Department of Computer Science & Engineering
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Architectural Design Specification
CSE 4316: Senior Design I
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Senior Design Bois
MetaGlass

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Revision History

Revision	Date	Author(s)	Description
0.1	12.05.2021	LN,TN,ZM,NP	document creation
0.2	12.05.2021	LN, TN	complete Introduction, Diagrams, Subsystem Definitions & Data Flow
0.3	10.12.2015	AT, GH	release candidate 1
1.0	10.20.2015	AT, GH, CB	official release
1.1	10.31.2015	AL	added design review requests

Contents

List of Figures

List of Tables

1 Introduction

The system has three layers: Input, Processing, and Output. The Input layer captures signals using capacitive touches, converts signals to data and send them to the Input controller. The Input controller communicates with the Processing layer by transmitting data to the Central Processing Unit (CPU). After receiving data, the CPU starts communicating with the software (games) by performing some data handling procedures. The CPU will convert data to signals after exchanging data with software before transmitting data to the Output layer. The Output controller in the Output layer receives signals from the CPU and send them to LED to display the software.

2 System Overview

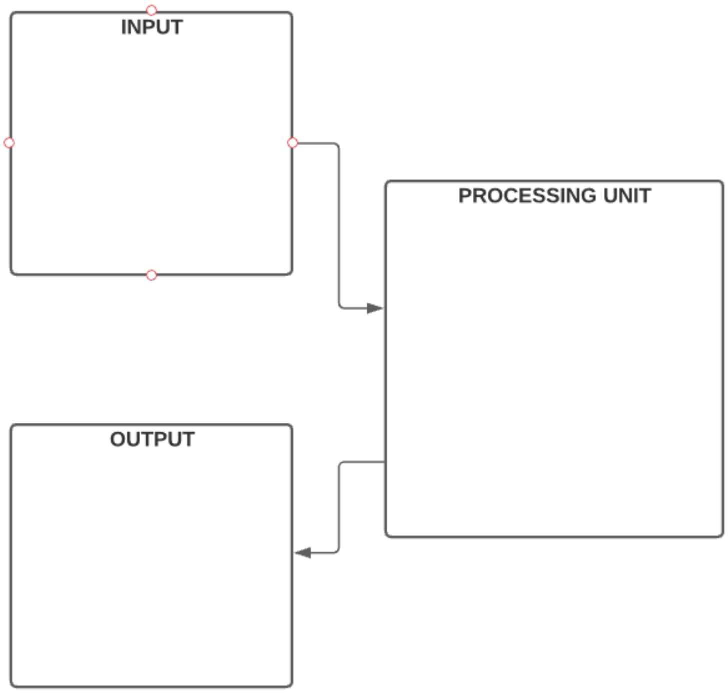

Figure 1: A simple architectural layer diagram

2.1 Processing Layer

The processing layer will control all processes and data flow, such as user inputs, LED outputs by using the TM4C123GH6PM micro-controller. The micro-controller will be sending and receiving data via I2C protocol. The micro-controller will also be controlling the games that are supported by the system.

2.2 Input Layer

The input layer is responsible for retrieving physical input sensed on the glass surface. This layer will transmit data into the processing layer for further logic manipulation. Each subsystem's labels are named according to their function. Each subsystem is defined by functionality.

2.3 Output Layer

The output layer is responsible for displaying on the game content on the glass surface. This layer will receive data from processing layer and translates into instructions to control the LED Strips in order to display on the glass surface. The description should clearly define the services that the layer provides.Each subsystem's labels are named according to their function. Each subsystem is defined by functionality.

3 SUBSYSTEM DEFINITIONS & DATA FLOW

The operation starts by the user touching the LED display. Capacitive touches will capture signals and send them to the Input controller at the Input layer, then the Input controller transmits signals the Processing Unit to process data. After receiving data, the Central Processing Unit (CPU) at the Processing layer communicates with the software (games) to perform some data handling in between, and then the CPU sends data to the Output layer. After getting data, the Output layer converts data into signals and display on the LED.

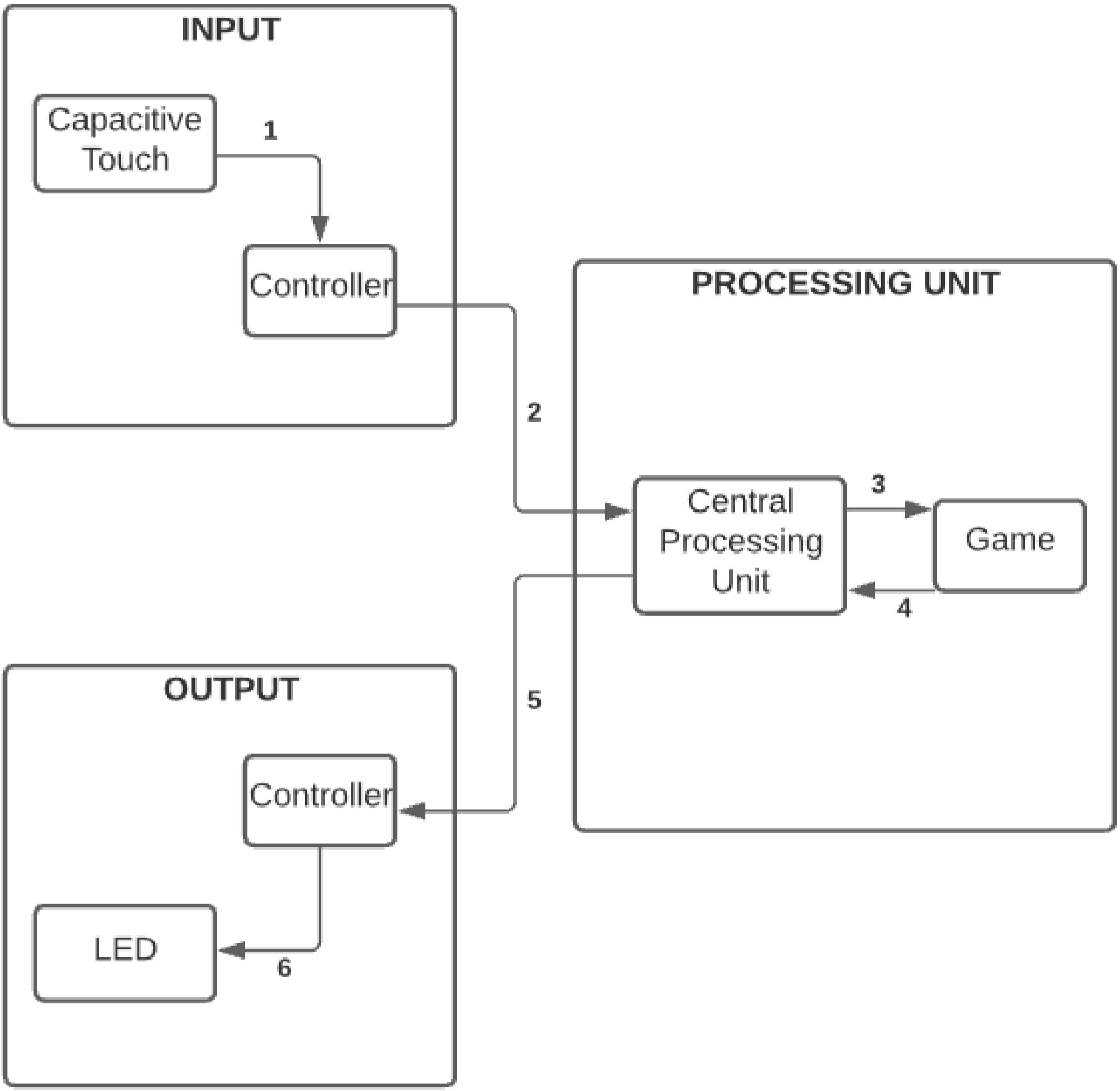

Figure 2: A simple data flow diagram

4 Processing Layer Subsystems

The processing layer will control all processes and data flow, such as user inputs, LED outputs by using the Tiva TM4C123GH6PM micro-controller.

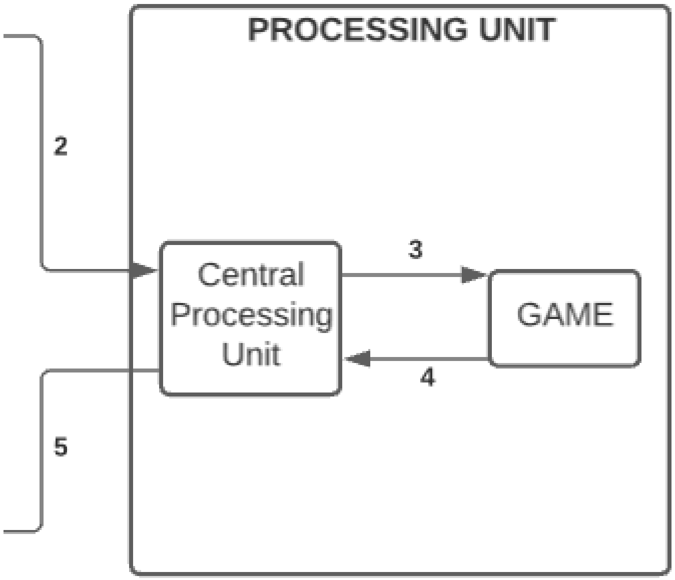

Figure 3: Processing Layer Diagram

4.1 Central Processing Unit

The I2C protocol is a serial communication bus that only uses a two wire protocol: a data line and a clock line. I2C is synchronous, so that output of the bits are synchronized to the sampling bits by a clock signal. Both the master and slave devices are run on the same clock.

4.1.1 Assumptions

Assumptions include: Two-Wire Protocol, all data is sent bit by bit across one wire. The Master Device always controls clock signal.

4.1.2 Responsibilities

I2C is responsible for all data communication between devices. If the I2C protocol fails in anyway then, the proper data will never be sent out to all connected sensors to the system. This will in turn cause the system to fail.

4.1.3 Subsystem Interfaces

Table 2: Subsystem interfaces: Central Processing Unit

ID	Description	Inputs	Outputs
#1	Data Line	Device/Register Addresses	Acknowledges from slave devices
#2	Clock Line	N/A	Clock Frequency

4.2 Game

The game will be based off of user input and will send out random patterns that the user must try and imitate in order to proceed to the next level.

4.2.1 Assumptions

Game subsystem will load instructions that will be sent to the output layer in order to be displayed. In addition, controller should have already made a decision on what game to be played.

4.2.2 Responsibilities

The game is the functionality/interactivity of the system. The game must be enjoyable for the user. Without the game there is no system.

4.2.3 Subsystem Interfaces

Table 3: Subsystem interfaces: Game

ID	Description	Inputs	Outputs
#1	Game Program	User will mimic the pattern displayed on the glass by touch	LEDs will display patterns
#2	Glass	N/A	Used as the interface and main display for the user

5 Input Layer Subsystems

The input layer manages the physical input of the overall system. It decides what happens when a person touches the glass surface / interface.

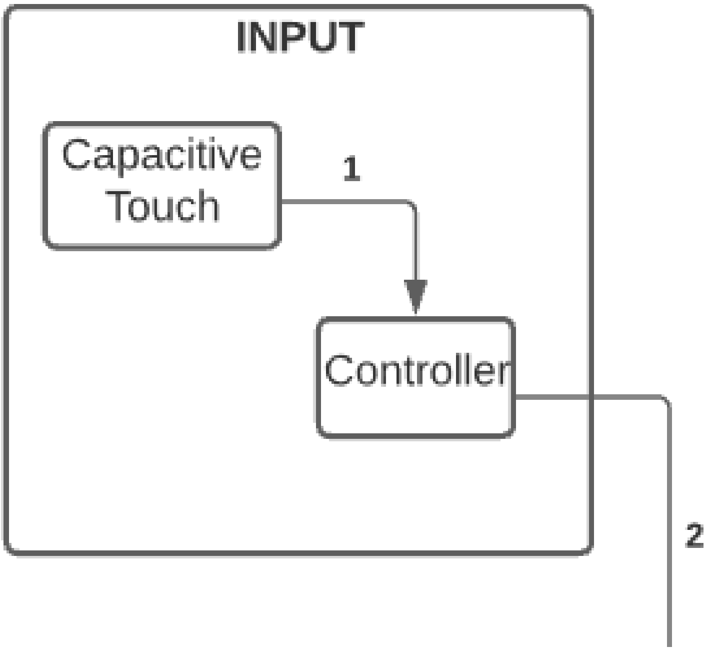

Figure 4: Going from touch to digital data output

5.1 Capacitive Touch

This component represents all the capacitive touch areas on the glass surface. Touching these individual glass areas sends data to the capacitive touch controller. Physically, this is the indium tin oxide film that is connected to a controller.

5.1.1 Assumptions

The capacitive touch subsystem expects to consistently output signals to the controller. It does not have high latency, and is able to send signals to the controller consistently and stably. The only input for this subsystem should be physical human touch.

5.1.2 Responsibilities

The main responsibility of the capacitive touch subsystem is to capture physical touch input into electrical signals.

5.1.3 Subsystem Interfaces

Table 4: Subsystem interfaces: Capacitive Touch

ID	Description	Inputs	Outputs
#01	Wire / ITO Film	human touch	electric signals

5.2 Controller

This component represents the main output of the layer. It will receive electric signals and output usable data for other layers. Physically, it is a controller that enables capacitive touch sensing on the indium tin oxide film.

5.2.1 Assumptions

The controller must consistently receive data from the capacative touch subsystem. The controller must be able to communicate to the processing layer. The controller does not receive input.

5.2.2 Responsibilities

The main responsibility of the capacitive touch subsystem is to convert physical inputs and interactions into digital signals. Here, these digital signals are processed for the processing layer to use as data for the game.

5.2.3 Subsystem Interfaces

Table 5: Subsystem interfaces: Touch Controller

ID	Description	Inputs	Outputs
#01	CAP1188 Sensor / Controller	wire	touch data

6 Output Layer Subsystems

Output layer handles the physical output of the overall system.Based on the instructions received from the controller from the processing layer, it will decide what to display on our glass.

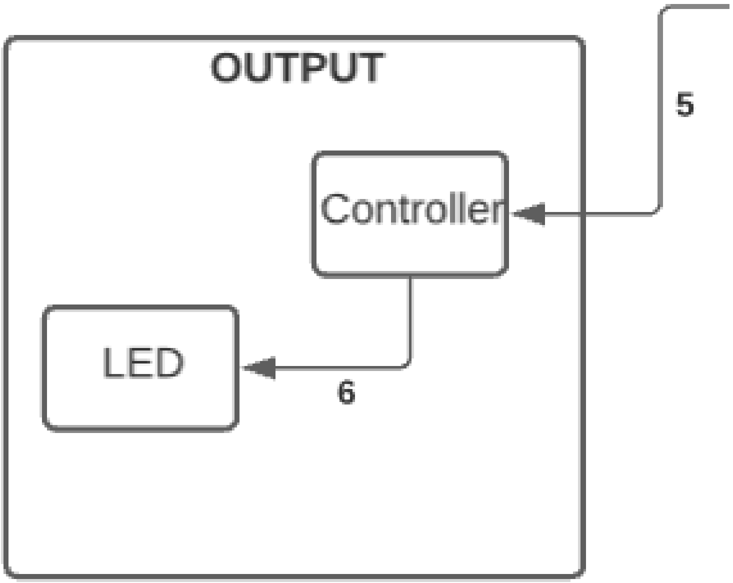

Figure 5: Output Layer Diagram

6.1 Controller

This component represents the main output of the layer. It will receive electric signals and output usable data for other layers. Physically, it is a micro-controller that enables LEDs to enable to display output on the glass surface.

6.1.1 Assumptions

The controller must consistently received data from processing subsystem. Based on this data, it should make a decision in real-time and be able to communicate to the LEDs on the frame to turn on/off and determine brightness of each LED.

6.1.2 Responsibilities

The main responsibility of the controller subsystem is to convert the data received from the processing layer and translate into LED output on the glass display.

6.1.3 Subsystem Interfaces

Table 6: Subsystem interfaces: Light Controller

ID	Description	Inputs	Outputs
#01	Tiva T4C123GH6PM	processing layer game data	instructions to LED Unit

6.2 LED Unit

This component represents all the LED areas on the glass surface. Each individual area of the glass can display a light and color specified. Physically, it a LED strip that runs along the frame of the glass that displays the light across the glass surface.

6.2.1 Assumptions

The LED must consistently received instructions from micro-controller. Based on this data, it should make a decision in real-time and to turn on/off and change brightness.

6.2.2 Responsibilities

The main responsibility of the controller subsystem is to convert the data received from the processing layer and translate into LED output on the glass display.

6.2.3 Subsystem Interfaces

Table 7: Subsystem interfaces: LED Unit

ID	Description	Inputs	Outputs
#01	LED Strips	data from controller	light display on glass surface

References