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Research Article

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Football best shooting area and goal ration correlation research based on multivariate statistical model

Bo Gao and Jie Dong

College of Physical Education, Shandong University of Technology, Zibo, Shandong, China

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ABSTRACT

With continuously development of human society science and technology, human race sports culture is also constantly improving. And football such a movement deep roots in history is also flourishing, which gradually drives national economic and culture as well as other fields moving forward. China as a large country of 1.3 billion population, its politics, economics, culture and society as well as other aspects get rapidly development since open and reform; China furthermore becomes a powerful sports country in sports field, and it has achieved excellent results of ranking gold medal standings first in the 29th Beijing Olympic Games, however China's men football cannot recover after a setback since 1985.In order to fast improve China football technical level, this paper establishes best shooting area model, applying two dimensional normal distribution and geometrical analysis as well as other methods to define shooting position, and analyzes previous world cups goal data by mathematical statistics analysis, test model precise so as to define players' best shooting area. Combine with these data, players can take targeted training.

Key words: Two dimensional normal distribution, geometrical analysis, mathematical statistics, inductive analysis

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INTRODUCTION

Now, football activity has already broken through countries and regional boundaries and limits gradually are integrated, and formed into global football integration tendency. It includes football talent globalization, professional clubs globalization as well as football technique and tactics globalization and so on. Due to pay television emergence, Boessman regulation generation and football business revenue constantly increasing, it powerfully promotes to the sports event development, investors and stock market joining in let the event move to a new trajectory [1-4].

To China football, football globalization is an opportunity for China football fast growing, foreign high level league provides more open communication platform for China, it let China football level have a growing chance during the perfect environment; meanwhile, China can also reference foreign football management mode and league operation mechanism to fast improve China football management level, so that let China football get sound development [5-7]. Besides, employ foreign coaches to guide and train players are helpful for speeding up football excellent talents cultivation. Because football has an important effect on global economy and culture that propels it become a kind of sports event mad loved by global people. In football game, referee judge the results of two parties with quantities of the two goals. Therefore, athletes' shooting position is of great importance to goal [8-10].

This paper carries analysis of the 19th world cup soccer tournament in South Africa total 145 goals' shooting areas, reveals modern football games' best shooting area so that China's men football strength can get improvement.

FOOTBALL BEST SHOOTING AREA MODEL ESTABLISHMENT

Analysis of football fields

Modern standard field, length is 104m, width is 69m; goal height is 2.44m, width is 7.32m. Goal area (six-yard box) width is 18.32m, (goal line) length is 5.5m; Free throw area (penalty area) length is 40.32m, (goal line) length is 16.5m. As Figure 1 show.

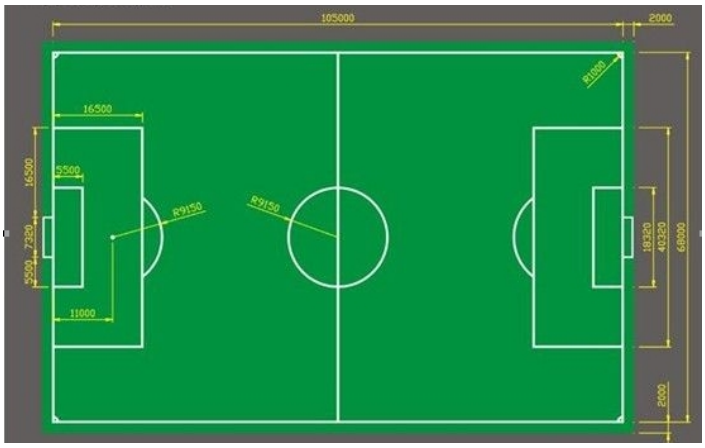

Figure 1: Standard football field schematic diagram

Shooting best area model analysis

Define football shooting best area that is to define player shooting highest success rate area. Therefore, we should make research on players' goals success rate when shooting in any position of opponent half ground. Players' shooting and goal are random events, due to there are many factors affect shooting goal success, this paper fixes some factors, only defines players' location when shooting and goals success rate connections [11-13].

Due to players' technical levels are basic fixed (refer to below hypothesis), in case no goalkeeper, when player shoot to the goal in any positions, player shooting location to goal distance and angle decide goal success rate. When ignoring player and goal angles, goal success rate in field (refers to half here) forms into a fixed probability distribution that is normal distribution. This paper decomposes player field position into horizontal direction and vertical direction these two directions, respectively analyzes player goal success rate in the two directions, let them multiply and can get player goal probability in the point; in case it has a goalkeeper, based on above analysis, this paper further makes analysis of goalkeeper save success rate . Due to football flies to goal, at this time it needs some time to arrive at goal.

On the problem, this paper defines time and goalkeeper success save probability relationships.

Question hypothesis:

(1)Assume that when player shoots, surrounding environment is in ideal state, no external disturbance;
(2)Assume that player technical level is relative stable, basic quality is fixed;
(3)Assume without considering air and ground influences on ground;

Symbol description:

p_1 —Player any point shooting horizontal direction hits the goal probability;

p_2 —Player any point shooting vertical direction hits the goal probability;

p —Player any point shooting success probability;

x —Player location horizontal coordinate;

y —Player location vertical coordinate;

z —Vertical coordinate;

α —Player location to goal horizontal direction included angle;

β —Player location to goal vertical direction included angle;

t —Time for ball arriving at goal;

f_1—Goalkeeper horizontal direction angle control capacity coefficient;

f_2—Goalkeeper vertical direction angle control capacity coefficient;

In above analysis, it decomposes field into horizontal and vertical two directions, as Figure 2 shows.

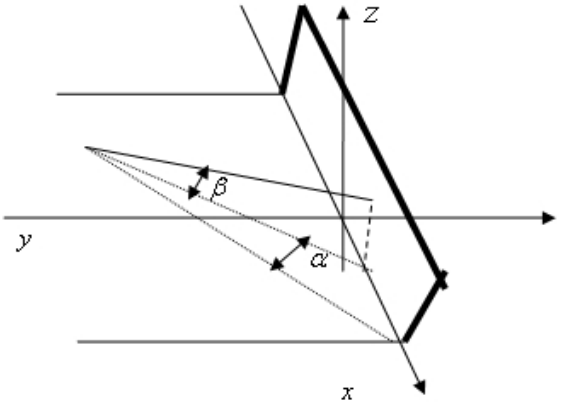

Figure 2: Decomposition schematic diagram

In horizontal direction, player observed goal is goal projection in vertical direction, therefore player should shoot the ball into projection goal's midpoint so as to ensure hit rate, so that it will form into a probability distribution around the point, analyze and affirm the distribution is normal distribution.

In vertical direction, player should lower ball exit height so as to ensure hit rate, so that it will also form into a normal distribution. This paper multiplies the two directions' goal success probabilities so that it can get player shoots the goal probability at one point in the field [14].

Random variable X probability density function is: $f(x)=\frac{1}{\sqrt{2\pi\sigma}}e^{\frac{-(x-\mu)^2}{2\sigma^2}},-\infty<x<\infty$

When $\mu=0,\sigma=1$, X conforms to standard normal distribution: $f(x)=\frac{1}{\sqrt{2\pi}}e^{-t^2/2}$

When player expected shooting angle is 90° that just face to available shooting area angle. Assume the player horizontal direction shooting standard deviation is 5°. Therefore, player horizontal direction goal success probability meets $N\sim(90,5^2)$.When player horizontal direction shooting angle is α, goal success probability is:

$$p\{(90-\frac{\alpha}{2})<X<(90+\frac{\alpha}{2})\}=\phi\{\frac{-\alpha/2}{5}<X<\frac{\alpha/2}{5}\}=1-2\times[1-\phi(\frac{\alpha/2}{5})]$$

Convert player shooting angle into standard normal, then use Matlab calculating and get field any point horizontal goal shooting probability p_1. And vertical direction probability meets $Z\sim(0,2.5^2)$ Therefore, player should kick low shot so as to avoid football flies away from goal, assume the player vertical direction shooting standard deviation is 2.5°. However, actually player can only kick to above ground part in the field, therefore when player vertical direction shooting angle is β, goal success probability: $p\{Z<\beta\}=\phi\{Z<\frac{\beta}{2.5}\}=\phi(\frac{\beta}{2.5})$

Similarly, after converting into standard norm, it solves every point vertical direction goal probability p_2.Therefore, player any point goal probability is $p=p_1\times p_2$.

In case it has goalkeepers, given goalkeeper stands in bisector of included angle between player shooting position and goalpost that is goal vertical shooting line plane projection midpoint. In ideal state, the point is the best defense

position.

When player shoots to any point (x, z) inside goal, ball would arrive at goal plane by time t, when the ball arrives at the point, goalkeeper has a save probability to the ball as $M(t, \alpha, \beta)$, when t is fixed, and then $M(t, \alpha, \beta)$ is a two dimensional function that centers on goalkeeper and damped to surrounding radiation, as Figure 3 provides corresponding isopiestic curves figure shows.

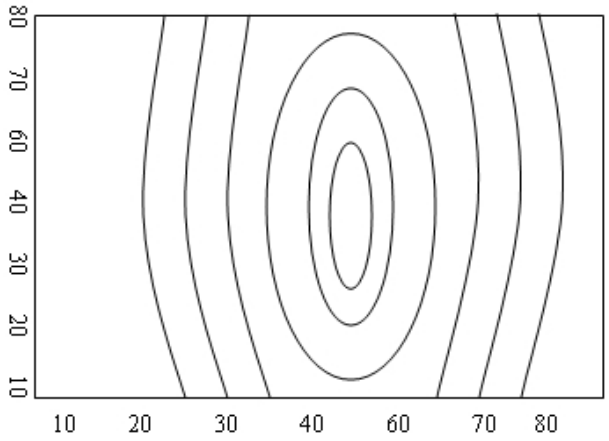

Figure 3: Corresponding isopiestics curves figure

When t gets small, curve kurtosis will increase, and the area will reduce, as Figure 4 shows.

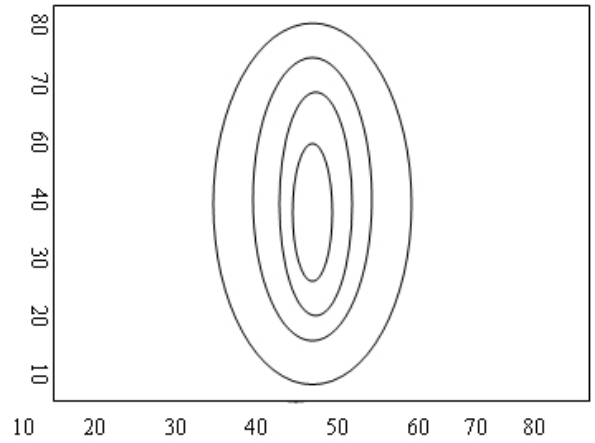

Figure 4: Corresponding isopiestic curves figure

From Figure 4, it is clear that the curved surface form extremely approximates to two dimensional normal distribution density functions; therefore, we adopt the function form describing the change tendency. t is the time from ball shooting to goal that is also goalkeeper reaction time, the longer the time is, the more smoothly the curved surface would be. Goalkeeper save success probability M is:

$$M = e^{\frac{(\frac{\alpha}{2\times f_1})^2+(\frac{\beta}{2\times f_2})^2}{(\frac{\sqrt{x^2+y^2}}{10}+t)}}$$

e is goalkeeper reaction coefficient, f_1 represents goalkeeper horizontal direction angle control capability coefficient, f_2 represents vertical direction angle control capability coefficient. According to lots of data statistics, it gets values of f_1、f_2 that respectively are $f_1 = 20, f_2 = 10$.So player field any point shooting success probability

should be revised as: $p \times [1 - M(t, \alpha, \beta)]$.

Work out goal probability after revising, it solves goal probability changes with distance curve graph that can refer to Figure 5.

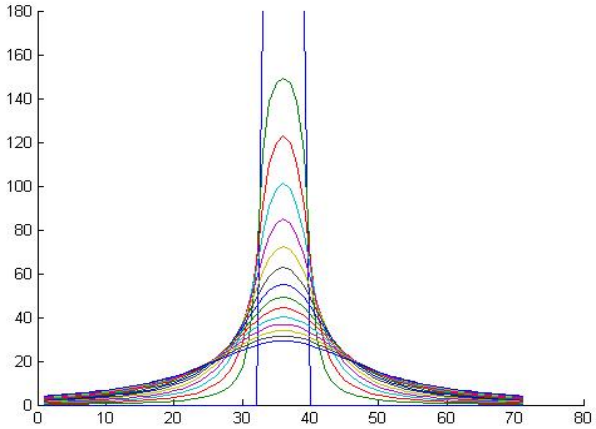

Figure 5: Goal probability changes with distance curve graph

From Figure 5, it is clear that player shooting success probability arrives at the maximum when it is 30 to 40m far from goal.

MODEL TEST

In order to verify model accuracy, this paper analyzes the 19th world cup soccer tournament in South Africa total 145 goals shooting areas; it solves best shooting area and makes comparison with area got from model. To find out shooting position features, this paper divides field into A area, B area, C area and D area four areas that can refer to Figure 6.

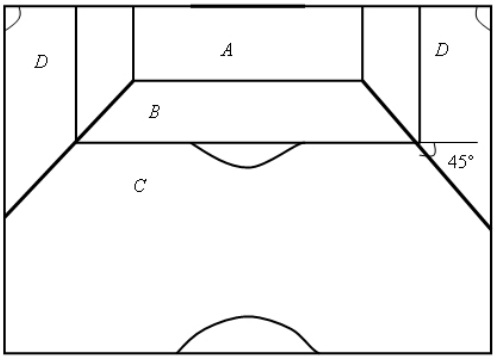

Figure 6: Field zoning map

In this session World Cup, 115 goals are by foot that accounts for 79.31% of total goals. Among them, right foot goals are 85; left foot goals are 30 which are respectively in the proportion of 58.6% and 20.7% of goals. There are 27 goals by head that accounts for 18.6% of goals. In order to more correctly define best shooting area, Table 1 provides 15 to 19 sessions World Cup competitions each goal located shooting area so as easier to observation.

Table 1: 15 to 19th World Cup Competitions' each goal located shooting area

Session	A area		B area		C area		D area		Total
	Goal	Goal rate %	Goal	Goal rate %	Goal	Goal rate %	Goal	Goal rate %	
15	26	18.44	81	57.45	15	10.64	8	5.67	141
16	40	23.39	97	56.73	12	7.01	10	5.85	171
17	48	29.81	83	51.55	25	15.53	5	3.10	161
18	39	26.53	78	53.06	23	15.64	7	4.76	147
19	32	22.07	79	54.48	26	17.93	8	5.51	145

CONCLUSION

Analysis of 15 to 19th World Cup competition goal areas, results showed that goal shooting areas existed some obvious features and rules. Among them, it indicated that B area had most goals, and then it was A area, C area and D area in successively. In football game, there were many attack ways, as winger low shot pass middle, back guard steep forward pass flank front, flank front cooperates with mid-way 2 fighting against 1, individual dribbles to break through goal area and so on, no matter what tactics and techniques it adopted, players locations when shooting were most in B area. To explore its reason, that was because B area was in proper distance from goal, was between goal area and penalty area, if the distance was too closer, the goalkeeper disturbance would enlarge, too further, player shooting precise would reduce, and B area was in front of goal, shooting angle was big, goal success rate was high. A area suffered goalkeeper and defenders' disturbance, the goal difficulty was big, most were corner tactics breaking through goal as well as goal relying on individual strength area was far away from goal, most were fierce shooting, shooting precise was lower. D area was limited mostly by angles, it requires high shooting technical level, and it was the least goal area.

By data analysis, it finally got that best shooting area was B area that was free throw area, while the paper model deduced best shooting area was the area 30 to 40 m far from goal. From Figure 1, it was clear that free throw area was area 30 to 40 m far from goal. Therefore, the paper established model was relative reasonable, deduced result was also relative correct conformed to actual status.

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