ISSN : 0974 - 7435 Volume 10 Issue 5

BioTechnology
An Indian Journal

FULL PAPER

BTAIJ, 10(5), 2014 [1168-1172]

Matlab simulation-based football shooting most valid region probability statistics

Yingcheng Zhang
Institute of Physical Education, Northeast Normal University, Changchun 130024, Jilin, (CHINA)

ABSTRACT

The paper researches on football game football goal dangerous regions, utilizes known football knowledge, it establishes football goal dangerous regions one dimension normal and two dimensional normal distribution model, and uses MATLAB software to solve and simulate established model. Calculate goal different positions' threat level, and draws most dangerous region. Firstly, in case no goalkeepers here let same player shoot in different regions of field, and research field's different points' threat level to goal. By statistical researching, shooting success points in the whole football field is in normal distribution, and finally uses MATLAB to simulate. Secondly, in case it has goalkeeper, research same player shooting probabilities in different points of field and goalkeeper success save odds, finally use Matlab to simulate. By calculation, it proves when player quality strengthened, threaten to goal is obvious increasing, and dangerous region expands.

KEYWORDS

Normal distribution;
Probability statistics;
Football shooting;
Dangerous region;
Mathematical model.

INTRODUCTION

Due to Chinese football development level is relative backward, researches and analyzes shooting best region, attack cooperation structure and technical and tactics ways have very important significances. Our country football experts use researches and comparative analyses to analyze football shooting technical ways and goal, shooting region and assisting region status. They thought domestic football players in shooting process such attack key linkage; they have obvious gap and shortcomings by comparing with world power team athletes, if no improvements are made, and it will restrict Chinese football attacking levels improvement. The final purpose of football competition is goal and interfering goal. In 2003, Yuan Ye researched different offensive tactics ways impacts on high level football competition shooting and goal[1]. Zou Qiu-Hua, Hu Hong-Quan made statistical analysis of the 17th world cup football game shooting goal statistical analysis, they revealed high level football game goal rules and features, and made clear current technical and tactics development trend, tides and orientations, discussed shooting effects improving methods and ways[2]. In 2009, Yu Ji-Cheng, Xiao Jin-Yong researched on world cup football game goal space features, by statistical analyzing the 14th to 17th world cup football games whole goals, explored and found that football goal time and space basic features and rules, as well as made actual combat applied suggestions[3].

The paper focuses on modeling simulation from two aspects. (1)For player different positions shooting threat level to goal, it makes analysis and gets dangerous region; (2) In case there is a goalkeeper to defense, makes further research on player threat level on goal and dangerous region.

MODEL ANALYSES

To define goal dangerous regions, which is also to define player shooting's easiest goal region. No matter from which point player shoots in the field, there are two possibilities, goal or not, it is a random event, from which some places have biggest possibility to goal that are dangerous regions. Lots of factors will impact on player shooting percentage, most important one point of them is player's basic quality (technical level) and goal site. To every player basic quality, it is impossible to change in a short time, therefore we mainly under some circumstances, make research on how to select most dangerous shooting region. That is to say, we mainly targeted same quality players shoot in any point of field such moment, research his threat level to goal.

When a player locates in one site before goal and shoots to some places in front of goal, player basic quality and the ball arriving at target point distance decide target shot probability. In fact, when the two factors are defined, ball's drop point in goal will show certain probability distribution. By analysis, it is clear that the distribution should be a two-dimensional normal distribution, it is the key point.

When player in the field shoots, the player should define a target point in some place of goal, ball will drop in one point of goal with certain probability distribution. We regard goal as a plane region, solve the distribution's distribution function with the region, and then it can get ball shooting goal's probability. However, shooting target point is randomly selected by players, target point selection have strong dependency on goal probability. In this way, we see through all points in target region, make integral on shooting probability, the paper will define it as field one point threat level to goal, and we use it to define goal dangerous region.

MODEL ESTABLISHMENT IN CASE NO GOALKEEPER

Firstly establish as Figure 1 showed space rectangular coordinate system, that is takes goal bottom midpoint as origin O, ground as xOy plane, goal located plane π as yOz plane.

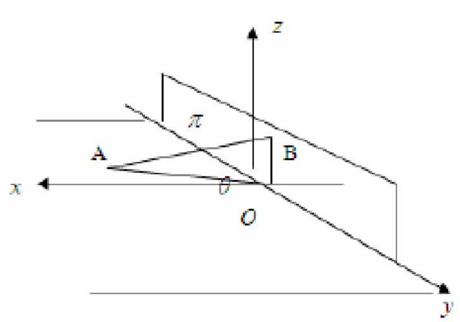

Figure 1 : Goal schematic diagram

According to above analysis, here assume that when basic quality as k player shoots from $A(x_0, y_0)$ point to distance as d goal target point $B(y_1, z_1)$, ball in target plane π drop point shows two-dimensional normal distribution, and random variable y, z are mutual independent from each other. Its probability density function is:

$$f(y,z) = \frac{1}{2\pi\sigma^2}\exp\left\{-\frac{(y-y_1)^2+(z-z_1)^2}{2\sigma^2}\right\},$$

$$(y,z) \in \Omega \qquad (1)$$

Among them, variance σ and player quality k are in inverse proportion, while it is in direct proportion with shooting point $A(x_0, y_0)$ and target point $B(y_1, z_1)$ distance d, and deflection angle θ gets bigger, the variance σ will get smaller. When $\theta = \frac{\pi}{2}$ (that directly face to goal center), σ ÅNonly is related to k, d. Therefore, we can define σ expression as:

$$\sigma = \frac{d}{k}(\cot\theta + 1)$$

Among them: $\cot\theta = \frac{|y_1 - y_0|}{x_0}$,

FULL PAPER

$d = \sqrt{x_0^2 + (y_1 - y_0)^2 + z_1^2}$.

It notes that in formula (1)density function, relative variable y, z are symmetric, but actually ball only drop on the ground that it only has $z \geq 0$. In order to balance the density function, we let:

$$p_D(x_0, y_0; y_1, z_1) = \iint_D f(y,z)dydz$$

$$p_\Omega(x_0, y_0; y_1, z_1) = \iint_\Omega f(y,z)dydz$$

Then take the two ratios as the shooting goal probability:

$$\mathbf{p(x_0, y_0; y_1, z_1) = \frac{p_D(x_0, y_0; y_1, z_1)}{p_\Omega(x_0, y_0; y_1, z_1)}} \quad \textbf{(2)}$$

Make integral on goal probability (2) in goal region D, define it to be field one point $A(x_0, y_0)$ threat level to goal, that: $D(x_0, y_0) = \iint_D p(x_0, y_0; y_1, z_1)dy_1dz_1$

Based on above analysis, to field any point $A(x, y)$, its threat level to goal is :

$$D(x, y) = \iint_D p(x, y; y_1, z_1)dy_1dz_1$$

Among them:

$$p(x, y; y_1, z_1) = \frac{p_D(x, y; y_1, z_1)}{p_\Omega(x, y; y_1, z_1)},$$

$$d = \sqrt{x^2 + (y_1 - y)^2 + z_1^2},$$

$$\cot\theta = \frac{|y_1 - y|}{x}.$$

To solve the problem, it is generally quite difficult; only adopt numerical integral method to solve. Firstly define player basic quality representative parameter k, concrete method is as following

According to general professional players status, we thought that a player makes power shot to goal target point from ten meters distance (d =10)from goal in the goal front($\theta = \frac{\pi}{2}$), standard deviation should be within one meters that takes $\sigma = 1$, by $\sigma = \frac{d}{k}(\cot\theta + 1)$, it can get $k = 10$. So, when player basic quality $k = 10$, solve the model and can get field any point to goal threat level, partial special points result can refer to following TABLE 1. According to each point threat level value, it can make field equivalent threat level curve.

MODEL ESTABLISHMENTS AND MATLAB SIMULATION IN CASE IT HAS A GOAL-KEEPER

Assume goalkeeper stands in the angular bisector between shooting point and two goal bars that goalkeeper standing position in goal vertical plane projection region central is the best defense position. Player starts shooting in field one point to goal any point $(y, z) \in D$, it arrives at goal plane after time t, when ball arrives at the point, goalkeeper will have a capture probability $p_0(t, y, z)$ to ball, in the following analyze the function $p_0(t, y, z)$ form.

At first, it should note that when t is certain, $p_0(t, y, z)$ should be a degenerative two-dimensional

TABLE 1 : Field some points' threat levels to goal

Position	(0, 1)	(0, 5)	(0, 10)	(0, 20)	(0, 30)	(0, 50)	(3, 1)	(3, 5)	(3, 10)	(3, 20)
With defense	14.46	14.54	12.69	8.64	5.71	2.81	11.56	13.48	11.76	7.95
Without defense	12.94	12.01	8.97	4.80	2.76	1.10	10.07	10.93	8.38	4.57
Position	(3, 50)	(5, 1)	(5, 5)	(5, 10)	(5, 20)	(5, 30)	(5, 50)	(10, 1)	(10, 5)	(10, 10)
With defense	2.67	6.30	11.41	10.36	7.16	4.87	2.51	0.89	5.33	6.47
Without defense	1.08	5.90	8.95	7.23	4.12	2.45	1.01	0.82	3.92	4.31
Position	(10, 30)	(10, 50)	(20, 1)	(20, 5)	(20, 10)	(20, 20)	(20, 30)	(20, 50)	(3, 30)	(10, 20)
With defense	3.82	2.12	0.06	0.88	1.85	2.43	2.19	1.48	5.32	5.24
Without defense	1.93	0.86	0.04	0.59	1.16	1.34	1.08	0.59	2.66	3.01

function that radiates around with goalkeeper as center, as Figure 2 and Figure 3:

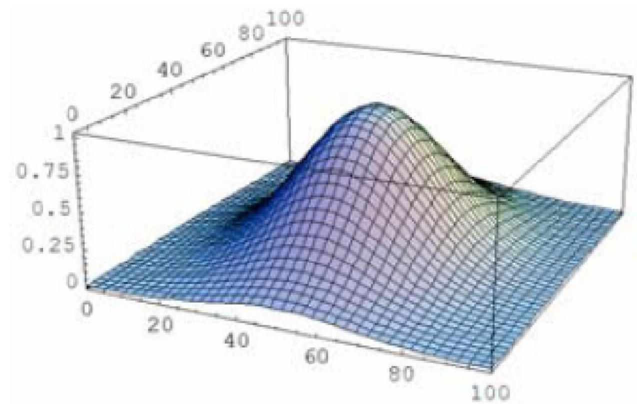

Figure 2 : Capture probability curved surface simulation figure in case t is certain

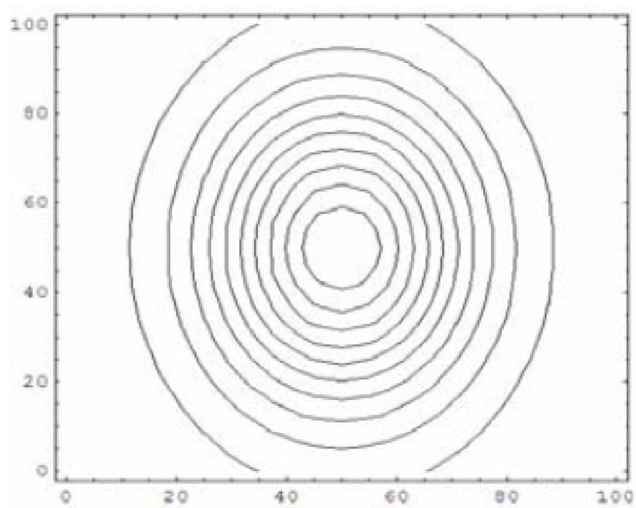

Figure 3 : Capture probability contour line simulation figure in case t is certain

When t gets smaller, curved surface peak should increase, and area reduces, as Figure 4 and Figure 5:

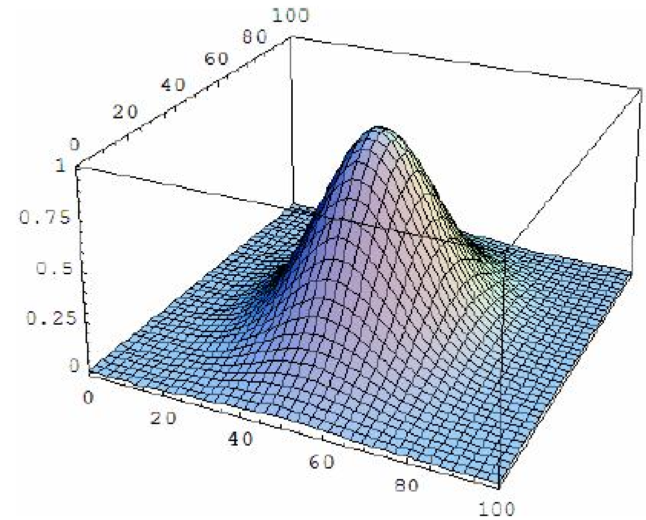

Figure 4 : Capture probability curved surface simulation figure in case t gets smaller

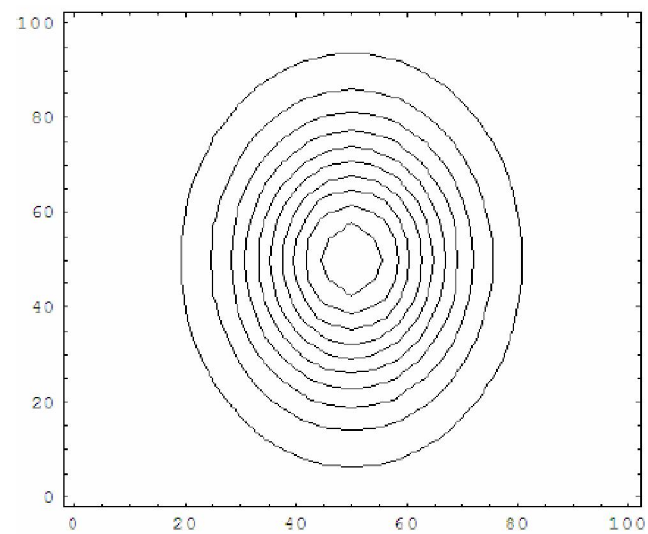

Figure 5 : Capture probability contour line simulation figure in case t gets smaller

From Figure 4, we can see that the curved surface situation is similar to two-dimensional normal distribution density function images, so we can use two-dimensional normal distribution probability density to describe the change trend. Parameter t represents time from ball shooting to goal arriving, which is also reaction time for goalkeeper, the time gets longer, curved surface will become more smooth, based on above, we get :

$$p_0(t,y,z) = \exp\left\{-\frac{(y-a)^2+(z-1.25)^2}{ct}\right\}$$

Among them c is goalkeeper reaction coefficient, according to expert prediction, common people reaction time is nearly 0.12~0.15 seconds. According to Figure 6, we establish equations as following :

$$\frac{CA}{AD}=\frac{CE}{ED}\Rightarrow\frac{CA}{AD+CA}=\frac{CE}{ED+CE}$$

$$b=CE-OC\Rightarrow\frac{CA(ED+CE)}{AD+CA}-OC$$

According to famous "strip test", it can get common people reaction time is nearly $\sqrt{2}/10$ seconds(that is proposing to put a strip between two fingers of people, when strip free falls under gravity effects, by $s=0.5gt^2$, it can calculate people reaction time). Therefore, here can take c =1/7 (experimental value),

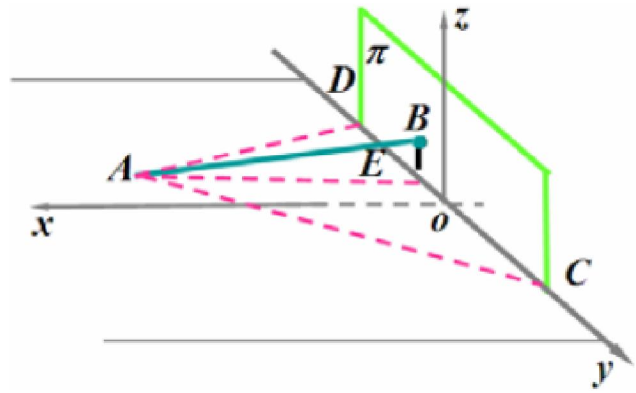

Figure 6 : Shooting force analysis

goalkeeper defends instant, deflection distance from goal center is:

$$a = \frac{7.32\sqrt{(y_0+3.66)^2+x_0^2}}{\sqrt{(y_0+3.66)^2+x_0^2}+\sqrt{(y_0-3.66)^2+x_0^2}} - 3.66$$

On the basis of no goalkeepers, to player field any point $A(x_0, y_0)$ shooting goal probability, it should amend as following:

$$p_D(x_0, y_0; y_1, z_1) = \iint_D f(y,z)[1-p_0(t,y,z)]dydz$$

That $p_0(t,y,z)$ represents goalkeeper capturing probability, $1-p_0(t,y,z)$ represents probability fail in capturing. So similarly, it gets field any point $A(x,y)$ threat level to goal is:

$$D(x,y) = \iint_D p(x,y;y_1,z_1)dy_1dz_1$$

Among them:

$$p(x,y;y_1,z_1) = \frac{p_D(x,y;y_1,z_1)}{p_\Omega(x,y;y_1,z_1)},$$

$p_\Omega(x,y;y_1,z_1)$ has no goalkeepers, and:

$$\sigma = \frac{d}{k}(\cot\theta + 1),$$

$$\cot\theta = \frac{|y_1 - y|}{x},$$

$$d = \sqrt{x^2+(y_1-y)^2+z_1^2},$$

$t = \dfrac{d}{v_0}$, v_0 is constant

Here, attack player can take basic quality $k = 10$, goalkeeper reaction coefficient c=1/7, ball speed $v_0 = 10$ meter/second, similar to without defense instant solution, and it can get field any point to goal threat level. According to each point threat level value, similarly it can make field equivalent threat level curve.

CONCLUSION

There are great differences between situations with and without defense, and when it has a goalkeeper, mainly relies on goalkeeper to let dangerous region to be obviously diminished. The largest threat level region is nearby goal especially in the direct front. Therefore it also shows field penalty and foul area setting rationalities.

In the model, k value is estimated, seriously speaking, it might as well define through lots of experiments with statistical rules. We proves by calculating when k increases (that player quality increases), his threaten to goal is obviously increasing, and dangerous region expands. Regarding goalkeeper quality, it is neglected in the mode for simplifying problems. Regarding correlation problems of multiple players attacking and defending situations, it is more complicated.

REFERENCES

[1] Dai Zhen-Qiang; Heyuan Vocational Technical College, Heyuan Guangdong. Table tennis operation mathematical model. China science and technology information, **14**, 31 **(2011)**.

[2] Yang Hua, Guan Zhi-Ming; Simulation of Ping-pong Trajectory Based on ODE. Computer Simulation, **28(9)**, 230-233 **(2011)**.

[3] Sun Zai, Yu Guang-Xin, Guo Mei, Zhu Li-Li, Yang Jun, He Zheng-Bing; Aerodynamic Principles of Table Tennis Loop and Numerical Analysis of Its Flying Route. China Sport Science, **28(4)**, 69-71 **(2008)**.

[4] Zhang Qiu-Fen, Su Jing; Analysis on Medal Distribution and Medallist's Playing Type of Table Tennis in the Olympic Games. China Sport Science and Technology, **41(5)**, 90-92 **(2005)**.

[5] Zhang Cui-Cui, Lin Lin, Hu Hong-Quan; Sociological Analysis on Overseas Corps of Table Tennis in China. Bulletin of Sport Science & Technology, **18(3)**, 123-124 **(2010)**.

[6] Gao Ying; The Study of Loop Track under Dynamic Mathematical Model. Journal of Hebei Institute of Physical Education, **4**, 79-82 **(2013)**.

[7] Zhong Yu-Jing, Wang Da-Zhong, Wang Juan; Philosophy in Table Tennis Development. Journal of Beijing Sport University, **31(4)**, 456-459 **(2008)**.