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# Autonomous Air Hockey Table

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# Abstract

The automated air hockey system has been in development since 2009. The previous groups implemented a light sensor array to track the puck as it moved across the playing field. However, the light system proved to be ineffective. It was the objective of James and I to implement a better tracking system using an analogue camera. Using this new tracking method, the system needed to be able to consistently hit an incoming puck back to the other side of the table.

A new tracking system was developed using two analogues cameras - one for each side of the table. A main verilog program performs blob detection on each frame to determine the x and y coordinates of the puck. The coordinates are then sent to a C program, which uses a Kalman Filter to determine the trajectory and velocity of the puck. By knowing the trajectory of the puck, the C program is able to determine the time and place where the paddle and puck will intersect. Furthermore, the C program makes strategic decisions on how the puck will be hit based on several parameters.

The result is a system that is able to hit an incoming puck 90% of the time. Because of the shape of the table and limitations imposed by limit switches, 63% of rallies end because the puck gets stuck in the corner.


# 1 Objective

The purpose of the Automated Air Hockey project is to create an air hockey table which is capable of playing by itself. Human assistance is required to serve the puck to start the game. After that, each paddle must be able to hit the puck back towards the other side. Each side of the table must be able to consistently defend its own goal and hit the puck back to the other side.

Along with the overall objective, this project came with several functional requirements:

1. By using an analogue camera to view the field of play, the system must be able to track the movement of the puck along the table.
2. The system must be able to analyse the puck's trajectory, and then deduce where the puck will end up and when the paddle must move to hit the puck.
3. Implement game logic so the system will make intelligent decisions on where and when to hit the puck.
4. Add an input peripheral to each side so that the paddle carriage can be controlled manually in addition to being automated.

# 2 Inherited Project State

The Autonomous Air Hockey Table has been in production since 2009, with two students initiating development in 2009 and another two students continuing production in 2010. The previous groups spent most their time implementing the physical and electrical components of the system. This section describes the state of the project when James and I began work in February 2010. Note that there are two sides to the table, one for each player, so there is one of each component on both sides.

## 2.1 The Air Hockey Table

The system runs on a 1.88 meter $\times$ 1.13 meter air hockey table. There are no physical alterations to the table, it is a standard air hockey table: There is a fan underneath which drives air through the holes dotting the playing field and a goal for each side. Anything added to the system was added on of the table. To keep people from putting their hands near the moving components, a glass rectangle with an aluminium frame spans the perimeter of the playing field. The frame rests on the border that runs around the playing field; not on the playing field.