## horizontal line



Capstone Project Specification and Plan (FIRST DRAFT)

Robotic Air Hockey System  
2018.02.23

David Eelman - 6365316  
Stanislav Rashevskyi - 7028178  
Thomas Abdallah - 7141518

Conestoga College

Electronic Systems Engineering  
Capstone Project I - EECE74125

Semester 7, Class of 2018

[0](#_Toc506200500)

[Complete System Diagram and Description 2](#_Toc506200501)

[System Level Design Specification 2](#_Toc506200502)

[Design Task 1: 2](#_Toc506200503)

[Design Task 2: 2](#_Toc506200504)

[Design Task 3: 3](#_Toc506200505)

[Project Schedule 3](#_Toc506200506)

[References 3](#_Toc506200507)

# Complete System Diagram and Description

The Air Hockey Robot (AHR) shall be comprised of four major modules as shown in Figure 1. The Master Controller will be the central interface for all other modules and is primarily responsible for control strategy. The Paddle Controller is the primary hardware interface responsible for safely controlling the AHR electromechanical system. The Puck Tracker will be responsible for tracking the position and velocity of the air hockey puck on the playing surface. The User Interface will allow users to interact with the AHR system.

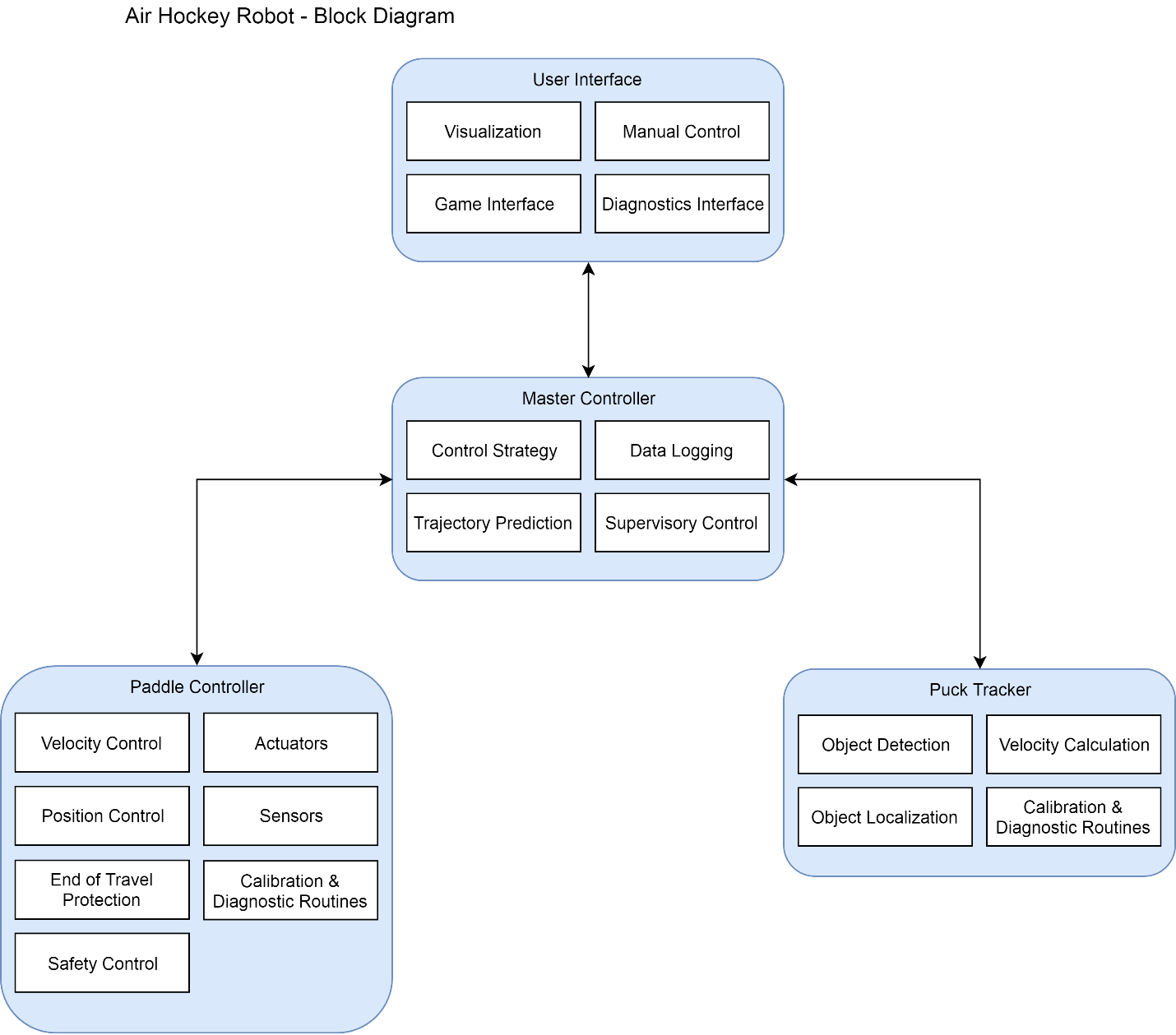


Figure - Air Hockey Robot Block Diagram

The Master Controller, Puck Tracker, and User Interface will be software of our own design running on and interfacing with off-the-shelf hardware. The Paddle Controller shall be software of our own design implemented on an embedded target of our own design which interfaces with off-the-shelf sensors and actuators. The team shall work collaboratively on the system level design. Each module shall have a lead developer who takes final responsibility for the design and implementation of the module. All group members may contribute to the design, implementation, and review of all modules. Stanislav shall lead development of the Master Controller, Thomas shall lead development of the Paddle Controller, and David shall lead development of the Puck Tracker (Semester 7) and User Interface (Semester 8). Appendix A includes the risk charter developed during the proposal phase of the project. Overall we believe the risk for this project is low as we have developed our work plan to address high risk challenges early on.

# System Level Design Specification

1. The AHR must be capable of detecting the position of a 2.5” diameter puck travelling at up to 10m/s to within +/-25mm on a 6’x4’ air hockey table in the ESE 4th year classroom regardless of outside lighting conditions.
2. The AHR must be capable of controlling the position of air hockey paddle in two dimensions covering one half of the air hockey table playing surface.
3. The AHR must be capable of tracking the position of the paddle to within +/-5mm.
4. The AHR must provide a mechanism to locate the home position of the paddle.
5. The AHR must be capable of accelerating the paddle to a speed of TBDm/s over a distance of 3’? (half table length).
6. The AHR must shield users from potentially dangerous elements such as rotating mechanical components or pinch points.
7. The AHR must include a mechanism to detect when the opposing player reaches over centre ice and stop the movement of the air hockey paddle within 100ms.
8. The AHR could include a mechanism to detect the presence of foreign objects in the path of the air hockey paddle.
9. The AHR must include a mechanism to stop the paddle from making contact with the boards of the air hockey table.
10. The AHR could include mechanism to adjust the difficulty.
11. The AHR must include a defensive control strategy and an offensive control strategy.
12. The AHR must include a visual user interface with a mechanism for the user to provide input.
13. The AHR could include a web interface or mobile application.
14. The AHR should provide a mechanism to visualize the position and trajectory of the air hockey puck.
15. The AHR should provide an interface to display the game score and time clock.
16. The AHR could automatically keep track of goals scored.
17. The AHR could include sound effects.
18. The AHR should provide an interface to allow the user to change control mode.
19. The AHR should provide an interface to allow the user to change difficulty.
20. The AHR should provide an interface to display debugging data and access diagnostics and calibration routines.
21. The AHR won’t support voice control.
22. The AHR must include an Emergency Stop button mounted in a central location that disables the entire system.
23. The AHR power supply must operate on 120VAC standard North American electrical power.
24. The AHR could provide an interface to allow users to manually control the air hockey paddle.
25. The AHR could provide a mechanism to detect game violations such as paddle crossing centre ice, puck leaving table, paddle covering puck, etc.
26. The AHR won’t support multiple pucks on the playing surface.

“A design specification is a detailed document providing information about the characteristics of a project to set criteria the developers will need to meet. Its use is called for where a structure or product has to be specially made to meet a unique need.” ~ Wikipedia

When you develop a system, and measure its performance, you need to compare it with some criteria to evaluate the performance. These criteria must be met when you perform validation test at the end of the project (in semester 8)

The specification should be a SMART (Specific, Measurable, Achievable, Realistic, Timely) specifications with MuSCoW (Must, Should, Could, Won’t), risk and effort ratings (high, medium, or low) for each functional/work block WHAT?

# Design Task 1: Master Controller

//one task for one group member//

o Design specification and methodology/process

o Assessment 1 and Assessment 2

o Requirement of new knowledge and skill, if any

o Requirement of tools and resources

o Risks and risk management plan

# Design Task 2: Paddle Controller

o Design specification and methodology/process

o Assessment 1 and Assessment 2

o Requirement of new knowledge and skill, if any

o Requirement of tools and resources

o Risks and risk management plan

# Design Task 3: Puck Tracker

**Lead Developer: David Eelman**

o Design specification and methodology/process

o Assessment 1 and Assessment 2

o Requirement of new knowledge and skill, if any

o Requirement of tools and resources

o Risks and risk management plan

# Design Task 4: User Interface

**Lead Developer: David Eelman**

o Design specification and methodology/process

o Assessment 1 and Assessment 2

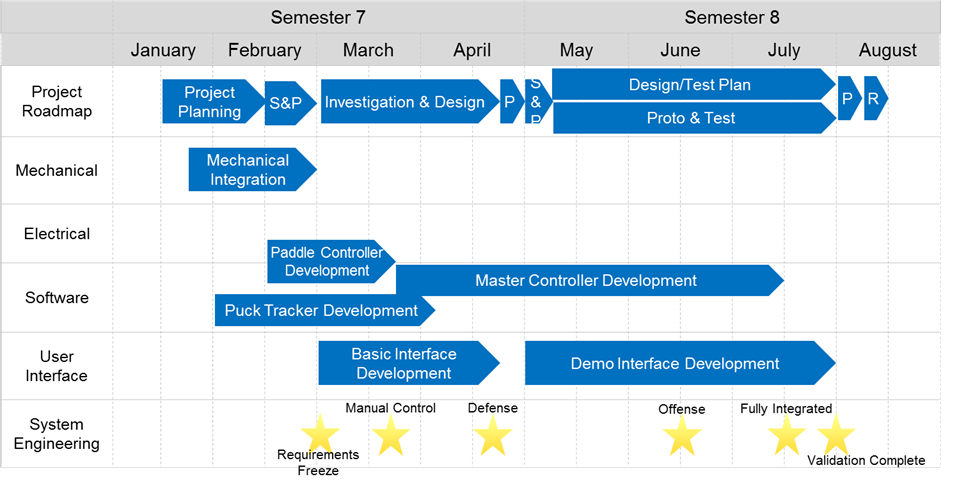
o Requirement of new knowledge and skill, if any

o Requirement of tools and resources

o Risks and risk management plan

# Project Schedule

ToDo: Detailed Gantt chart



(Gantt chart or equivalent)

Modularity is expected in your system development work. It is expected that each group member will work on individual component separately as long as it makes sense, and tests each module separately to ensure that the module works properly. At one point two or more components/modules are to be integrated. This process will continue until final complete integrated system is developed. The schedule should give a timeline of this process.

Group should identify the most complex, challenging and/or uncertain part first and start working on it as early as possible. Research, prototype & experiment, simulate, acquire knowledge/skill, and also ask for help, as needed, in order to reduce risk.

Some procurement and out-sourcing task may cause delay. You should send orders out as early as possible. Also, plan your work in such a way that you don’t need to sit idle until ordered resources are available.

In the first week of Part 2 (semester 8) you will revise this document based on your project status and risk at that time, and use it for the remaining part of the project.

# Appendix A - Risk Charter

|  |  |  |  |
| --- | --- | --- | --- |
| Risk (Priority Highest to Lowest) | Category | Impact on Project Objectives | Potential Risk Reduction |
| 1. Mechanical design/integration problems | Technical | Unable to control robot motion | -Start mechanical prototyping early  -Leverage group members Mechanical Engineering experience |
| 2. Real-time object tracking problems | Technical | Unable to automate robot motion | -Start object tracking prototyping early  -Leverage proven open-source object tracking solutions |
| 3. Security of project in shared classroom | External | Lack of lab workspace availability.  Potential damage to project hardware. | -Utilize dedicated ESE lab space  -Advocate for continued support of ESE dedicated lab space |
| 4. Catastrophic loss of data | Organizational, external, technical | Schedule delays. | -Utilize source control for all project materials  -Manually back up all data once per week |
| 5. Managing scope creep | Organizational, project management | Schedule delays.  Lack of focus on core features. | -Strictly define scope of project during planning phase  -Additional features shall only be implemented after 100% completion of core project features |
| 6. System sizing incorrect | Technical, performance | Lower than desired system performance. | -Use system level performance requirements to drive component design  -Define system level performance requirements based on real-world data |
| 7. Inexperience with HMI design & implementation | Technical | Less relatable demonstration.  Worse user experience.  Difficult to debug. | -Define user interface features early (see: Managing scope creep)  -Start HMI prototyping early  -Utilize popular GUI implementation solutions |