THE OPTIMAL KICK FOR GOAL IN RUYGBY

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Introduction

What is the best way to achieve a satisfactory kick for goal in rugby? In order to provide the answer, we have measured aerodynamic forces and moments acting on a rugby ball spinning on its transverse axis by wind tunnel tests and optimized the initial conditions for the goal kick by using a genetic algorithm.

Methods

A full-size ball model was employed to determine the aerodynamic forces and moments in a wind tunnel. A motor was inserted in order that the ball could be spun on its transverse axis. The kick for goal from 45° on the 22 meter line is optimized. Two objective functions F1 and F2 are considered. F1 means the lateral deviation of the distance of the ball position and the center of both goalposts at t_f. The moment at which the ball passes over the crossbar is denoted by t_f. F2 is the height of the ball position (negative value) at t_f. Both objective functions must be minimized for this optimization.

$F1 = |Y_E(t_f) - 35|$ (1), $F2 = Z_E(t_f)$ (2)

Here, the origin of the inertial coordinate system is defined as the point of intersection of the opposition's 22 meter line and the left touch line from the kicker's view on the ground. The X_E-axis is in the horizontal forward direction, while the Y_E-axis is in the horizontal right direction and the Z_E-axis is in the vertical downward direction.

Results & Discussion

Two optimal flight trajectories are shown in Fig.1. In the case of two objective functions (F1 and F2) the flight trajectory (Broken line) looks straight. This prevents the decrease of the ball height by reducing the flight time, so that F2 is minimized. In the case of an objective function (F1, Solid line), the ball tends to hook to the left due to a side force. This allows considering that the hooked kick is less susceptible to the deviation from the optimal initial conditions than the straight kick if the kicker pays all attention to the control.

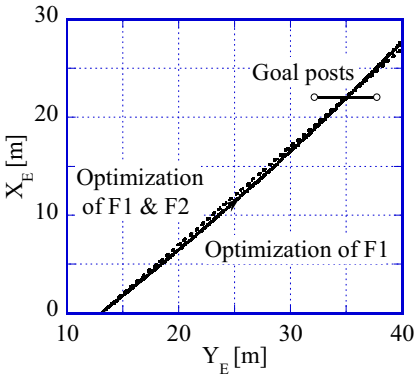

Fig.1 Optimal flight trajectories.

Conclusion

A powerful kicker who has a confidence in the flight distance should make the trajectory hooked. The hooked trajectory is less susceptible to the deviation from the optimal initial conditions. The kicker who has a confidence in his/her control should make the trajectory straight. A straight trajectory will increase the flight distance.