Vision-based Robot Arm System Design for Air-Hockey

Ching-Chang Wong, Chia-Jun Yu, and Yu-Cheng Lai

Abstract—A vision-based robot arm system is designed and implemented so that a robot arm can play air-hockey with human being. The image processing unit and the arm control unit of two main units of the system architecture are described in this paper.

Keywords— Air-Hockey Robot, Robot Arm, image processing.

I. Introduction

"Air-Hockey" is a representative game. It only needs one puck and two mallets on a table to let two players to play an exciting game. In this paper, a vision-based robot arm system is designed and implemented so that a robot arm can play air-hockey with human being.

II. System Architecture

In the hardware part, a six degree of freedom industry robot arm ABB-IRB120 [1] is considered. In the software part, the background subtraction algorithm [2] is applied to detect the puck and determine its coordinate. Furthermore, in tactics, the implemented robot system will forecast the route of puck so that it can send a position command to the robot arm and wait for the feedback to send the next command.

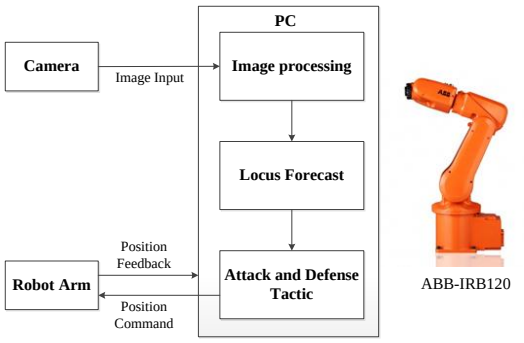

Fig. 1. Block diagram of system architecture.

The block diagram of the system architecture is shown in Fig. 1. There are two main units: image processing unit and arm control unit. They are described as follows:

A. *Image Processing Unit*

In the image processing unit, the background subtraction algorithm is used to detect puck. Its illustration is shown in Fig. 2. The processing steps are described as follows:

1) Generate and save a gray background image.
2) Subtract the gray background image from the dynamic image.
3) Choose a fit value to excute binary operation.

This research was supported in part by the National Science Council of the Republic of China under contract NSC 102-2221-E-032-048.

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(a) Background Gray Image (b) Input Gray Image (c) Operation Output

Fig. 2. Illustration of background subtraction algorithm.

B. *Arm Control Unit*

In the arm control unit, there are two main parts: route forecast and internet transmission. In the route forecast part, as shown in Fig. 3, the characteristic of linear function and mirror reflection rule are used to forecast the knock position. The processing steps are described as follows:

1) Set an attack line function.
2) Record the last time and past time position of puck.
3) Create a linear function L by two positions in Step 2.
4) Calculate the cross point P_V of two linear functions in Step 1 and Step 3.
5) Calculate a real knock position P_A by the mirror reflection rule (a1=a2).

In the internet transmission part, it will send the position to the robot arm and wait for the feedback to send the next command.

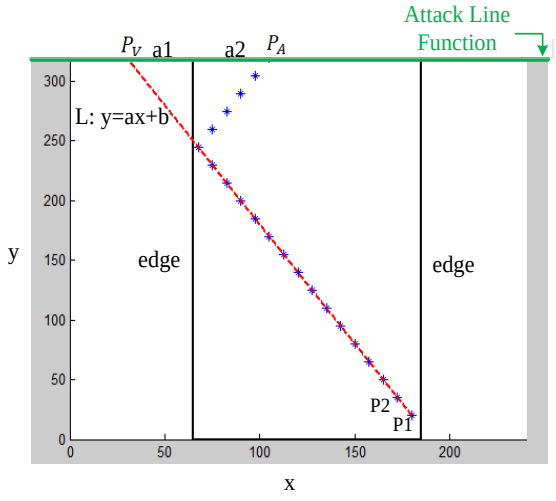

Fig. 3. Illustration of the route forecast.

References

[1] ABB Manipulator, URL: http:// www.abb.com
[2] W.J. Wang, I.D. Tsai, Z.D. Chen, and G.H. Wang, "A vision based air hockey system with fuzzy control," *International Conference on Control Applications*, pp.754-759, 2002.