Urban air pollution resolution and basketball training optimization based on time convolution network

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Abstract
The optimization of basketball training service rate ball playing position angular impact is extremely large. Neck structure construction curve analysis effective area individual model, sphere ball-like mathematical model, angle sum and angle, angle-dependent, angle-wise mathematical model, selection-appropriate numbers angle. Nonlinear Heterosexual Ellipse Equation (NHEE) analyzes basketball’s free throw choice kinematics parameters while determining which learning process has a major impact if one succeeds. Basketball knee curve shows statistical analysis that helps to determine the success of basketball training curve analysis. NHEE uses a set of different measures of curve fit given during basketball practice.

Keywords Air pollution · Urban environment · PM2.5 · Basketball training curve

Introduction
This paper points out three efficient time series models of urban environmental pollutants. They are increasing trend, decreasing trend, and constant trend. Using the linear top-down way to record the time data of environmental pollutants, giving segmentation to the original air environmental pollutants to give basic filtering, the obtained data and samples are compared through the comparison method. The model matching method is used to measure the impact of different air pollutants on the study city.

Basketball is an exciting and competitive sport. In order to get the competitive advantage, you need to win basketball, you need to fully understand (slowly, e.g., shooting handed over) and develop basic skills. Basketball training curves are based on Nonlinear Heterosexual Ellipse Equation (NHEE) technology. The performers are athletes and the players are human bodies. Shooting technique, the main evaluation factor of the performance of human movement biomechanical function.

During the filming process, the athlete’s primary movement link is the connection between leg movements and upper leg movements. The movements of the lower limbs are mainly reflected in the knee joint, and the movements of the upper limbs are mainly reflected in the hand holding the ball. At the moment of shooting, the instant training athlete releases the action and training moment release hand movement state and releases the player’s knee joint condition before training the player’s knee joint condition.

Related review
Because of the phenomenon of environmental pollution, the literature points out a causal spatiotemporal model of urban environmental pollutants based on Gaussian bell. The model uses quotient algorithm to analyze and study the corresponding space, and contact the impact of meteorological information on the model, has found the main causes of environmental pollutants, and analyzes the correlation between each other, but this method cannot extract the best based on causality (Mo et al. 2019). In addition, the environmental quality data collected by many sensors contain a lot of noise, which will adversely affect the causal analysis. In order to effectively control the above problems, some researchers based on several years of relevant authoritative data information, through the establishment of Bayesian posterior probability experiment, create a mobile geographic model, and apply the model to...
delay the physics and time of environmental pollution. Urban renewal is the key variable (Burnett et al. 2006). In the dynamic changing space, this paper analyzes the impact of new urbanization on environmental pollution in detail. In addition, it is also of great significance to analyze and study the spatiotemporal relationship of urban environmental pollutants.

The lighting of powerful players is blocked. To demonstrate the potential of our technology, the proposal of a stroke-based system allows users to get basketball videos. The same type of cardio and strength training can be used as an individual sport. Basketball training requires stability, strength, explosive power, speed and coordination of basketball players above average height (Shaban et al. 2014). Research data further show that this method can improve learning, first-class interactions, and the quality of learning outcomes in sports, as well as the curriculum, and this new teaching method. It confirmed the satisfaction of the students (Clayton 2001).

The rapid development of smart wearable devices based on the development of the Internet of Things (IoT) calls for the development of devices that can monitor performance and remotely analyze how a basketball player shoots. Advanced tools proved to be more effective than the traditional Carnot diagram clustering method. However, sporting events such as shoots, fouls, and rebounds caused by transfers from such players are fully recorded by manual operation of the video recorder (Knill 2003).

Automatically extract events generated by players and judge basketball games. Experiments show that it is possible to extract events by automatically tracking players and referees and analyzing predefined sports of players and referees. Increase the level of learning opportunities everywhere for more freedom and convenience. Offers more opportunities in mobile technology, but see living environment (Liu et al. 2018b). How to Improve Lifetime Learning Wave Facing Assumption Working with Internet Sources and Tools. Additional Technologies to Overcome All Technologies and Design and Integration methods to increase cost, raw materials, must be integrated teaching and learning process, how to impress a mobile game where learning key the project is done on both sides, and is linked to the future development of the new learning generation different countries, cultures and sports are affecting the satisfaction of fans’ full support.

Implementation of proposed system

For a series of environmental pollutants, there is usually no small fluctuation or noise in the initial data. These small fluctuations or noises will have a very important evolutionary impact on the actual proportion of environmental pollutants in the initial data. Therefore, this paper segments the time series to filter out some small changes and collect the real evolution interval. The current time series segmentation methods usually use gliding window method and bottom-up method. The specific information is shown in Fig. 1.

The basic principle of the slider is to calibrate some different paragraphs as the first data point in the time series. Then, add more paragraphs to get closer to the approximation to the right. It is a kind of regression algorithm that the sequence segments continue to increase until they exceed a certain error limit (Liu et al. 2018c). Only through local optimization to give segmentation, from the global observation, we can see the bottom-up rules. After segmenting the original fragment, we continue the iterative method, and then increase the error in the segmentation process, so as to expand the adjacent fragments and achieve better simulation results (Clayton 2009). Therefore, this paper uses this method to segment the time series of environmental pollutants. In order to smooth the super long endurance, only the environmental pollutants involved in the study city and surrounding areas are divided in the subdivision process, as shown in Fig. 2.

Data analysis

The longitudinal propagation of the optical wave with a frequency $\omega$ along the waveguide ($z \in [0, L]$) is characterized by a propagation constant.

$$D(x, t) = \omega c n e f f (\omega, n) + i 2 (g(\omega, n) - \alpha 0)$$

Strength training takes place at different times during the season. It combines forward and backward traveling waves in the cavity. Therefore, the overall basketball curve can be described by the superposition of two counter-propagating waves:

$$D(x, t) = D + (x, t)e^{-i\pi z} + D - (x, t)e + i\pi z / \alpha e i\omega 0 t$$

Where $D$ represents distance of the basketball curves, $A$ represents periodic gratings.

Let’s see how to improve goals, training, sports, strength $v$, speed and acceleration during play $h$, and reducing the risk $k$ of joint and tendon injuries.

$$i v g \partial t E = \pi i \partial z + h k (n, 0) - \pi i E \pm + \kappa \pm E$$

The mode structure of the laser results from the coupled-mode equations. By setting the boundary conditions at the right facet $E = 0 (L, t) = 0$, the reflectivity $r$ is obtained as ratio of out- and ingoing fields $x = 0$ at the left facet from

$$r(\beta L) = \kappa L \sin \gamma L \gamma L \cos \gamma L \gamma L \sin \gamma L$$

To assume that the volume fraction $c$ of inclusions is very low ($c < 1$); it means that Equation is valid for each particle and that the average value of the electric field over the entire structure can be obtained as
\[ hEi = cEi + (1-c) E\infty \]

In a similar way, it is possible to calculate the average value of the displacement vector as

**Fig. 1** Air pollutant data

**Fig. 2** Prediction of pollution concentration at different time
pending on $hEi$ is given by ball shooting of the flight of the ball. Humans, analyzing the initial angle, speed, spin and altitude taken into consideration. Similar questions are considered angle between the player and the ball and the high speed are  

The particle is composed by a core with radius and permittivity and a shell contained between the radii a and b with permittivity $\varepsilon^2$. On such a system, an electric field $E_\infty = d \varepsilon \varepsilon_0$ is remotely applied. The electric potentials in the three regions can be calculated as

$$\varphi_1 = -E_\infty \rho \cos \theta + A_1 \rho d - 1 \cos \theta \text{ if } \rho > b$$

$$\varphi_2 = B \rho \cos \theta + C_1 \rho \rho d - 1 \cos \theta \text{ if } a < \rho < b$$

The height of the basket above the ground is 3.05 m, as it may not be necessarily high depending on the role you are playing in the fair advantage. The team scored the highest points of victory by hitting the ball in their opponent’s basket (Skidmore 1989). This sounds easy to say, but not like many others with a variety of motor skills and abilities needed for this subject. The important Equation is still valid but now it is an implicit equation giving the actual internal field

$$E^i = \frac{CC}{d}1^2(E^i) + (d-1)^21, E_\infty$$

A key exercise issue is to analyze the factors that influence the best exercise to achieve your results. In all sports, there are factors whose performance directly affects the final result. Throw is a special part of every player that is based on the technical preparation of the free self-winding movement. It always does the same (right cadence, speed).

$$\frac{\partial t_2(i)}{Z \rho g(s)} \Delta t_2(t-s) \, ds = 0$$

Where g represents self-winding movement of the basketball shooting.

Therefore, the effective nonlinear dielectric constant (depending on $hEi$) is given by

$$2(E^i) = 22 + \alpha |E^i|$$

The analysis of the parameters of the free choice mechanism of throw throws has a great influence on the effectiveness of throw on jump when done in the learning process. The angle between the player and the ball and the high speed are taken into consideration. Similar questions are considered humans, analyzing the initial angle, speed, spin and altitude of the flight of the ball.

During the experiment, it was reported that a specific rating of this model might customize performance indicators from a first-person basketball video.

$$hDi = c (2^2 - 1) Ei \frac{C}{hEi}$$

It defines the concept of effective permittivity $\varepsilon^2$ through the relation

$$hDi = \varepsilon^2 f \, hEi$$

$$\alpha = 2 \left( d - 1 \right) \left\{ \left( d - 1 \right)^2 + 2 \right\} + \varepsilon \left( \frac{2 - 2^2}{1} \right)$$

$$\beta = \left( d - 1 \right) \left( (2^2 - 1)^2 \right)^2 + \left( \left( d - 1 \right)^2 \right)^2$$

In addition, the model can be seen to contribute both positively and negatively to the player performance in basketball events. Basketball is one of the most popular sports teams play in the shared garden. It is important to shoot the basket strategically (Sudatian et al. 2016). In terms of individual games, it is essential as well as a strategy as an attacking player to understand how an organized team can play a simple shot. In this study, we introduced the basic technique applied to surveillance players and ball data and proposed the automatic extraction of environmental scenarios.

However, this takes some time additionally are uploaded after each event, as the clips are being edited by hand. Also, the editor wastes his time with such troublesome work (Farr et al. 2007).

Such combinations are time consuming and largely dependent on domain experts, thus challenging the general media production of game, trying to constitute a complete game interpretation analysis of heterogeneous data sets, and discovered a small part of the game. The court field is divided into nine basic cases that are used to define player movements. However, it is possible to learn golf information and new play of algorithms. In-depth research shows fading has good statistical results.

Previous studies of sensors and acceleration suggest that it can be used to determine individual signal patterns if a player resists the ball. This applies to further research as shown in this study on traffic.

Therefore, the semantic event of basketball in broadcast video is closely related, whether it is global movement (camera movement) and mass movement (Matta et al. 2018).

Three basketball triples, jumps, returns. Changing the order of integration in it applies the saddle-point method to estimate the integral $\int_0^\infty$.

$$\tau = \frac{t - \tau}{\tau}$$

The clustering algorithm as a Q-algorithm is used to complete the authentication task, and a new method is used to initialize the central point that solves the problem of large differences between the results of each test.

When the basketball descends into the hollow basket, the basketball velocity direction has an acute angle, not perpendicular to the basket surface, and the basket shape is elliptical when viewed from the direction of basketball movement (Vu and Goldscheider 2006).

It then uses acceptable video data to compile a kinematic analysis of basketball training curves. In the preparation of
each free throw, the elapsed time is calculated in milliseconds at the main and final stages of the network. The 2D segment hand velocity and FT are calculated for the shoulders, elbows and wrists, and also the angular displacements of the hips, joints and knees (Kalsnes et al. 2010). The linear motion of the two adjacent joints of each joint and the curve is calculated as the relative motion between the chain segment and its center of rotation. The angular movement of each joint is (1) shoulder joint, (3) wrist joint (relative movement between forearm and torso and arm), (2) elbow joint between arm and forearm) (Calculated as Relative movement), Hand), (4) Hip joint (relative movement between trunk and thigh), and (5) Knee joint (relative between thigh and leg) motion.

**Calculate the basketball path through air**

Gravity, resistance and Magnus force: It receives three forces that rotate the ball in the air. Therefore, the movement of the ball is determined by the following formula.

Nonlinear Heterosexual Ellipse Equation

\[
\frac{d^2}{dt^2} = g + \frac{1}{m_{\text{ball}}} (3.14 \cdot r^3)
\]

Velocity = \(d_t/\text{time to travel distance}\)  \(\text{(17)}\)

\[
\text{(start}_X, \text{start}_Y) = (\text{int(maximum Location}[0]+(\text{int(maximum Location}[1]*r)), \text{int(maximum Location}[0]+(\text{int(maximum Location}[1]*r))
\end{aligned}
\]

\[
\text{(end}_X, \text{end}_Y) = (\text{int((maximum Location}[0]+(\text{int(maximum Location}[1]*r))), \text{int((maximum Location}[1]+(\text{int(maximum Location}[1]+(\text{int(maximum Location}[1]*r)))
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\end{aligned}
\]

Angular velocity \(\theta/t\) \(\text{(19)}\)

\[
\theta - \text{Change of the position angle of a basketball with respect to time.}
\]

Mass = \(d_{m1, m2}/r^2\) \(\text{(20)}\)

Radius = \(2 \cdot \pi \cdot r\) \(\text{(21)}\)

Cross-sectional area is calculated using the formula \(\pi R^2\) \(\text{(22)}\)

Among these, \(R, V, \) velocity, and basketball angular velocity are accelerations for gravity, mass, radius, basketball cross-sectional area, \(\rho\) is air density, and basketball drag coefficient is found in air.

**Basketball curve tracking**

The visual difference between the player and the background object is further used to improve the surveillance process. Features can be used to separate objects from the background and are necessary for success.

\[
\text{if found is None or maximum Value > found[0]:}
\]

\[
\text{found = (maximum Value, maximum Location, r)}
\]

\[
\text{Maximum Location, r) = found}
\]

\[
\text{(start}_X, \text{start}_Y) = (\text{int(maximum Location}[0]+(\text{int(maximum Location}[1]*r)), \text{int(maximum Location}[0]+(\text{int(maximum Location}[1]*r))
\end{aligned}
\]

\[
(\text{end}_X, \text{end}_Y) = (\text{int((maximum Location}[0]+(\text{int(maximum Location}[1]*r))), \text{int((maximum Location}[1]+(\text{int(maximum Location}[1]+(\text{int(maximum Location}[1]*r)))
\end{aligned}
\]

This is a difficult problem as the player changes shape over time and the image resolution is low. Single-player games are represented by relatively small areas with a diameter of 10 to 15 pixels.

**Correlation between basketball hand speed and body angle/phase duration**

Variable angle is about the total movement. Knee joint angle that shows statistical analysis is to have a relationship of the highest and speed.

High negative correlation \(p \leq 0.01; r = -0.75\)  \(\text{(24)}\)

In addition, the angle between the shoulder and waist also affects the speed at hand.

\(p = 0.05; \) and \(r = 0.56 \) and \(-0.56\), respectively.

The result was an increase in the size of the hip joint values, but a decrease in the speed value, which indicates that the speed value up to the shoulder of a leading wire increased the keratin of many results. Relevant search results attempted at 15 feet (full time) and overall movement changes may be due to movements within the frame, especially in the first and second stages (Yan et al. 2014). The hand velocity preparation phase is directly related to height and shoulder angle. The results are related to hip and knee angles with a decrease (\(P < 0.01; R = 0.7\) along with a successful or unsuccessful increase in FT (like overall movement < 0.5 (negative); \(R = -0.6 \) and \(-0.5\) respectively). In the main phase, the most important correlation of hand speed is thought to be related to knee angle (\(Y < 0.01; R = 0.7\) Shoulder and hip angles (less relative to \(P < 0.05, R = -0.6\) and 0.6, respectively).

**Basketball rotational mechanical analysis**

When the basketball curve is released, basketball provides three forces to move into the air. Gravity, air buoyancy, air resistance Air buoyancy, air resistance is very small and can be ignored. Relatively therefore, the basketball air motion trajectory can be considered to be tilted slow motion (Zhang et al. 2006). The shooter releases basketball, the ball releases instant action, and before its trajectory, the various parameters

\[
\text{Angular velocity} = \theta/t
\]

\[
\theta - \text{Change of the position angle of a basketball with respect to time.}
\]

\[
\text{Mass} = d_{m1, m2}/r^2
\]

\[
\text{Radius} = 2 \cdot \pi \cdot r
\]

\[
\text{Cross-sectional area is calculated using the formula } \pi R^2
\]

Among these, \(R, V, \) velocity, and basketball angular velocity are accelerations for gravity, mass, radius, basketball cross-sectional area, \(\rho\) is air density, and basketball drag coefficient is found in air.
of the oblique throwing motion are the sum of most of the various elements at the moment of shooting: The shooting motion enables the basketball to rotate in the air, as the motion of the basketball in the air is a complex motion. Tilt firing around the front axis of the ball and rotation of the basketball, so that the trajectory of the basketball in training motion is different from the general tilt firing motion. When training basketball spinning, the lower limb of the shooter relies on each joint chain to push the ground, hips, abdomen, and upper limbs. The wrist is bent forward when the basketball is ejected and is acted on the index finger on the back of the basketball.

**Result and discussion**

The section presented in this article is divided into basketball training curve evaluation. First, it focuses on the proposed system where accuracy, time complexity, precision, recall and the error rate, which includes the state-of-the-art presentation. Then, the performance of the technology was analyzed.

The result is discussed based on evaluation performances in the proposed system NHEE and is compared to the existing method CNN (Convolution Neural Network), BDA (Boundary Detection Algorithm), SVM (Support Vector Machine), RNN (Recurrent Neural Network). Analysis of Accuracy as shown in Fig. 3.

Current basketball curve that the rotational analysis was chosen as one of the best algorithm for human detection because the type of broadcast video they deal with consists of shots. Fig. 3 shows the comparison of accuracy in the proposed and existing methods. The existing methods CNN in 55 %, BDA in 64%, SVM in 77% and the proposed NHEE in 88%. Performance of Time Complexity is shown in Fig. 4.

It turns out that this algorithm is significantly better than existing solutions. Compile support at this time is much slower than the proposed real-time version of the system. In sports video broadcasts, a single shot typically occurs for at least a few seconds, and there is a need to process all other frames. The real-time version can process video at up to 17 frames per second, so it is suitable for sports video broadcast real-time applications.

**Precision**

Precision is useful when the cost of false positives is high. Let’s assume that the problem consists of detecting a basketball lineup. Precision = True Positive / True Positive + False Positive \hspace{1cm} (25)

**Recall**

Recall in basketball is the part of the sports pertinent to the query that are effectively tracking. Recall = True Positive / True Positive + False Negative \hspace{1cm} (26)

**Error rate**

Error rate refers to the fraction of the non-relevant basketball data and the relevant which are not tracked, proportional to the total number of data used. When the error rate increases, the reliability in data transmission is decreased. Analysis of Sequence Phrase as shown in Fig. 5.

Error Rate = \frac{FP + FN}{TP + TN + FP + FN} \hspace{1cm} (27)
Fig. 5 shows the proposed NHEE that shows the value of precision is 87%, recall is 75%, and Error Rate 30%.

**Conclusion**

Modeling features that are constantly changing based on the discovery of sports video content, this document not only proposes detailed model building and optimization methods, but also a deep analysis based on a detailed analysis of NHEE technology. NHEE technical factors that influence the training rate of basketball are analyzed and explained, and it is an important technical factor that influences the analysis of sports training technique. Through analysis, we know that the training rate of basketball made after the ball comes in contact with the co-basket, the former is possible so high performance in long-range training needs to make a ball that spins fast. There, it increases the hit ratio compared. In addition, we also want to provide coaches and players as a reference, paying attention to the angles of incidence of curves and mechanics in order to analyze the effects of the shoot. The proposed NHEE shows the accuracy in 88%, time complexity is 17 s, sequence phrase shows that the precision value is 87%, recall is 75%, and Error Rate 30%.

**Declarations**

**Conflict of interest** The authors declare that they have no competing interests.

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**References**

Burnett WC, Aggarwal PK, Aureli A, Bokuniewicz H, Cable JE, Charette MA, Kontar E, Krupa S, Kulkami KM, Loveless A, Moore WS, Oberdorfer JA, Oliveira J, Ozyurt N, Povinec P, Privitera AMG, Rajar R, Ramesur RT, Scholten J et al (2006) Quantifying submarine groundwater discharge in the coastal zone via multiple methods. Sci Total Environ 367:498–543

Clayton CRI (2001) Managing geotechnical risk. Thomas Telford, London

Clayton CRI (2009) Urban site investigation. In: Culshaw MG, Reeves HJ, Jeffreerson I, Spink TW (eds) Engineering geology for tomorrow’s cities, Geological Society, vol 22. London, Engineering Geology Special Publication, pp 15–141

Farr TG, Rosen PA, Caro E, Crippen R, Duren R, Hensley S, Kobrick M, Paller M, Rodriguez E, Roth L, Seal D, Shaffer S, Shobava L, Umland J, Werner M, Oskin M, Burbank D, Alsdorf D (2007) The shuttle radar topography mission. Rev Geophys 45(2):RG2004

Kalnones B, Nadim F, Lacsse S (2010) Managing geological risk. In: Williams et al (eds) Geologically active: Proceedings of the 11th IAEG Congress, Auckland, New Zealand, 5–10 September 2010. Taylor & Francis group, pp 111–120

Knill J (2003) Core values: the first Hans-Cloos lecture. Bull Eng Geol Environ 62(1):1–34

Liu SL, Li WP, Wang QQ (2018b) Height of the water-flowing fractured zone of the Jurassic coal seam in northwestern China. Mine Water Environ 37(2):312–321

Liu SL, Li WP, Wang QQ, Pei YQ (2018c) Investigation on mining-induced fractured zone height developed in different layers above Jurassic coal seam in western China. Arab J Geosci 11(30):2–10

Matta G, Kumar A, Thak AK, Naik Pradeep K, Berndtsson R (2018) HPI appraisal of concentrations of heavy metals in dynamic and static flow of Ganga River System. Environ Dev Sustain. https://doi-org.proxy2.cl.msu.edu/10.1007/s10668-018-01182-3

Mehrabi, Kerney MS, Turner RE (2019) Feedback of coastal marshes to climate change: long-term phenological shifts. Ecol Evol 9(12):6785–6797. https://doi-org.proxydgb.buap.mx/10.1002/ece3.5215

Sivathanu A, Darwich T, El Hage M (2014) Studying snowpack and the related terrain characteristics on Lebanon Mountain. Int J Water Sci Technol 2:1–10

Skidmore AK (1989) A comparison of techniques for calculating gradient and aspect from a gridded digital elevation model. Int J Geogr Inf Syst 3(4):323–334

Sudatian AD, Muttil N, Yilmaz AG, Perera (2016) Development of river water quality indices—a review. Environ Monit Assess 188:58. https://doi-org.proxydgb.buap.mx/10.1007/s10661-015-5050-0

Vu TMN, Goldscheider N (2006) A simplified methodology for mapping groundwater vulnerability and contamination risk, and its first application in a tropical karst area, Vietnam. Hydrogeol J 14(8):1666–1675. https://doi-org.proxydgb.buap.mx/10.1007/s10040-006-0069-5

Yan H, Zhan J, Liu B, Huang W, Li Z (2014) Spatially explicit assessment of ecosystem resilience: an approach to adapt to climate change. Adv Meteorol 2014:1–9. https://doi-org.proxydgb.buap.mx/10.1155/2014/798428

Zhang F, Yang Q, Jia X, Liu J, Wang B (2006) Land-use optimization by geological hazard assessment in Nanjing City, China. In: Engineering Geology for Tomorrow’s Cities. IAEG 2006, 6–10 September 2006, CD-rom, paper no. 4 – 324