DAFTAR PUSTAKA

[1] M.S.V Appaji, "*An 8051Microcontroller Based Syringe Pump Control System For Surface Micromachining"* School of Mechanical Engineering SASTRA University, Tirumalaisamudram, Thanjavur, Tamilnadu, 2014.

[2]John R. Lake *"Low-cost feedback-controlled syringe pressure pumps for microfluidics applications",*Department of Bioengineering, University of Pittsburgh, Pittsburgh, PA, United States of America,2017.

[3]Kian Sek, "*Development of a Mechatronic Syringe Pump to Control Fluid Flow in a Microfluidic Device Based on Polyimide Film"*Biosensor and Bioengineering Laboratory, MiNT-SRC, Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Johor, Malaysia.

[4]Adam Polák, *"Design and Fabrication of Controllable Syringe Pumps for Microfluidics"*Faculty of Electrical Engineering Katedra řídicí technik, 2017.

[5] Syahrul, " *MOTOR STEPPER: TEKNOLOGI, METODA DAN RANGKAIAN KONTROL*" Jurusan Teknik Komputer , Universitas Komputer Indonesia, Bandung.

[6] Hari Santoso, " *Panduan Praktis Arduino Untuk Pemula* ", Trenggalek, 2015.

[7] Deni Dwi Yudhistira, dkk, " *PENGENALAN MIKROKONTROLER ARDUINO UNO"* Teknik Sipil dan Lingkungan, Institut Pertanian Bogor, Indonesia.

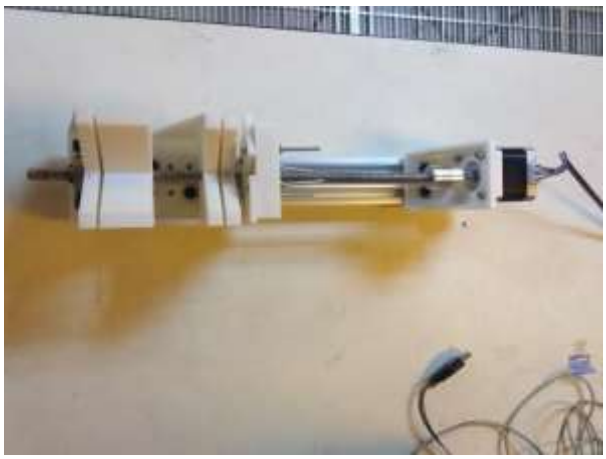
[8] Bas Wijnen, " *Open Source Syringe Pump Library"* Department of Materials Science & Engineering, Michigan Technological University, Houghton, Michigan, United States of America, 2014.

LAMPIRAN

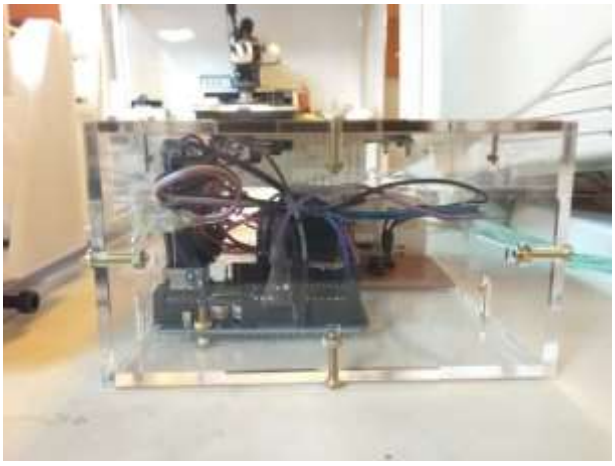
Lampiran 1 Alat dan Bahan

Gambar 1. Jarum Suntik

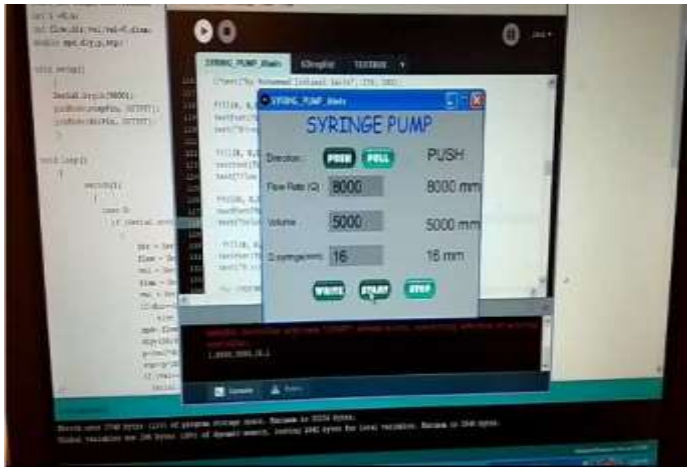
Gambar 2. Fotoresis Positif S1805



Gambar 3. Perangkat *Syringe Pump*



Gambar 4. Box Akrilik Tempat Rangkaian



Gambar 5. Komputer Untuk Pemrograman GUI

Lampiran 2 Code Program Arduino dan GUI Processing

Berikut code program arduino untuk mengontrol motor stepper dengan direction dan langkah motor :

```
#define phi 3.142857
const int dirPin = 12;
const int stepPin = 13;
const int stepsPerRevolution = 200;
int i =0,u;
int flow,dir,vol,val=0,diam;
double spd,dly,p,stp;

void setup()
   {
   Serial.begin(9600);
   pinMode(stepPin, OUTPUT);
   pinMode(dirPin, OUTPUT);
   }
void loop()
   {
        switch(i)
         {
          case 0:
            if (Serial.available() > 0)
              {
                dir = Serial.parseInt();          // ambil data ke-1
                flow = Serial.parseInt();         // ambil data ke-2:
                vol = Serial.parseInt();        // ambil data ke-3:
                diam = Serial.parseInt();
                val = Serial.parseInt();
                if(dir==1) digitalWrite(dirPin, HIGH);
                   else digitalWrite(dirPin,LOW);
                spd= flow/(2*0.25*phi*diam*diam);
                dly=150/spd;
                p=(vol*4)/(phi*diam*diam);
                stp=(p*200)/2;
                if (val==1) i=1;
              }
            break;
```

```
            case 1:
            for(u=0;u<stp;u++)
               {
                 motor();
                 char val = Serial.read();
                 if (val == 'z')
                     {
                       i=0;
                     }
               }
              i=0;
             break;
          }
   }
void motor()
    {
       digitalWrite(stepPin, HIGH);
       delay(dly);
       digitalWrite(stepPin, LOW);
       delay(dly);
    }
```

IV.1.12 Desain dan program GUI Processing

Berikut Code Program dan tampilan GUI processing yang telah dibuat :

```
ArrayList<TEXTBOX> textboxes = new ArrayList<TEXTBOX>();
//ArrayList<GDropList> gdroplist = new ArrayList<GDropList>();
import controlP5.*;
import g4p_controls.*;
import processing.serial.*;

Serial port;

ControlP5 cp5;
PFont font;
PFont font1;
PImage on;
PImage PUSH;
PImage PUSH2;
PImage PULL;
PImage PULL2;
```

```
PImage start;
PImage stop;
PImage write;
PImage start2;
PImage stop2;
PImage write2;

boolean send = false;
String vol = "";
String flow = "";
String volkir = "";
String flowkir = "";
String diamkir = "";
String dir = "";
String diam = "";
String kirim = "";
int x=0; //direction
int y=0; //flowrate
int z=0; //volume
int m=0;
void setup()
  {
   size(400,300);
   InitLayout();
printArray(Serial.list());
port= new Serial(this, "COM14", 9600);

    on = loadImage("on.png");
    PUSH = loadImage("push.png");
    PUSH2 = loadImage("push2.png");
    PULL = loadImage("pull.png");
    PULL2 = loadImage("pull2.png");
    start = loadImage("start.png");
    stop = loadImage("stop.png");
    write = loadImage("write.png");
    start2 = loadImage("start2.png");
    stop2 = loadImage("stop2.png");
    write2 = loadImage("write2.png");

    cp5 = new ControlP5(this);
    font= createFont("calibri light bold", 15);
```

```
  font1= createFont("Comic Sans MS", 30);

  cp5.addButton("START")
    .setPosition(175,240)
    .setColorBackground(color(0,0,255))
    .setSize(60,30)
    .setImage(start)
    //.setImage(on)
    .setFont(font)
    .setColorForeground(color(0,255,0));

  cp5.addButton("STOP")
    .setPosition(260,240)
    .setSize(60,30)
    .setImage(stop)
    .setColorBackground(color(0,0,255))
    .setColorForeground(color(255,0,0))
    .setFont(font);

  cp5.addButton("WRITE")
    .setPosition(90,240)
    .setSize(60,30)
    .setImage(write)
    .setFont(font);

  cp5.addButton("PUSH")
    .setPosition(110,50)
    .setImage(PUSH)
    .setSize(60,30)
    .setColorBackground(color(0,0,255))
    .setFont(font);
  cp5.addButton("PULL")
    .setPosition(180,50)
    .setImage(PULL)
    .setSize(60,30)
    .setColorBackground(color(0,0,255))
    .setFont(font);
 }
void draw()
 {
  background(180);
```

```
  fill(0, 0,255);
  textFont(font1);
  text("SYRINGE PUMP", 80, 30);

  fill(0, 0,0);
  textFont(font);
  text("Direction :", 10, 70);

  fill(0, 0,0);
  textFont(font);
  text("Q(ml/s) :", 10, 110);

  fill(0, 0,0);
  textFont(font);
  text("Volume(ml):", 10, 160);

   fill(0, 0,0);
  textFont(font);
  text("D.syringe(mm):", 10, 210);

  for (TEXTBOX t : textboxes)
    {
      t.DRAW();
    }

   if(send)
     {
       text(dir, 300,  70);
       text(flow, 300, 115);
       text(vol, 300, 170);
       text(diam, 300, 215);

     }
 }

void InitLayout()
 {
  TEXTBOX volume = new TEXTBOX(120,140,100,30);
  textboxes.add(volume);

  TEXTBOX flowrate = new TEXTBOX(120, 90, 100, 30);
```

```
  textboxes.add(flowrate);

  TEXTBOX diameter = new TEXTBOX(120, 190, 100, 30);
  textboxes.add(diameter);


 }

void mousePressed()
 {
  for (TEXTBOX t : textboxes)
   {
    t.PRESSED(mouseX, mouseY);
   }
 }

void keyPressed()
 {
  for (TEXTBOX t : textboxes)
   {
    if(t.KEYPRESSED(key, keyCode))
      {
       // send = true;
        vol=  textboxes.get(0).Text;
        flow =  textboxes.get(1).Text;
        diam =  textboxes.get(2).Text;

      }
   }
 }
 void WRITE()
 {
  vol = textboxes.get(0).Text + " mm'3";
  flow = textboxes.get(1).Text + " mm'3/s";
  diam = textboxes.get(2).Text + " mm";
  volkir=textboxes.get(0).Text ;
  flowkir=textboxes.get(1).Text ;
  diamkir=textboxes.get(2).Text ;
   m=1;
   if(x==1) y=1;
   else y=0;
```

```
    send = true;
    cp5.addButton("WRITE")
      .setPosition(90,240)
      .setSize(60,30)
      .setImage(write2)
      //.setColorBackground(color(0,0,255))
      //.setColorForeground(color(0,255,0))
      .setFont(font);
      cp5.addButton("STOP")
      .setPosition(260,240)
      .setSize(60,30)
      .setImage(stop)
      .setColorBackground(color(0,0,255))
      .setColorForeground(color(255,0,0))
      .setFont(font);

  }

void PUSH()
  {
    dir= "PUSH";
    x=1;
    send =false;

    cp5.addButton("PUSH")
      .setPosition(110,50)
      .setSize(60,30)
      .setImage(PUSH2)
      .setColorBackground(color(0,255,0))
      .setFont(font);
    cp5.addButton("PULL")
      .setPosition(180,50)
      .setImage(PULL)
      .setSize(60,30)
      .setColorBackground(color(0,0,255))
      .setFont(font);
  }
void PULL()
  {
    dir= "PULL";
    x=0;
```

```
    send =false;

    cp5.addButton("PULL")
      .setPosition(180,50)
      .setImage(PULL2)
      .setSize(60,30)
      .setColorBackground(color(0,255,0))
      .setFont(font);
    cp5.addButton("PUSH")
      .setPosition(110,50)
      .setImage(PUSH)
      .setSize(60,30)
      .setColorBackground(color(0,0,255))
      .setFont(font);
  }
void START()
  {
    cp5.addButton("START")
      .setPosition(175,240)
      .setColorBackground(color(0,0,255))
      .setSize(60,30)
      .setImage(start2)
      //.setImage(on)
      .setFont(font)
      .setColorForeground(color(0,255,0));

    if(send) {kirim =y+","+flowkir+","+volkir+","+diamkir+","+m+"\n";
    println(kirim);
    port.write(kirim);}

  }
void STOP ()
  {
    send =false;
    port.write('z');
     cp5.addButton("STOP")
      .setPosition(260,240)
      .setSize(60,30)
      .setImage(stop2)
      .setColorBackground(color(0,0,255))
      .setColorForeground(color(255,0,0))
```

```
    .setFont(font);

     cp5.addButton("START")
    .setPosition(175,240)
    .setColorBackground(color(0,0,255))
    .setSize(60,30)
    .setImage(start)
    .setFont(font)
    .setColorForeground(color(0,255,0));

     cp5.addButton("WRITE")
    .setPosition(90,240)
    .setSize(60,30)
    .setImage(write)
    .setFont(font);
  }

public class TEXTBOX {
  public int X = 0, Y = 0, H = 35, W = 200;
  public int TEXTSIZE = 24;

  // COLORS
  public color Background = color(140, 140, 140);
  public color Foreground = color(0, 0, 0);
  public color BackgroundSelected = color(160, 160, 160);
  public color Border = color(30, 30, 30);

  public boolean BorderEnable = false;
  public int BorderWeight = 1;

  public String Text = "";
  public int TextLength = 0;

  private boolean selected = false;

  TEXTBOX() {
    // CREATE OBJECT DEFAULT TEXTBOX
  }

  TEXTBOX(int x, int y, int w, int h) {
    X = x; Y = y; W = w; H = h;
```

```
}

void DRAW() {
  if (selected) {
    fill(BackgroundSelected);
  } else {
    fill(Background);
  }

  if (BorderEnable) {
    strokeWeight(BorderWeight);
    stroke(Border);
  } else {
    noStroke();
  }

  rect(X, Y, W, H);

  // DRAWING THE TEXT ITSELF
  fill(Foreground);
  textSize(TEXTSIZE);
  text(Text, X + (textWidth("a") / 2), Y + TEXTSIZE);
}
boolean KEYPRESSED(char KEY, int KEYCODE) {
  if (selected) {
    if (KEYCODE == (int)BACKSPACE) {
      BACKSPACE();
    } else if (KEYCODE == 32) {
      addText(' ');
    } else if (KEYCODE == (int)ENTER) {
      return true;
    } else {
      // CHECK IF THE KEY IS A LETTER OR A NUMBER
      boolean isKeyCapitalLetter = (KEY >= 'A' && KEY <= 'Z');
      boolean isKeySmallLetter = (KEY >= 'a' && KEY <= 'z');
      boolean isKeyNumber = (KEY >= '0' && KEY <= '9');

      if (isKeyCapitalLetter || isKeySmallLetter || isKeyNumber) {
        addText(KEY);
      }
    }
```

```
    }

    return false;
  }

  private void addText(char text) {
    // IF THE TEXT WIDHT IS IN BOUNDARIES OF THE TEXTBOX
    if (textWidth(Text + text) < W) {
      Text += text;
      TextLength++;
    }
  }

  private void BACKSPACE() {
    if (TextLength - 1 >= 0) {
      Text = Text.substring(0, TextLength - 1);
      TextLength--;
    }
  }
  private boolean overBox(int x, int y) {
    if (x >= X && x <= X + W) {
      if (y >= Y && y <= Y + H) {
        return true;
      }
    }

    return false;
  }

  void PRESSED(int x, int y) {
    if (overBox(x, y)) {
      selected = true;
    } else {
      selected = false;
    }
  }
}
```