}\text{-}\ln\mathrm{f}_{\mathrm{er}}^{T}\right)} \tag{1}$$

In the formulas: $\mathrm{TRU}_{\mathrm{er}}$ represents the standardization of the difference in sports quantity. H_{er}^{T} represents the standard association visual operator. $\mathrm{f}_{\mathrm{er}}^{T}$ represents the entropy value of motion image frames. $\mathrm{U}_{\mathrm{er}}^{2}$ represents the effective fluctuation of motion visual images[2]. In this paper, an embedded system using the principles of intelligent vision is designed to correct sports scores, adopting a reverse engineering vision model for precise adjustment. During this adjustment process, dynamic changes in sports data are taken into account along with the precision of tuning parameters to ensure their coordinated consistency. After completing the standardized adjustments, the validation criteria for sports data are established as follows:

$$ML_{\mathrm{er}}^{2}\left(\mathrm{a,b}\right)=\left|2I_{\mathrm{er}}^{2}\left(\mathrm{a,b}\right)-I_{\mathrm{er}}^{2}\left(\mathrm{a,b}\right)-I_{\mathrm{er}}^{2}\left(\mathrm{a,b}\right)\right| \tag{2}$$

In the formulas: ML_{er}^{2} represents the standardization of correction parameters for sports data. I_{er}^{2} represents the manual visual correction data quantity difference. after the aforementioned parameter adjustments, the establishment of the reverse engineering vision model can proceed as follows:

$$\Phi_{\mathrm{er}}=\frac{\Phi_{\mathrm{er}}+\Phi_{\mathrm{er}}\times E}{\sum\Phi_{\mathrm{er}}+\sum\Phi_{\mathrm{er}}\times E},\left(\mathrm{UYGJ}\in R\right) \tag{3}$$

In the formulas: Φ_{er} represents the bit error traces of motion images, which can be detected through coded information on the traces. Typically, bit error traces carry 3 to 4 coded pieces of information[3,4]. UYGJ serves as the initial condition for the reverse engineering vision model. By constraining the conditions, the accuracy of the designed model can be improved. E denotes parameters of the reverse engineering vision model, facilitating more accurate quantification standard calibration.

3.2 Optimization of embedded code calculation

This study proposes a sports performance verification system embedded with intelligent vision technology, utilizing a reverse engineering vision model. However, this model has limitations when assessing sports performance across multiple dimensions, failing to comprehensively consider multidimensional measurements. Given this, optimizing the computational logic of the underlying code becomes crucial, with the primary step involving categorizing data characteristics. This process can be abstracted into a formula as follows:

$$Q=\mathrm{A}_{\mathrm{pbr}}T_{\mathrm{NIHO}}J_{\mathrm{p}}E_{\exp}\mathrm{T}_{\mathrm{HW}}\left(E_{\mathrm{r}}+\mathrm{E}_{\mathrm{m}}\right) \tag{4}$$

In the formula: T_{NIHO} represents the slight texture parameters of sports performance. T_{HW} represents the weight values of sports performance levels. $E_{\exp}$ represents the maximum division level parameter. E_{m} represents the parameterization coefficient of quality.

After the data has been categorized at the level of data, it needs to undergo confirmation of related evolutions[5,6]. This process can enhance the accuracy of the calculation process.

$$W=E_{0}^{2}\left[Y_{\mathrm{er}}^{\mathrm{t}}-\sin\left(\delta_{\mathrm{m}}\text{-}\delta_{\mathrm{r}}\right)\right]/4 \tag{5}$$

In the formula: E_{0}^{2} represents the original limited level parameter. $Y_{\mathrm{er}}^{\mathrm{t}}$ represents the position of the correction data's Rubik's cube ratio function, providing a certain constrained reference quantity. δ_{m} represents the inter-level differences. δ_{r} represents the entropy value of multi-ability quantification. After the optimization mentioned above, the calculation process still requires redefining the conditions of use. The formula is as follows:

$$E = \frac{\sqrt{2}}{4} E_0 \begin{bmatrix} \exp(-i\phi) + \exp(-i\phi) \\ 0 \end{bmatrix} \quad (6)$$

In the formula: $\exp(-i\phi)$ represents the process quantity data after completing the correction process. The optimization of the embedded code calculation is accomplished through the above formula.

4. SIMULATION EXPERIMENT ANALYSIS

4.1 Parameter setting

To ensure the effectiveness of the designed embedded sports performance verifier based on human visual perception, parameters are set as follows: the standardization of the difference in sports quantity TRU_{er} is within the range of 62.58 to 98.36; According to Reference[7], the texture parameter for the slight texture of sports performance is set to 17.66[8]. The schematic diagram of the simulated experiment designed in this paper is shown in Figure 2.

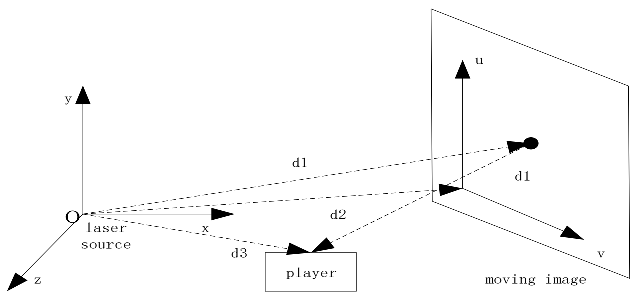

Figure 2. Experimental schematic diagram.

4.2 Result analysis

During the experiment, the test results of the traditional sports performance verifier and the embedded sports performance verifier with intelligent vision designed in this paper were recorded.

The data distribution of the traditional sports performance verifier is as follows[9] in Figure 3; The data distribution of the embedded sports performance verifier with intelligent vision is as follows in Figure 4:

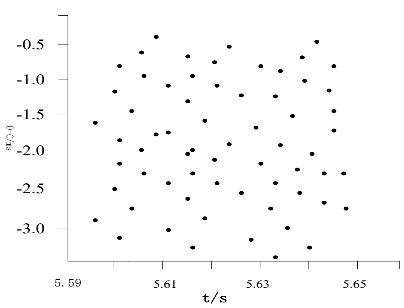

Figure 3. Experimental result (1).

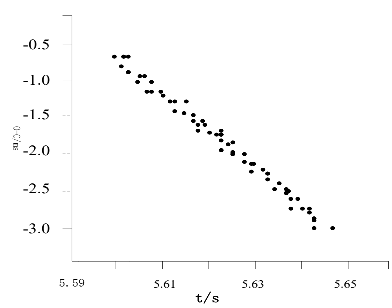

Figure 4. Experimental result (2).

Through Figures 3 and 4, it can be observed that the data distribution of the embedded sports performance verifier with intelligent vision designed in this study is more concentrated. Moreover, it exhibits a certain regularity within a defined range, demonstrating faster and more accurate correction effects compared to the traditional scattered distribution.

Analysis of the results from Figure 5 reveals that the embedded sports performance verifier with intelligent vision designed in this study exhibits almost no significant data variation compared to the set standard values.

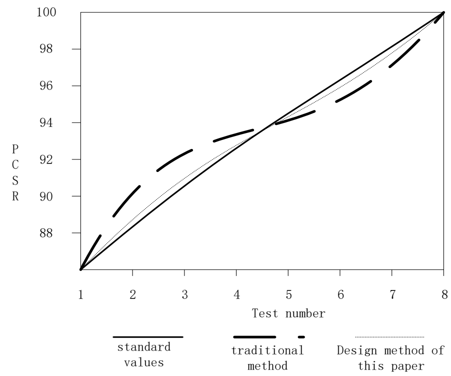

Figure 5. Contrast of test results, PCSR (parameter calibration standard ratio).

5. CONCLUSION

This study introduces an innovative embedded system design, which utilizes advanced intelligent vision technology to achieve precise verification of sports performance. Through detailed experimental comparative analysis, the effectiveness of this system is validated. The research results demonstrate a significant improvement in the accuracy of performance correction achievable through the enhanced verification system. We hope that the outcomes of this study can introduce a more efficient and reliable solution for performance verification in the sports domain, thereby promoting the development and refinement of related application systems.

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