Department of Computer Science & Engineering
The University of Texas at Arlington

Architectural Design Specification
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Ganbare
Duck Hunt

Alexander Olmedo
Duy Nguyen
Jack Gervasi
Justin Geisen
Lam Do

REVISION HISTORY

Revision	Date	Author(s)	Description
0.1	4.19.2023	JuG, LD	document creation & near completion
0.2	4.25.2023	JuG, LD	proofed and finished
1.0	8.08.2023	AO, DN, JaG, JuG, LD	official release

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1 Introduction

The product will consist of a Mitsubishi robot arm playing a point and shoot game that requires it to identify a target and engage the target. The product will make use of machine learning using OpenCV to identify the target. The robot arm will be able to move towards the target and engage it after the target is identified. This product will be able to keep the audience engaged by allowing an audience member to play against the robot arm in a multiplayer setting. The purpose of the product is to encourage curiosity in engineering majors at UTA in an engaging way.

2 System Overview

The Wii U will give each frame to an HDMI splitter which forwards the frames over to a television and a Pi. The Pi will process the image then tell the robot arm to move to the target. When the target is aligned, the PLC will tell the PI. Once the PI knows that they are in position, it will tell the Wii remote to pull the trigger.

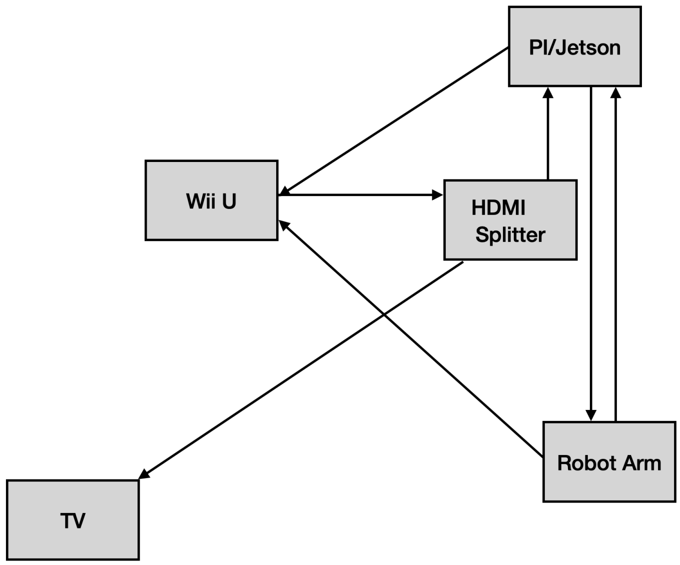

Figure 1: A simple architectural layer diagram

2.1 Wii U

The Wii controller will transmit the trigger button data and pointer position to the IR. The IR transmits the controller data to the Wii U console. The Wii controller with a screen that is held by the audience member will transmit the data to the 2878D-MICA2 module in the Wii console though either bluetooth or wifi communication.

2.2 Robot

The robot consists of the physical robot arm, the programmable logic controller (PLC), the power supply, and the desktop computer. The power supply directly provides power to the PLC. The PLC sends and receives data from the physical robot arm, the desktop computer, and the Pi.

2.3 HDMI Splitter

The HDMI splitter duplicates the signals received from the Wii U to three different HDMI output ports. Only 2 of 3 output ports are used. The duplicated HDMI data is forwarded to the television and PI/Jetson.

2.4 PI/Jetson

The PI analyzes frames received from HDMI splitter and will shift the robot arm and pull the trigger according to the frame input and robot arm feedback.

2.5 TV

The TV displays the game and information received from HDMI splitter to the audience.

3 Subsystem Definitions & Data Flow

The figure below displays how different components of the system interact with each other in more detail. The WiiU consists of the Wii controller held by the robot, the Wii controller with a screen held by an audience member, the console, and the IR sensor. The console will provide data to the HDMI splitter so that data can be distributed to the Pi/Jetson and the TV. Then, the Pi/Jetson will communicate with the robot, which consists of the PLC, the desktop computer, the power supply, and the physical robot arm. The PLC will provide instructions to the physical robot arm to move, which will move the Wii controller held by the robot. The Wii controller held by the robot will make use of the IR sensor to engage with the target on the console.

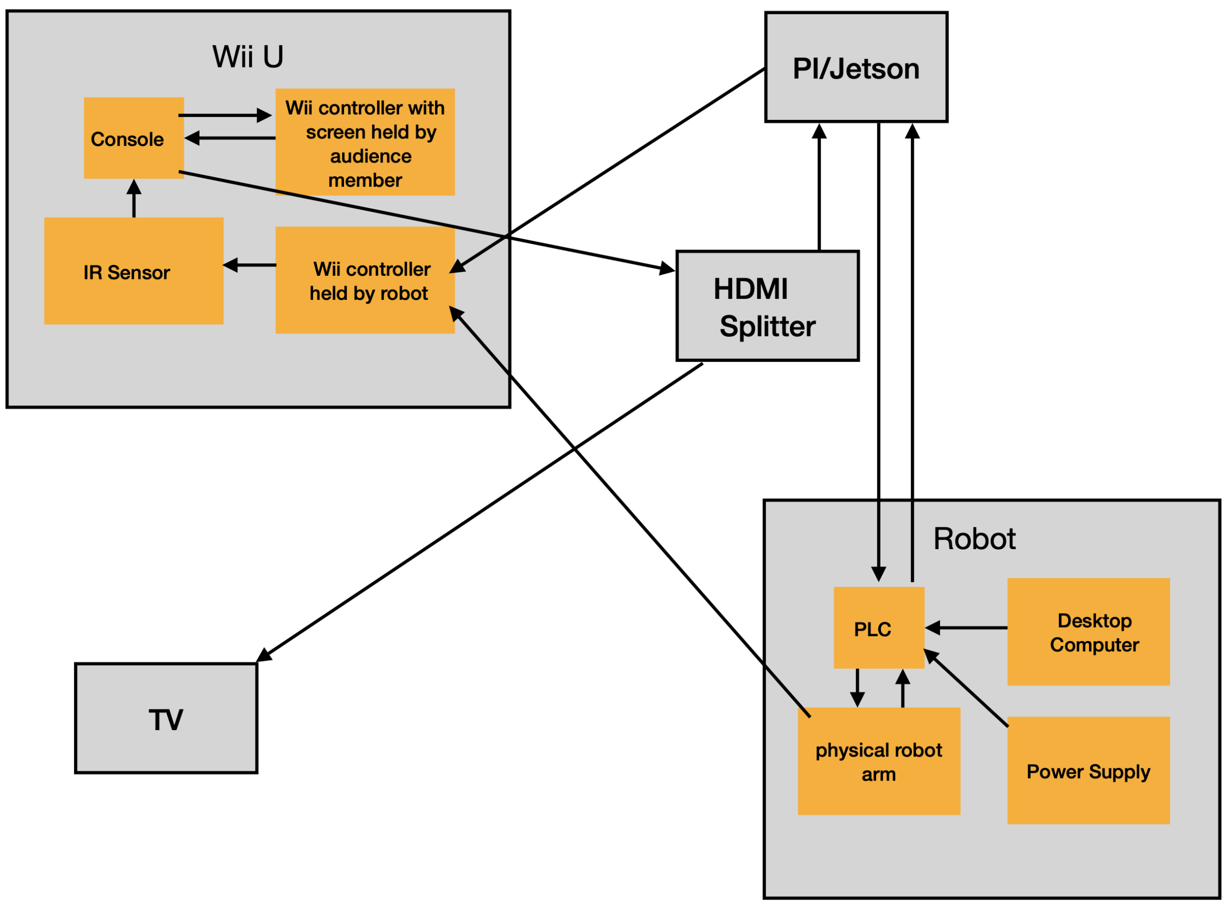

Figure 2: A simple data flow diagram

4 Wii U

This layer will be generating data to be displayed on the television screen and the Raspberry PI. The Robot layer and PI subsystem will be controlling one of the Wii controllers which will affect the game.

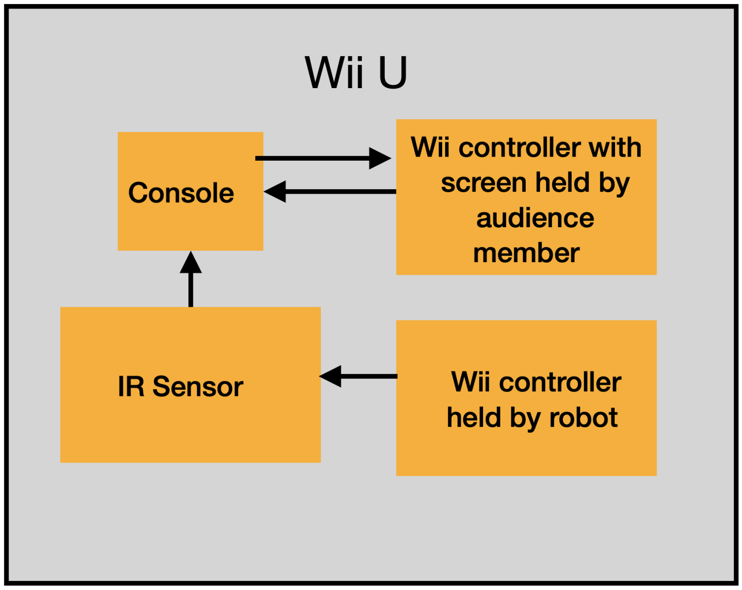

Figure 3: Subsystems in Wii U layer

4.1 Wii Controller held by robot

The Robot layer and PI subsystem will be controlling one of the Wii controllers which will affect the input data into IR sensor.

4.1.1 Assumptions

1. The Wii remote is functional and works as intended by the manufacturer. We are assuming that there is no IR interference with the Wii remote being held by the robot and the IR sensor.
2. The Wii controller can be safely taken apart and able to have new connections soldered onto it for the PI to control it.

4.1.2 Responsibilities

The Wii remote will accurately point and properly shoot IR beams for the IR sensor to read. The remote will allow the robot to point and shoot at the television.

4.1.3 Subsystem Interfaces

The PI and robot arm will be controlling the remote while the remote will be transmitting the information to the IR sensor.

Table 2: Wii Controller Held by Robot

ID	Description	Inputs	Outputs
#0	Wii Remote	Robot Arm PI	infrared signals to IR sensor

4.2 IR Sensor

Received IR data from remote and transmits it to the console.

4.2.1 Assumptions

1. The IR sensor will be functional.
2. There will be small or no IR interference.

4.2.2 Responsibilities

The IR sensor will properly read IR data and transmit it to console.

4.2.3 Subsystem Interfaces

IR sensor will receive IR from Wii remote held by robot and transmit via electrical wire to Wii console.

Table 3: IR Sensor

ID	Description	Inputs	Outputs
#1	IR Sensor	Wii Remote held by robot	electrical cable to console

4.3 Wii Console

Receives data from IR sensor, processes it, then sends HDMI display to HDMI splitter.

4.3.1 Assumptions

1. The Wii console will be functional.

4.3.2 Responsibilities

The console will accurately interpret the IR data from the IR sensor.

4.3.3 Subsystem Interfaces

Will receive controller data from IR sensor (cursor location and button presses). Send output data to HDMI splitter.

Table 4: Wii Console

ID	Description	Inputs	Outputs
#2	Wii Console	IR sensor	HDMI frames to splitter

4.4 Wii Controller with screen held by audience

The Wii controller will transmit the trigger button data and pointer position to the IR. The IR transmits the controller data via bluetooth or wifi to the 2878D-MICA2 module in the Wii U console.

4.4.1 Assumptions

1. The audience member does not break it.
2. The glass will not largely affect transmission from controller to console.

4.4.2 Responsibilities

Properly communicate to the console. Have fast responsiveness when screen is pressed to reduce latency for video game.

4.4.3 Subsystem Interfaces

The PI and robot arm will be controlling the remote while the remote will be transmitting the information to the IR sensor. Ensure that screen receives updated frames from Wii console.

Table 5: Wii Controller with Screen Held by Audience

ID	Description	Inputs	Outputs
#3	Wii Remote	Audience Interaction	Bluetooth or wifi signals to console

5 Robot

The robot consists of the physical robot arm, the programmable logic controller (PLC), the power supply, and the desktop computer. The power supply directly provides power to the PLC. The PLC sends and receives data from the physical robot arm, the desktop computer, and the Pi.

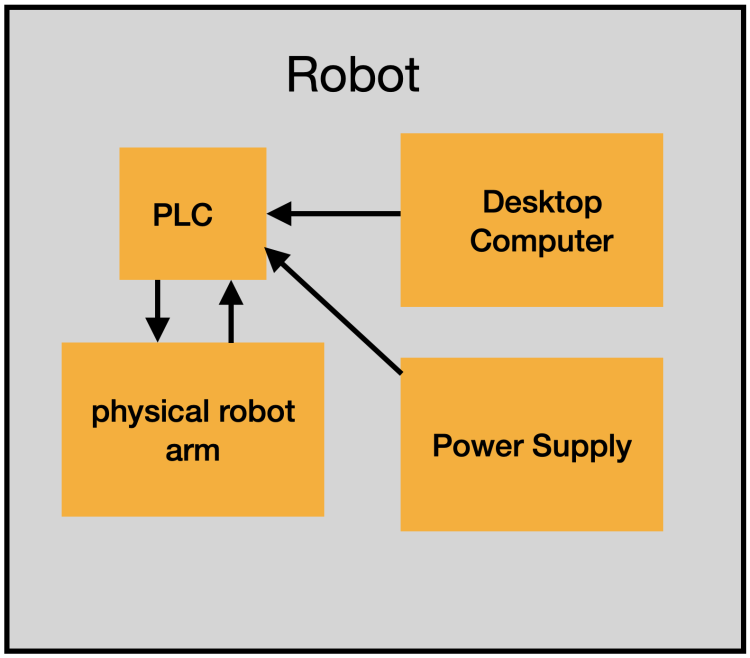

Figure 4: Subsystems in Robot layer

5.1 Power Supply

The power supply provides power to the PLC which allows the PLC to interact with other major components of the system.

5.1.1 Assumptions

The power supply should be functional and it should be compatible with the system. The power supply should also supply the proper amount of power to the system.

5.1.2 Responsibilities

The power supply is responsible for continuously supplying power to the PLC to allow the PLC to operate and perform its necessary tasks.

5.1.3 Subsystem Interfaces

Table 6: Power Supply

ID	Description	Inputs	Outputs
#4	Power Supply-PLC Interface	N/A	Provides power to the PLC

5.2 PLC

The PLC sends and receives data from the physical robot arm, the desktop computer, and the Pi.

5.2.1 Assumptions

The PLC is properly powered by the power supply and should be functional. There should be enough connections available to used while running the system.

5.2.2 Responsibilities

The PLC is responsible for receiving input from key components pertaining to the movement of the robot arm. It is also responsible for providing data to these components as feedback for the data it received.

5.2.3 Subsystem Interfaces

Table 7: PLC

ID	Description	Inputs	Outputs
#5	PLC-Robot Arm Interface	Availability of robot arm to receive instructions	Instructions to move robot arm
#6	PLC-Desktop Interface	Program from desktop	Instructions to move robot arm
#7	PLC-Pi Interface	Data of game state	Feedback to Pi

5.3 Physical Robot Arm

The physical robot arm moves towards the target based on data received from the PLC.

5.3.1 Assumptions

The physical robot arm should be functional and capable of moving to the necessary location. There should be no one near the robot arm while it is moving.

5.3.2 Responsibilities

The physical robot arm is responsible for moving to the necessary location to engage with the target.

5.3.3 Subsystem Interfaces

Table 8: Physical Robot Arm

ID	Description	Inputs	Outputs
#8	PLC-Robot Arm Interface	Instructions from PLC	Movement of the robot arm

5.4 Desktop Computer

The desktop computer sends the program to the PLC.

5.4.1 Assumptions

The desktop computer holds the data for the program that will be sent to the PLC.

5.4.2 Responsibilities

The desktop computer is responsible for sending the program data to the PLC so that the PLC can interact with other major components of the system.

5.4.3 Subsystem Interfaces

Table 9: Desktop Computer

ID	Description	Inputs	Outputs
#9	PLC-Desktop Interface	N/A	Program data to the PLC