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Deliverable D

Prototype 1, Project Progress Presentation, Peer Feedback and Team Dynamics

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1. Introduction

In order to achieve our project design, a first of three prototyping tests will be carried out to evaluate the performance and potential weaknesses of our concept. The prototype will be tested and planned through a pre-developed test plan. In addition, feedback and comments on the prototype will be collected from our upcoming client meeting as well as from potential users or customers of the final product.

2. Testing metrics

We will be testing the following metrics for our first prototype :

- Input lag ⇒ <12ms
- Clock rate ⇒ fully working
- Power delivery ⇒ works for shift registers
- Shift register functionality ⇒ all pins work
- 3D Print time ⇒ enough time to print during a makerspace session (<6 hours)

3. Prototype choice

We chose to make a medium fidelity physical prototype of the game controller to test the metrics outlined above. It consists of a breadboard, with a shift register on it and eight buttons, a joystick, and they are all connected to an Arduino Leonardo with Xinput which itself is connected through USB to a computer. We programmed a code that receives the signal from the buttons we press and input from the joystick and sends those signals to the system device.
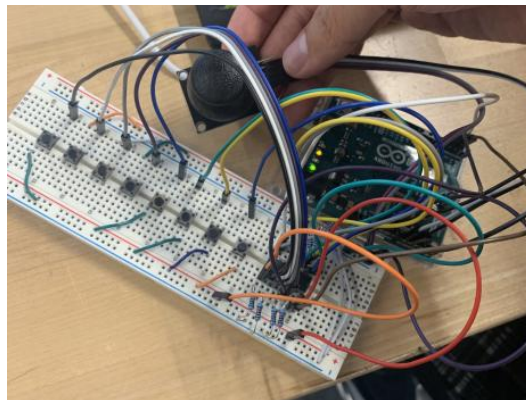

Fig. 1 - Preliminary circuit, joystick and arduino

```
#include <XInput.h>

//Digital Pin Defintions
#define ioSelect 2
#define clockPulse 3
#define dataIn 4
```

```cpp
#define Vx A0 // Define / Equate "Vx" with A0, the pin where Vx is
connected
#define Vy A1 // Define / Equate "Vy" with A1, the pin where Vy is
connected
int x, y;
byte inputButtons[8];

// Analog Input Range
const int AnalogRead_Max = 1023;  // 10-bit ADC

void setup() {
  //Start Xinput Protocal
   XInput.begin();
  //Set Pin Modes For Button Inputs
  pinMode(ioSelect, OUTPUT);
  pinMode(clockPulse, OUTPUT);
  pinMode(dataIn, INPUT);
  XInput.setRange(JOY_LEFT, 0, 1023);



};

void loop() {
  int joystickValueX = analogRead(Vx);
  int joystickValueY = analogRead(Vy);
  XInput.setJoystick(JOY_LEFT, joystickValueX, joystickValueY);  // move
x, leave y centered



  readButtonInputs();
  setButtonstate();
  delay(1);

};

void readButtonInputs(){

  //enable parallel input
  digitalWrite(ioSelect, 0);
```

```
//start clock pin low
digitalWrite(clockPulse, 0);

//set clock pin high (load data into SR)
digitalWrite(clockPulse, 1);

//enable serial output
digitalWrite(ioSelect, 1);


for(int i = 0; i < 8; i++){
  //set value of input to the array
  inputButtons[i] = digitalRead(dataIn);


  //load next bit (pulse clock)
  digitalWrite(clockPulse, LOW);
  digitalWrite(clockPulse, HIGH);
};

};
void setButtonstate(){
  for (int i=0; i < 8; i++){
    if (i==0){
      XInput.setButton(8, inputButtons[i]);

    }
    else {
    XInput.setButton(i, inputButtons[i]);
    }

  }
}
```

Fig. 2 - Prototype 1 Arduino Code

We also made a low fidelity test print for our joystick. It is smaller than the actual joystick design we are going for, and we are not using very refined nozzle sizes (0.6 and 0.4 mm) or printing techniques, but it gives us a rough estimate of the print time.

Fig. 3 - Test Print Joystick

4. Test selection

We chose four tests that should bring clarification and answers to our critical assumptions. The first 3 were for the controller itself, and the fourth was just to test the 3D printer. First, we chose an input lag test called "Xbox 360 Controller (XInput) Polling Rate Checker". This software requires the user to constantly rotate the left stick, then it measures the delay between requests to the Xinput controller. This is the actual lag felt by any game. Next, we used a website called Gamepad tester to make sure that all the buttons register when using the PISO Shift Registers. The last test for the controller itself, was to play Super Mario Bros using the controller, to see if we could actually perceive any lag. We also did a 3D print test for a smaller version of the joystick we want to print.

5. Results and analysis

Test	Expected Value	Actual Value
Input Lag Test	<12 milliseconds	9.3086 milliseconds
Gamepad Tester	All 13 Buttons Working	All 13 Buttons Working
SMB Play Test	No Perceived Lag	No Perceived Lag

When we did the Input lag test, we were hoping the input lag would be less than 12 milliseconds. Fortunately, we measured just over 9 milliseconds with our converter, which is required to do the test. We also compared this with 3 versions starting with an Xbox Elite 2 controller, then Bluetooth USB and USB with converter. The results we got were reasonable at

15.2 ms, 8.27 ms, and 9.11 ms respectively. This means that the converter adds an estimated 2 milliseconds. This means that our controller is on par with an actual Xbox Elite 2 controller. When running the gamepad tester, we switched around the pins on the Shift registers, to check that all the buttons would function. The results were satisfying, as it passed all the tests, meaning all 13 buttons showed up. We also played Super Mario Bros, and the lag was not perceivable.

We designed the joystick with a 3D design application and uploaded it to the Ultimaker Cura software; where we have to set the printing option and speed. Because we decided to have a low fidelity prototype for this part, we chose the 8 mm 3D print so that the precision is not that significant. Finally, it took us 19 min to 3D print the joystick, and to improve this result and the print time, we are planning to use three 3D print machines for each joystick and then reduce the millimeter to 4 mm for the precision. That being said, we estimated 30 min for the design time of the final joystick then 1 hour and 30 min to 3D print all of them.

6. <u>Preparation for upcoming client meeting</u>

For our next client meeting with Chris Aube, we intend to present the medium fidelity prototype we made for this deliverable, along with showing him the button choices we made. We also plan on showing him different joystick style designs and asking him which one he prefers and which one would suit his limited mobility most. The information we hope to collect is any feedback or comments or ideas that Chris would want us to add.
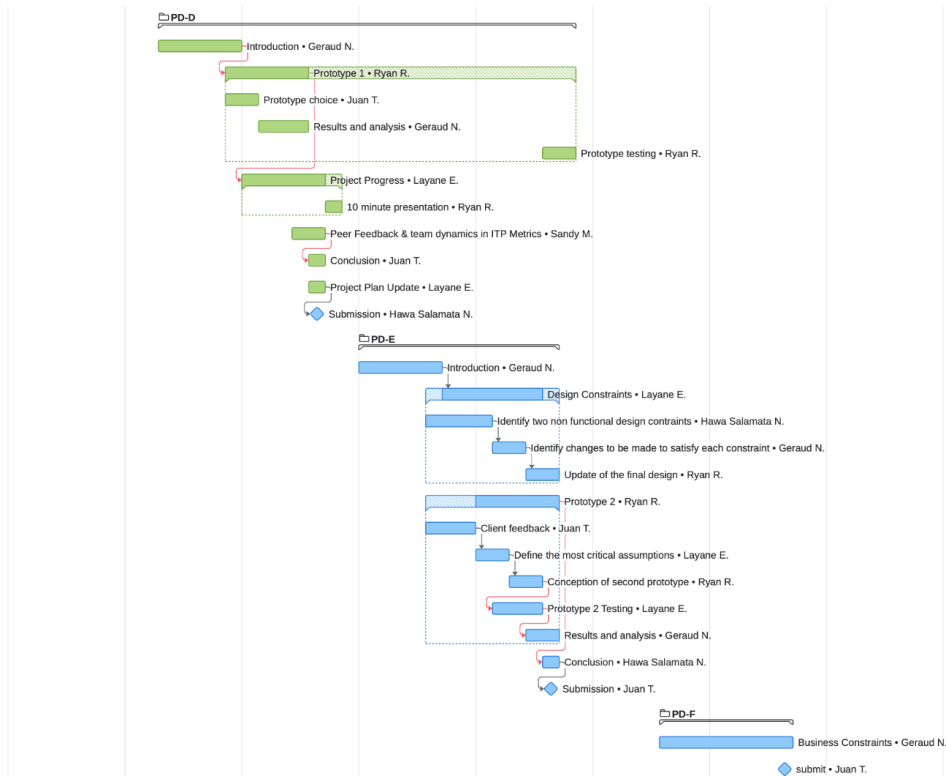
7. <u>Conclusion</u>

Our first prototyping test achieved suitable results, but plenty of improvements remain to be done. We concluded that the testing metrics outlined above were completed, however the ease of use and data processing formulas of our prototype need to be refined to achieve better product performance. These results will be used in the second prototyping trial, as described in our project plan. To that end, we will test the buttons of our controller and how efficient the switch mode works, as well as carry out some tests for the shell of our controller, meaning the conception of our box.

B.1 References

[1] Input test portable   (*visited on 04/06/2023*)
[2] https://canasstech.com/products/ultra-joystick (*visited on 06/06/2023*)
[3] https://assets.nexperia.com/documents/data-sheet/74HC_HCT166.pdf (*visited on 07/06/2023*)

B.2 Project Plan Update

Snapshot :
https://www.wrike.com/frontend/ganttchart/index.html?snapshotId=iCYSG7rmMJ9UOkn041N5
JAJ7UxxEsGLI%7CIE2DSNZVHA2DELSTGIYA

B.3 Slide Show

🟧 GNG2101 Progress Presentation