Proposal

Autonomous Foosball Table

Proposed by Team FIFA

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2. Executive Summary

An automated foosball table offers a challenging player versus computer match-up in a game of table-football (foosball). In addition to being challenging for the expert foosball player, it allows one to play without the need of finding a formidable human opponent. Furthermore, the idea of "man versus machine" makes an automated foosball table an interesting and fun challenge to play against. The autonomous foosball table (AFT) falls within the same category as typical arcade games found in entertainment centers, such as pinball, air hockey, and arcade video games. Currently there is no such automated foosball arcade machine in mass production; therefore, there is an excellent opportunity to market such a product. By offering an AFT at a competitive arcade machine price, the potential for profitability is great. This proposal will examine the underlying technology required to build an AFT and prove that a challenging computer-controlled opponent can be developed. The prototype is expected to play competitively against an advanced foosball player and function reliably. After successful demonstration of the prototype, further development can be made to reduce costs and improve presentability for a marketable and manufacturable arcade machine.

3. Introduction

A prototype foosball table with a robotic opponent will be designed and constructed by project engineers. An autonomous foosball table will effectively bring a fast-paced multi-player game to lone players or teams of players.

3.1 Objective

The ultimate goal is to create an automated foosball opponent that can compete with a human player. It will be challenging, but not overly so, thereby encouraging players of all skill levels. With this level of playability attained, it could be sold to a number of commercial locations as well as occasional individuals. Bars, arcades, theme parks, and locations with small fun centers like some airports and movie theaters would be interested in the product at a competitive price.

3.2 Motivation

There currently is only one AFT on the market, however, it is very expensive and has low functionality. The goal is to develop an AFT that can be offered at a competitive arcade machine price, and has more functionality than what is currently on the market. With a competitive price, the AFT will be easily marketed to the customer and offer the manufacturer a big profit.

3.3 Background

Robotic foosball tables have been created in recent years by students at a few universities, but as of yet there have been no commercial applications. The Foosbot, a project of students at Rice University, used a series of infrared LEDs and phototransistors to track the ball as it traversed the table and potentiometers on the gears to track player position [1]. It is said to be undefeated, but has yet to play against experienced foosball players. To achieve better tracking, the system will utilize a camera above the table for tracking the ball and lateral player movement, and servos for accurate player rotation. KiRo, a project out of the University of Freiburg in Germany, uses a top mounted camera as in this design and has defeated 85% of its opponents, including expert players [2]. It, however, uses much more expensive equipment than what the proposed prototype will use, and is thus not commercially viable.

The underlying technology of the table lies largely within three fields, each of which has vast amounts of research available. Accurate tracking through computer vision is integral to the success of the device, and several resources are available at Georgia Tech. The Computational Perception Laboratory, for example, currently has a project underway to track eyes as people approach a camera [3]. This project is a rather complex task compared to following a colored ball, but the underlying research is vast and readily available. PIC control of the servos used to control the players is another important aspect of the device, and another area with a great amount of available resources. The technology has been around since the 70's and has been used in a wide variety of projects due to its low cost and extensive collection of application notes [4]. The final field in use will be simple artificial intelligence used to decide the best strategies for both offense and defense in a given scenario. Artificial intelligence has been applied in varying degrees to machines for decades to accomplish goals as simple as case based reasoning in a recommendation system, or as complex as defeating a world champion chess player [5]. All of these combined can form a challenging and playable autonomous foosball robot.

4. Project Description and Goals

The main project goal is to complete a working prototype for an AFT, where a human player faces a robotic opponent. From the human perspective of the game, the foosball table will be very similar to a regular table. The player(s) on the human side will be controlled via a series of four handles that can be moved in and out and rotated to move the players linearly across the playing field and to kick the ball towards the opponent's goal. The autonomous side will consist of:

- Eight servo motors used to manipulate the handles of the foosball table
- A microcontroller to activate the servo motors and communicate with the computer
- An over-head mounted webcam to track the ball and players
- A computer to process the webcam images, implement artificial intelligence, and communicate with the microcontroller

The initial prototype goals will be to make a simple functioning automated player to play against, one that is at least able to defend the goal and make an effort to kick the ball toward the other end of the table. Once a simple level of gameplay is established, the next goal will be to improve the artificial intelligence (AI) of the automated player in order to increase the challenge of the game for the human player. The project prototype should prove that an automated foosball table is feasible and cost-effective, and that a simple level of AI can be achieved for a somewhat challenging game to the novice foosball player.

5. Technical Specifications

Table 1 lists the technical specifications required to successfully implement the AFT.

Item	Specification
Camera frame rate	minimum 60 frames per second
Camera resolution	minimum 30 pixels per square inch of table
Localized ball tracking success rate	80% of frames minimum
Kick rate (ball velocity)	up to 10 feet per second
Lateral player speed	up to 2.5 feet per second
Lateral player position resolution	at least 1 cm
Rotational player position resolution	at least 1.5°
Move and kick success rate	75% of attempts minimum
Unopposed goal rate	50% of attempts minimum
Goalie blocking success rate	90% of attempts minimum
Reaction time from webcam	200 ms maximum
Power requirements	TBD
Weight	TBD
Table dimensions	TBD

Table 1. Automated Foosball Table Technical Specifications

In order to achieve proper operation, one pivotal feature of the table lies with the webcam. If the computer cannot keep up with the movement on the table, there is no hope for successful kicks or blocks. For this reason, a high speed camera capable of over 60 frames per second at 1.3 megapixels will be used. Additionally, in order to track the ball more efficiently, the search will be localized in each frame based on a prediction algorithm to limit the computation time. Since the camera will be mounted above the table, the view of the ball will sometimes be obscured when it rolls underneath players. With proper prediction, the aim is to keep the ball within a localized frame at least 80% of the time. Once the computer has determined the best move, the next pivotal feature lies in the servo motors' ability to move quickly and accurately. It has been determined that for competitive play, the players must be able to move laterally at up to 2.5 feet per second and quick rotation should allow the players to kick the ball at an initial velocity of up to 10 feet per second. For good passes and attempts on the goal, a strict movement resolution has been chosen to maintain accurate kicks. The goal is to be able to block 90% of attempts on the goal and score at least 50% of the time when the path to the goal is clear. For general offensive and defensive kicks, the goal is to maintain at least a 75% success rate.

6. Design Approach and Details

Figure 1 shows the overall design approach and all of the components required for the proposed AFT.

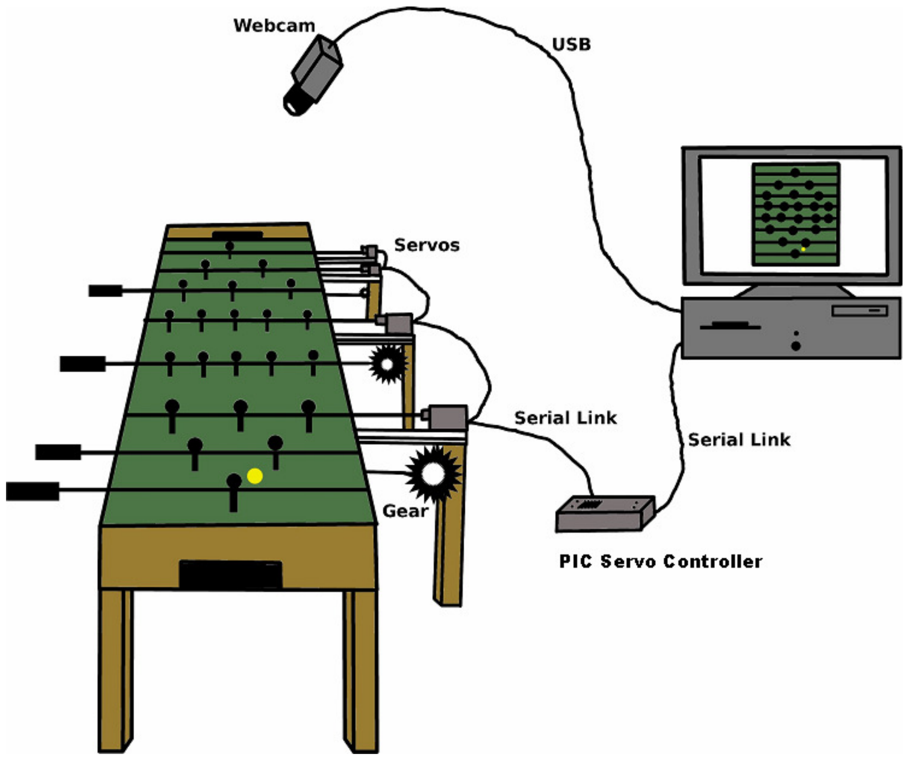

Figure 1. System design overview.

The specifics of each subsystem are described in detail in this section.

6.1 Ball Detection

Ball detection will be done via a visual system involving a high speed webcam. Once a frame has been gathered, the image will be processed in software. The foosball game will use a yellow colored ball, which is ensured to be the only yellow object within the field of view. In this way, it will be easy to average the location of yellow pixels in order to find the center of the ball.

In order to increase the rate of processing, the area to search for yellow pixels will be localized via a predictive algorithm. Given the ball's current velocity, an attempt will be made to predict the next location using a Kalman filter. If this tracking method proves to be too slow in processing, either a simple quadratic or linear prediction will be used. If a predictive design proves to be too inaccurate due to random bouncing or kicking, it will be necessary to increase the window size for localization and use the last position for centering.

6.2 Gameplay Processing

The gameplay will consist of some basic strategy, both defensive and offensive. The majority of the defensive strategy will be to position the players in a way that minimizes the chance of scoring. The offensive strategy will be to look for an open shot and take it when possible. If an open shot is not possible, the robot will attempt to look for passes that may open up a shot. A simplified diagram of this action is found in *Figure 2* below.

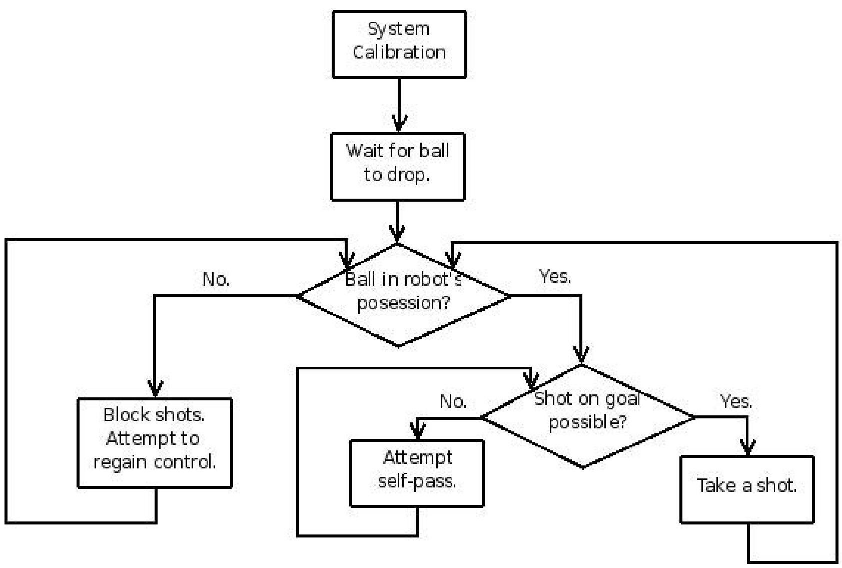

Figure 2. Gameplay decision flow.

In addition, the robot will watch for the disappearance of the ball, which would indicate it has either disappeared from view or a goal was scored. If the ball disappears from view, the robot will have to rescan the table several times to ensure a goal was scored.

6.3 Manipulation of Foosball Table

The foosball table will have to be modified in a few ways to accommodate the robot. First, there will need to be a lofted mount for the downward looking camera used to track the ball. Additionally, there will need to be a method to mount the motors to control both the horizontal and rotational movements. A gearing system will be used for the horizontal motor. This design will ensure quick lateral motion. Each handle will be mounted directly to the rotational motor.

6.4 Codes and Standards

The AFT must abide by standard foosball rules [6]. One of those rules is that spinning the players beyond a 360 degree rotation is not allowed. Therefore, it is not possible to run a DC motor constantly to hit the ball as quickly as possible in a forward motion. Another standard that will be used is the RS-232 connector [7]. The AFT will use the RS-232 interface to connect the PC and the microcontroller, although a custom standard for communication will be used. The webcam will use the universal serial bus (USB) 2.0 standard to communicate with the computer. Given a 320x240 pixel resolution from the camera, in order to transfer a minimum of 60 frames per second, a bandwidth of at least 105 Mbit/s will be required. The USB 2.0 specification gives 480 Mbit/s [8]. While other standards exist to handle such transmissions, USB 2.0 cameras are the most common and have the lowest cost for this application. Finally, the servo motors that will be used communicate across a RS-485 physical layer. The servo motors allow for quick data rates of over 1 Mbit/s [9].

6.5 Constraints, Alternatives, and Tradeoffs

Servo motors will be used, as opposed to DC motors or stepper motors. The most significant trade-off with this choice is price. While DC motors would be faster and carry higher torque ratings, it would be much more difficult to track them and ensure they are moving accurately.

Likewise, stepper motors are more difficult to interface while offering minimal benefits from a servo motor in this application. Linear actuators were also considered, but they offer very little control.

In the tracking system, less processor-intensive methods were also considered. One such example would be using multiple infrared sensors to gauge the distance and then triangulating the ball position from that data. However, this method adds complexity and it was decided to not be as accurate as visual processing. One other way to handle the tracking visually would be to use an FPGA to process the webcam data. However, this method would make the FPGA hardware design to interface with the USB camera extremely complicated. An analog input source may be adequate, but such a design offers additional complexity compared to a USB webcam input.

7. Schedule, Tasks, and Milestones

In the development phase of the prototype, it is important to create a schedule, identifying all of the tasks and milestones necessary to complete the project. This schedule will give the development team a timeframe to aim for in the development process.

7.1 Schedule

The prototype development schedule is maintained by the Gantt chart shown in *Appendix A*. As a means of communicating the schedules amongst the developers, Google Calendar will be used in addition to the open source project management software activeCollab. Together, these resources effectively communicate critical development dates, milestones, goals, and tasks, and also offer a means for the developers to communicate and share files in a central and convenient location.

Table 2 shows important development dates that the team needs to be aware of to keep the development on schedule.

Date	Item	Description
10/1/2007	Draft Prototype Summary	Brief description of the prototype, providing important parameters and descriptive elements.
10/10/2007	Website	Online presence for the prototype project, providing the public with an overview of the project along with relevant information and updates on the development progress.
10/10/2007	Final Prototype Summary	Final version of the prototype summary.
10/19/2007	Preliminary Design Review	First formal presentation of the progress of the prototype's development phase. Schedules will be weighed against actual progress and adjustments can be made, if necessary.
12/5/2007	Prototype Demonstration	Final demonstration of the completed prototype, along with presentation all necessary documents required to reproduce the design.

Table 2. Important dates for prototype development.

The schedule is designed to give the development team a month of test and revision time, thus ensuring enough time to come up with solutions to all problems and for final design improvements before the final demonstration.

7.2 Tasks

There are several components of the prototype that can be isolated as tasks. The responsibility for completing each task will be assigned to someone on the development team. *Table 3* describes the tasks that will be required to complete the AFT prototype as well as how many people may be required to complete a specific task.

Task	Description	Persons
Mechanical assembly	Assembly of the mechanical parts required to move the handles of the foosball table, which includes the enclosures for the electrical components and a mounting mechanism for the ball-sensing camera.	2-3
Microcontroller development	Design and programming of the microcontroller and its circuitry that will manage the communication between the control motors of the foosball table and the image processing computer.	1-2
Image processor development	Development of the computer software that will interpret the images from the overhead-mounted webcam and run the necessary processing for ball detection and path prediction.	1-2
Computer-controlled communication	Design of the communications protocol between the processing computer and the motor controller.	1
Presentation materials	Development of the materials required for properly presenting the prototype development, including the final design documents.	1-2

Table 3. Overview of tasks required to complete the prototype.

7.3 Milestones

During the development phase, there are certain milestones that need to be achieved before development can continue to the next phase. It is important to identify these milestones and make sure that they are met in a timely fashion in order to keep the development of the prototype on schedule. The important milestones for the AFT are shown below.

- Functioning microcontroller board and reliable communication with the servo motors.
- Mechanical assembly of the AFT so that the handles of the table can be autonomously moved by the computer-controlled motors.
- Basic computer-controlled lateral movement of a handle on the foosball table.
- Successful computer-controlled movement of all four handles on the foosball table, including kicking action.
- Basic image processing software for ball detection.
- Advanced image processing implementation for ball path prediction.
- Proper communication commands to the motor microcontroller.
- Artificial intelligence to implement challenging foosball gameplay.

Refer to the Gantt chart in *Appendix A* to see how these milestones relate to the overall schedule of the development and the tasks required to complete the prototype.

8. Project Demonstration

A final demonstration of the product will be allowing the robot to play humans of varying levels of foosball experience, thereby demonstrating the overall working abilities of the robot. However, there is also the need to test all individual subsystems separately in order to validate them. By breaking the project into smaller systems, the progression of the system will be measurable as development continues.

8.1 Visual System

In order to test the object tracking speed, a timer will be added to the tracking software. A log of the frames per second may be processed by calculating the total number of frames in a given time period. In order to calculate the physical resolution of the camera, the number of pixels will be divided by the total distance covered in the field of vision, thus giving pixels per meter.

8.2 Motors

The kicking speed as well as the lateral movement speeds of the motors will need to be tested. The kick speed will be measurable by setting the motor controller to the maximum acceleration and velocity and then beginning a kick of a stationary ball. The velocity can be measured by using the high speed webcam to record a video, which can be analyzed manually. Lateral movement of the players may be tested by using the internal timer of the control board's microcontroller in order to find the total time to move a specified distance. Once the distance and time are known, the lateral velocity can be calculated. Additionally, the lateral movement physical resolution can be calculated by dividing the total allowable movement distance by the number of uniquely addressable positions across that distance.

8.3 Total System Latency

The latency from webcam image grabbing to motor control signal will be measured with an oscilloscope. An output signal will be pulsed on the control computer once an image is acquired, which will read on the oscilloscope. After the visual processing is done and a control signal is finished sending to the motor control board, the microcontroller will pulse a second signal, which will also be read on the oscilloscope. The time differential in these two signals is the reaction time of the system.

9. Marketing and Cost Analysis

9.1 Marketing Analysis

The targeted market for an AFT is the arcade entertainment industry. While individual customers are not likely to purchase such a foosball machine a few such sales to very active, wealthy foosball enthusiasts, looking for a unique in-home game may be expected. However, arcades or "fun" centers have the resources to purchase a more sophisticated form of a foosball table to offer a variety of challenges to their customers. The following is an example list of potential customers to which the AFT may be marketed:

- Chuck E. Cheese (http://www.chuckecheese.com/)
- Celebration Station (http://www.celebrationstation.com/)
- Malibu Grand Prix (http://www.malibugrandprix.com/)
- Dave and Busters (http://www.daveandbusters.com/)

Local bars and pubs may also be a potential market for such a foosball table, as they are also popular entertainment locations where customers would consider playing such a game and where similar games already exist.

In order to be successful, the foosball table must be a challenging and fun experience to the player. Such a machine can be tailored towards the intermediate to expert foosball player who has trouble finding a challenging human competitor. A successfully designed computer-controlled foosball player has the potential to approach perfection and challenge any expert-level player. Given a high expectation of victory, a computer-controlled opponent motivates an expert player to invest in playing the game, hence the marketable appeal of an AFT. Various difficulty levels would also open up the marketability to the beginner-level foosball player. The marketing appeal is strong for a game that does not require a human opponent.

Figure 3. Star Kick foosball arcade game.

Currently there is only one AFT on the market, the Star-Kick, shown in *Figure 3*. The Star-Kick has its roots in a project by the School of Computer Science at the University of Freiburg in Germany. However, the marketed arcade version of the Star-Kick is listed at a price of $27,000, which is out of the range for smaller arcade centers and local bars [10]. The goal of the proposed prototype is to compete with this product by improving the gameplay, and significantly lower the cost of this unique type of arcade machine.

9.2 Cost Analysis

The final cost of an AFT should be competitive with other similar entertainment devices that the customer would place in their facility. Such devices include pool tables, pinball machines, air hockey, driving simulators, and arcade video games. The short list in *Table 4* shows the price for some of these typical entertainment machines.

Name	Description	Price
NASCAR Pinball	Coin-operated NASCAR-themed pinball machine (new).	$4,395
Dracula Pinball	Bram Stroker's Dracula themed pinball machine (1993).	$3,249
Great American Air Hockey Table	8ft. air hockey table with electronic overhead scoring.	$3,470
Bubble Hockey Machine	Signature Stick Hockey bubble hockey machine.	$1,245
Ford Racing Full Blown	Driving arcade game based on recognizable Ford cars by Sega.	$8,795
Dance Dance Revolution Supernova	Arcade version of the DDR video game. 2 Players.	$13,895
Golden Tee Live 2007	The latest installment of the famous Golden Tee arcade machine.	$5,395
Great American Eagle Billiard Table	Standard bar-quality coin-operated billiard table.	$1,825
Tornado Cyclone II Foosball Table	Typical quality human vs. human foosball table.	$1,195
Average Price:		$4,829

Table 4. Typical entertainment machine prices. Source: ArcadeGameSuperstore

From the list in *Table 4* of typical arcade machines, a targeted price range can be determined for an AFT. The higher priced arcade machines are typically larger, more complex, and usually have a computer opponent component; therefore it is viable to put the AFT into a similar range, depending on the extra features that the final product may have. A realistic selling price for such an arcade machine would fall in the price range of $5,000 - $8,000. In order to satisfy customers with different budgets, it is possible to offer a variety of AFTs: a basic version for playing against an automated opponent and a feature-rich version suitable for arcade presentation.

Assuming that the basic version of the AFT would sell at $5,000 and the high-end version would sell at $8,000, a large profit can be made from such a product. *Appendix B* and *Appendix C*, respectively, show the profitability of an AFT at these two prices, given costs for parts, cost of labor, and the selling of 500 units. For a selling price of $5,000 for a basic version, a profitability of 28.7% can be achieved, which amounts to $717,041 in profit. The high-end end version which sells at $8,000 achieves almost the same profitability with 27.8%, which amounts to $1,112,050 in profit.

In conclusion, the market for such an arcade machine is well established, and the void for such a unique machine gives it a great amount of selling power. Given costs of parts and labor, selling such an arcade machine at a competitive price compared to other machines in the market allows the manufacturer to make a substantial profit.

10. Project Summary

The prototype is still in the beginning stage, as several design decisions are still being made. The microcontroller supplies have arrived and the development of the prototype has started. However, a test can not be performed until the table has arrived and is set up. A variety of features require a great deal of complexity, such as passing strategy and adjusting to player difficulty. Therefore, a prototype may not include some of these features, but a final product would. The servo motors selected to drive the rods communicate with one another, which will simplify programming. The biggest issue is reducing the latency of the system and producing a challenging AI to play against. The mechanical design to drive the rods of the foosball table is also an issue. These problems should be resolved once all the parts arrive and construction on the table can begin.

11. References

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[8] Compaq Computer Corporation et. al., *Universal Serial Bus Specification*, USB Implementers Forum, Inc., April 27, 2000 (Rev. 2.0).

[9] Tribotix Robotis Technical Staff, *Dynamixel User's Manual*, Tribotix, 2005.

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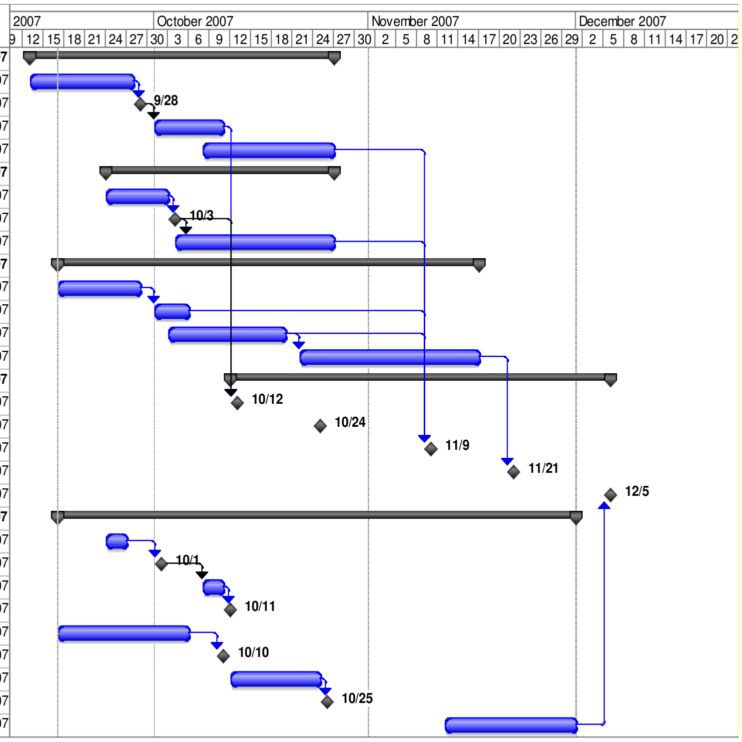
A. Appendix: Prototype Development Gantt Chart

ID		Task Name	Duration	Start	Finish
1		**PIC Microcontroller Board**	**32 days?**	**Thu 9/13/07**	**Fri 10/26/07**
2		Assemble PIC board	11 days	Thu 9/13/07	Thu 9/27/07
3		Demonstrate PIC Board	1 day?	Fri 9/28/07	Fri 9/28/07
4		Servo motor communication	8 days?	Mon 10/1/07	Wed 10/10/07
5		Communications w ith compute	15 days?	Mon 10/8/07	Fri 10/26/07
6		**Mechanical Assembly**	**25 days?**	**Mon 9/24/07**	**Fri 10/26/07**
7		Work on basic assembly	7 days?	Mon 9/24/07	Tue 10/2/07
8		Basic assembly finished	1 day	Wed 10/3/07	Wed 10/3/07
9		Continue assembly improveme	17 days?	Thu 10/4/07	Fri 10/26/07
10		**Image Processing Computer**	**45 days?**	**Mon 9/17/07**	**Fri 11/16/07**
11		Ball detection	10 days?	Mon 9/17/07	Fri 9/28/07
12		Ball path prediciting	5 days?	Mon 10/1/07	Fri 10/5/07
13		Communication w ith microcont	13 days?	Wed 10/3/07	Fri 10/19/07
14		Artificial Intelligence	20 days?	Mon 10/22/07	Fri 11/16/07
15		**Prototype Integration Mileston**	**39 days?**	**Fri 10/12/07**	**Wed 12/5/07**
16		Lateral movement of one hand	1 day?	Fri 10/12/07	Fri 10/12/07
17		Lateral and kick movement of a	1 day?	Wed 10/24/07	Wed 10/24/07
18		Automated movement tow ards	1 day?	Fri 11/9/07	Fri 11/9/07
19		Prototype completed	1 day?	Wed 11/21/07	Wed 11/21/07
20		Prototype Presentation	1 day?	Wed 12/5/07	Wed 12/5/07
21		**Presentation Materials**	**55 days?**	**Mon 9/17/07**	**Fri 11/30/07**
22		Work on project summary	3 days?	Mon 9/24/07	Wed 9/26/07
23		Draft finished	1 day?	Mon 10/1/07	Mon 10/1/07
24		Make revisions to project sumi	3 days?	Mon 10/8/07	Wed 10/10/07
25		Final Project Summary due	1 day?	Thu 10/11/07	Thu 10/11/07
26		Work on w ebsite	15 days?	Mon 9/17/07	Fri 10/5/07
27		Website live	1 day?	Wed 10/10/07	Wed 10/10/07
28		Work on PDR	9 days?	Fri 10/12/07	Wed 10/24/07
29		Preliminary Design Review	1 day?	Thu 10/25/07	Thu 10/25/07
30		Design Report	15 days?	Mon 11/12/07	Fri 11/30/07



B. Appendix: Cost with $5,000 Selling Price

Cost and price calculations for a basic AFT with a selling price of $5,000.

Fringe Benefits	***25%***	of labor
Overhead	***55%***	of materials, labor & fringe
Sales & Marketing Expense	***25%***	of selling price
Warranty & Support Expense	***5%***	of selling price

Development Cost (Non-recurring Cost)

What it costs the company to develop the product

Parts	***800***
Labor	***15,000***
Fringe Benefits, % of Labor	3,750
Subtotal	19,550
Overhead, % of Matl, Labor & Fringe	10,753
Total	$30,303

Determination of Selling Price

What the customer pays the company for the finished product

Based on: ***500*** units

Parts Cost	***1,200***	
Assembly Labor	***25***	
Testing Labor	***50***	
Total Labor	75	
Fringe Benefits, % of Labor	19	
Subtotal	1,294	
Overhead, % of Matl, Labor & Fringe	712	
Subtotal, Input Costs	2,005	
Sales & Marketing Expense	1,250	
Warranty & Support Expense	250	
Amortized Development Costs	61	
Subtotal, All Costs	3,566	
Profit	1,434	28.7%
Selling Price	***$5,000***	

Total Revenue	$2,500,000
Total Profit	$717,041

C. Appendix: Cost with $8,000 Selling Price

Cost and price calculations for a fully-featured AFT with a selling price of $8,000.

Fringe Benefits	***25%***	of labor
Overhead	***55%***	of materials, labor & fringe
Sales & Marketing Expense	***25%***	of selling price
Warranty & Support Expense	***5%***	of selling price

Development Cost (Non-recurring Cost)
What it costs the company to develop the product

Parts	***1,500***
Labor	***20,000***
Fringe Benefits, % of Labor	5,000
Subtotal	26,500
Overhead, % of Matl, Labor & Fringe	14,575
Total	$41,075

Determination of Selling Price
What the customer pays the company for the finished product
Based on: ***500*** units

Parts Cost	***2,000***	
Assembly Labor	***40***	
Testing Labor	***60***	
Total Labor	100	
Fringe Benefits, % of Labor	25	
Subtotal	2,125	
Overhead, % of Matl, Labor & Fringe	1,169	
Subtotal, Input Costs	3,294	
Sales & Marketing Expense	2,000	
Warranty & Support Expense	400	
Amortized Development Costs	82	
Subtotal, All Costs	5,776	
Profit	2,224	27.8%
Selling Price	***$8,000***	

Total Revenue	$4,000,000
Total Profit	$1,112,050