

# LAMPIRAN

```

#define MIN1A 6
#define MIN2A 7
#define PWMA 10
#define MIN1B 9
#define MIN2B 8
#define PWMB 11

#define pinL1 6
#define pinL2 7
#define pwmL 10
#define pinR1 9
#define pinR2 8
#define pwmR 11
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
#define TBL1 12
#define TBL2 13
#define TBL3 3
// #define LED1 12
// #define LED2 13
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
float Error, ErrorD, ErrorI, le;
int time_delay;
int Read, SetRead, out;
float sudut, delta, delta_pot, nilai;
float potensio = 0;
float rule_1, rule_2, rule_3, rule_4, rule_5;
float rule_6, rule_7, rule_8, rule_9, rule_10;
float rule_11, rule_12, rule_13, rule_14, rule_15;
float R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15;
float
MBJSC1, MBJSC2, MBJC1, MBJC2, MBJS1, MBJS2, MH1, MH2, MH3, MSJSC1, MSJSC2, MSJC1, MSJ
C2, MSJS1, MSJS2;
float MA, MB, MC, MD, ME, MF, MG, MH, MI, MJ, MK, ML, MN, MO, MP, ABC, Defuzzifikasi;
int kondisi;
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
int kp = 0.5, kd = 0.8, ki = 1.8;
int Read1, SetRead1, out1;
float Error1, ErrorD1, ErrorI1, le1;
float p, d, i;

void setup()
{
  pinMode(TBL1, INPUT_PULLUP);
  pinMode(TBL2, INPUT_PULLUP);
  pinMode(TBL3, INPUT_PULLUP);
  //pinMode(LED1, OUTPUT);
  //pinMode(LED2, OUTPUT);

  Serial.begin(9600);
  pinMode(A0, INPUT);
  sudut_kiri(sudut);
  sudut_agak_kiri(sudut);
  sudut_tengah(sudut);
  sudut_kanan(sudut);
  sudut_agak_kanan(sudut);
  delta_left(delta);
  delta_right(delta);
  delta_center(delta);
  rule_1=Z1(R1);
  rule_2=Z2(R2);
  rule_3=Z3(R3);

```

```

rule_4=Z4(R4);
rule_5=Z5(R5);
rule_6=Z6(R6);
rule_7=Z7(R7);
rule_8=Z8(R8);
rule_9=Z9(R9);
rule_10=Z10(R10);
rule_11=Z11(R11);
rule_12=Z12(R12);
rule_13=Z13(R13);
rule_14=Z14(R14);
rule_15=Z15(R15);
MA=max1(MBJSC1);
MB=max2(MBJC1);
MC=max3(MSJS1);
MD=max4(MH1);
ME=max5(MH2);
MF=max6(MBJS1);
MG=max7(MSJC1);
MH=max8(MSJSC1);
}
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
void FUZZY(){
  inputan();
  sudut_pot();
  Tampilkan();
  Fuzifikasi();
  Inferensi();
  Proses_Akhir();
  motor1();
}
void PID(){
  Read1 = analogRead(A0);
  SetRead1 = Read1;

  Error1 = (SetRead1 - 511);
  p = kp*Error1;
  ErrorD1 = Error1-le1;
  d = kd*ErrorD1;
  ErrorI1 = ErrorI1+Error1;
  i = ki*ErrorI1;
  le1 = Error1;
  out1 = abs(p+d+i);

  //maju
  if(Error1>0){
    motor(-(Error1+245), (Error1+245));
  }
  else if(Error1==0){
    motor(0,0);
  }
  else if(Error1<0){
    motor(-(Error1-245), (Error1-245));
  }

  Serial.println(Error1);
}
void motor(int L, int R) {
  if (L > 0) {
    analogWrite(pwmL, L);
    digitalWrite(pinL1, 1);
    digitalWrite(pinL2, 0);
  } else if (L < 0) {

```

```

        analogWrite(pwmL, 0 - L);
        digitalWrite(pinL1, 0);
        digitalWrite(pinL2, 1);
    } else {
        digitalWrite(pinL1, 0);
        digitalWrite(pinL2, 0);
    }
}
if (R > 0) {
    analogWrite(pwmR, R);
    digitalWrite(pinR1, 1);
    digitalWrite(pinR2, 0);
} else if (R < 0) {
    analogWrite(pwmR, 0 - R);
    digitalWrite(pinR1, 0);
    digitalWrite(pinR2, 1);
} else {
    digitalWrite(pinR1, 0);
    digitalWrite(pinR2, 0);
}
}
}
void loop()
{
    while (digitalRead(TBL1)==HIGH){FUZZY();
}
    while (digitalRead(TBL2)==HIGH){PID();
}
    while (digitalRead(TBL3)==HIGH){motor(0,0);
}
}
}
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
////////////////////////////////////////////////////////////////Program Rata-Rata Sudut Dan Delta////////////////////////////////////////////////////////////////
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
void sudut_pot()
{
    sudut = Error;
    delta = delta_pot;
    if ( Error > 0) {
        delta_pot=sudut+5;
    }
    else if (Error < 0){
        delta_pot=sudut-5;
    }
    else (0);
}
}
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
////////////////////////////////////////////////////////////////Program Tampilan LCD////////////////////////////////////////////////////////////////
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
void inputan() {
    // put your main code here, to run repeatedly:
    Read = analogRead(A0);
    // SetRead = map(Read, 0, 1023,0 ,255);
    SetRead = Read;
    // if(SetRead<=124){
    //   Error= 10*(SetRead - 512);
    // }
    // else if(SetRead>124 && SetRead<125){
    //   Error = 0;
    // }
    // else if(SetRead>125){
    //   Error = 10*(SetRead - 125);
    // }
    Error = (SetRead - 511);
}

```

```

}
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
void Tampilkan()
{
  Serial.print("Sudut = ");
  Serial.println(sudut);
  Serial.print("Delta = ");
  Serial.println(delta);
  Serial.print("Defuzzifikasi = ");
  Serial.println(Defuzzifikasi);
  delay(100);
}
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//Program Motor
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
void motor1()
{
  if (Defuzzifikasi <0 )
  {
    analogWrite(pwmR, 255);
    analogWrite(pwmL, 255);
    digitalWrite(pinR1, 0);
    digitalWrite(pinR2, 1);
    digitalWrite(pinL1, 1);
    digitalWrite(pinL2, 0);
  }
  else if (Defuzzifikasi >0 )
  {
    analogWrite(pwmR, 255);
    analogWrite(pwmL, 255);
    digitalWrite(pinR1, 1);
    digitalWrite(pinR2, 0);
    digitalWrite(pinL1, 0);
    digitalWrite(pinL2, 1);
  }
  else
  {
    digitalWrite(pinR1, 0);
    digitalWrite(pinR2, 0);
    digitalWrite(pinL1, 0);
    digitalWrite(pinL2, 0);
  }
}
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
//Program_Fuzzyfikasi
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
void Fuzifikasi ()
{
  sudut_kiri(sudut);
  sudut_agak_kiri(sudut);
  sudut_tengah(sudut);
  sudut_kanan(sudut);
  sudut_agak_kanan(sudut);
  delta_left(delta);
  delta_right(delta);
  delta_center(delta);
}
////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
void Inferensi ()
{
  Z1(R1);Z2(R2);Z3(R3);
  Z4(R4);Z5(R5);Z6(R6);
  Z7(R7);Z8(R8);Z9(R9);
  Z10(R10);Z11(R11);Z12(R12);
}

```



```

float sudut_agak_kanan(float sudut)
{
    if (sudut<=0) return (0);
    else
    {
        if (sudut<=12) return ((sudut-0)/(12-0));
        else
        {
            if (sudut<=50) return ((50-sudut)/(50-12));
            else
            {
                return (0);
            }
            if (sudut<=100) return (0);
            else
            {
                return (1);
            }
        }
    }
}

float sudut_kanan(float sudut)
{
    if (sudut<=30) return (0);
    else
    {
        if (sudut<=100) return ((sudut-30)/(100-30));
        else
        {
            return (1);
        }
    }
}

////////////////////////////////////
////////////////////////////////////membership function delta////////////////////////////////////
////////////////////////////////////

float delta_left(float delta)
{
    if (delta<=-60) return (1);
    else
    {
        if (delta<=-10) return ((-10-delta)/(-10+60));
        else
        {
            return (0);
        }
    }
}

float delta_center(float delta)
{
    if (delta<=-40) return (0);
    else
    {
        if (delta<=0) return ((delta+40)/(0+40));
        else
        {
            if (delta<=40) return ((40-delta)/(40-0));
            else
            {
                return (0);
            }
        }
    }
}

float delta_right(float delta)
{
    if (delta<=10) return (0);
    else
    {
        if (delta<=60) return ((delta-10)/(60-10));
    }
}

```

```

        else
        {
            return (1);
        }}
//////////////////////////////////////
//////////////////////////////////////
//////////////////////////////////////
//////////////////////////////////////
float Z1(float R1)
{
    if (sudut_kiri(sudut) < delta_left(delta))
        return R1 = sudut_kiri(sudut);
    else
    {
        return R1 = delta_left(delta);
    }
}
float Z2(float R2)
{
    if (sudut_agak_kiri(sudut) < delta_left(delta))
        return R2 = sudut_agak_kiri(sudut);
    else
    {
        return R2 = delta_left(delta);
    }
}
float Z3(float R3)
{
    if (sudut_tengah(sudut) < delta_left(delta))
        return R3 = sudut_tengah(sudut);
    else
    {
        return R3 = delta_left(delta);
    }
}
float Z4(float R4)
{
    if (sudut_agak_kanan(sudut) < delta_left(delta))
        return R4 = sudut_agak_kanan(sudut);
    else
    {
        return R4 = delta_left(delta);
    }
}
float Z5(float R5)
{
    if (sudut_kanan(sudut) < delta_left(delta))
        return R5 = sudut_kanan(sudut);
    else
    {
        return R5 = delta_left(delta);
    }
}
float Z6(float R6)
{
    if (sudut_kiri(sudut) < delta_center(delta))
        return R6 = sudut_kiri(sudut);
    else
    {
        return R6 = delta_center(delta);
    }
}
float Z7(float R7)
{
    if (sudut_agak_kiri(sudut) < delta_center(delta))
        return R7 = sudut_agak_kiri(sudut);
    else
    {
        return R7 = delta_center(delta);
    }
}

```



```

    }}
float Z8(float R8)
{
    if (sudut_tengah(sudut) < delta_center(delta))
        return R8 = sudut_tengah(sudut);
    else
    {
        return R8 = delta_center(delta);
    }
}}
float Z9(float R9)
{
    if (sudut_agak_kanan(sudut) < delta_center(delta))
        return R9 = sudut_agak_kanan(sudut);
    else
    {
        return R9 = delta_center(delta);
    }
}}
float Z10(float R10)
{
    if (sudut_kanan(sudut) < delta_center(delta))
        return R10 = sudut_kanan(sudut);
    else
    {
        return R10 = delta_center(delta);
    }
}}
float Z11(float R11)
{
    if (sudut_kiri(sudut) < delta_right(delta))
        return R11 = sudut_kiri(sudut);
    else
    {
        return R11 = delta_right(delta);
    }
}}
float Z12(float R12)
{
    if (sudut_agak_kiri(sudut) < delta_right(delta))
        return R12 = sudut_agak_kiri(sudut);
    else
    {
        return R12 = delta_right(delta);
    }
}}
float Z13(float R13)
{
    if (sudut_tengah(sudut) < delta_right(delta))
        return R13 = sudut_tengah(sudut);
    else
    {
        return R13 = delta_right(delta);
    }
}}
float Z14(float R14)
{
    if (sudut_agak_kanan(sudut) < delta_right(delta))
        return R14 = sudut_agak_kanan(sudut);
    else
    {
        return R14 = delta_right(delta);
    }
}}
float Z15(float R15)
{
    if (sudut_kanan(sudut) < delta_right(delta))
        return R15 = sudut_kanan(sudut);
    else
    {

```



```

        return MBS1 = Z7(R7);
    }}
    //////////////////////////////////////
    //////////////////////////////////////ARAH JAM CEPAT////////////////////////////////////
    //////////////////////////////////////
    float max7(float MSJC1)
    {
        if (Z10(R10) < Z13(R13))
            return MSJC1 = Z13(R13);
        else
        {
            return MSJC1 = Z10(R10);
        }
    }
    //////////////////////////////////////
    //////////////////////////////////////ARAH JAM SANGAT CEPAT////////////////////////////////////
    //////////////////////////////////////
    float max8(float MSJSC1)
    {
        if (Z14(R14) < Z15(R15))
            return MSJSC1 = Z15(R15);
        else
        {
            return MSJSC1 = Z14(R14);
        }
    }
    //////////////////////////////////////
    //////////////////////////////////////Defuzzifikasi////////////////////////////////////
    //////////////////////////////////////
    float DF(float ABC)
    {
        int A;
        A=1;
        if (A=1)
            return Defuzzifikasi=((max1(MBJSC1)*(-60))+(max2(MBJC1)*(-
35))+(max6(MBJS1)*(-
10))+(max5(MH2)*0+max3(MSJS1)*20)+(max7(MSJC1)*35)+(max8(MSJSC1)*60)
/(max1(MBJSC1)+max2(MBJC1)+max6(MBJS1)+max5(MH2)+max3(MSJS1)+max7(MSJC1)+
max8(MSJSC1)));
        else
        {
            return Defuzzifikasi=((max1(MBJSC1)*(-60))+(max2(MBJC1)*(-
35))+(max6(MBJS1)*(-
10))+(max5(MH2)*0+max3(MSJS1)*20)+(max7(MSJC1)*35)+(max8(MSJSC1)*60)
/(max1(MBJSC1)+max2(MBJC1)+max6(MBJS1)+max5(MH2)+max3(MSJS1)+max7(MSJC1)+
max8(MSJSC1)));
        }
    }
    //////////////////////////////////////
    boolean A(){
        if (digitalRead(TBL1)==0){return true;}
        else{return false;}
    }
    boolean B(){
        if (digitalRead(TBL2)==0){return true;}
        else{return false;}
    }
}

```



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Berdasarkan Rapat Tim Penguji Ujian Sarjana

Hari : Kamis  
Tanggal : 26 September 2019  
Tempat : R. Lab

Memutuskan bahwa mahasiswa :

Nama : Devita Yuliani  
NIM : 30601501705  
Judul TA : Analisis Penggunaan Inverted Pendulum dengan Menggunakan Fuzzy logic

wajib melakukan perbaikan dan membuat tugas seperti tercantum dibawah ini:

NO	REVISI	BATAS REVISI
1.	Abstrak (3 paragraf) → LB, Metode, Kesimpulan. ✓	Sejem! Acc 4 okt '19
2.	Penulisan di tinggalkan pustaka dan kata asing tdk konsisten ✓	
3.	Persamaan 2.3. dst. ✓	
4.	Gambar 2.4 dijejerkan. ✓	
5.	Flauchart ✓	
6.	tabel 4.3. (-56 / -80)? ✓	
7.	Kasih contoh y mendapatkan arah keo. ✓	
8.	Grafik di Gambar 4.14. ✓	

NO	TUGAS
9.	tabel 4.6 → SPt apa pengambilannya?
10.	Gambar 4.15 → dijejerkan / Analisa. ✓ - Gambar mutlak - (+) Pengukuran waktu.

Mengetahui,  
Ketua Tim Penguji

Jenny Putri Hapsari, ST, MT  
NIDN. 0607018501

Semarang, 26 September 2019  
Penguji, I

Jenny Putri Hapsari, ST, MT  
NIDN. 0607018501





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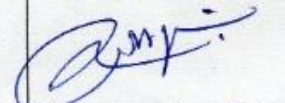
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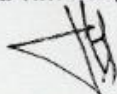
NO	REVISI	BATAS REVISI
1.	Perbaiki susunan bab 3 & bab 4	2 minggu.
2.	Abstrak belum ada	
3.	Pengukuran & pembuatan simulasi dg input yang sama	
4.	Perrentuan nilai PID disampaikan di bab 4.	

10/9

  
Bustanul Arifin

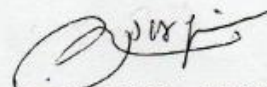
NO	TUGAS
	Apakah betul hasilnya bahwa PID lebih baik dr Fuzzy pd alat ini selgkan bateray/alat idk fix. Begitu juga dengan potensiometer.

Mengetahui,  
Ketua Tim Penguji



Jenny Putri Hapsari, ST, MT  
NIDN. 0607018501

Semarang, 26 September 2019  
Penguji, II



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Bismillah Membangun Generasi Khaira Ummah

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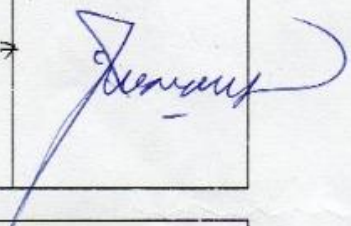
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Tanggal : 26 September 2019  
Tempat : R. Lab

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NIM : 30601501705  
Judul TA : Analisis Penggunaan Inverted Pendulum dengan Menggunakan Fuzzy logic

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-	Urutkan perubahaan, mulai dari sensor & prosesor → aktuator (Bab II, III, IV).	

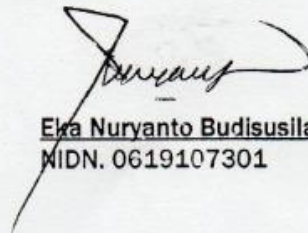
NO	TUGAS

Mengetahui,  
Ketua Tim Penguji



Jenny Putri Hapsari, ST, MT  
NIDN. 0607018501

Semarang, 26 September 2019  
Penguji, III



Eka Nuryanto Budisusila, ST, MT  
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