

LAMPIRAN



PERKUMPULAN PENGELOLA PENDIDIKAN UMUM DAN TEKNOLOGI NASIONAL MALANG
INSTITUT TEKNOLOGI NASIONAL MALANG

**FAKULTAS TEKNOLOGI INDUSTRI
FAKULTAS TEKNIK SIPIL DAN PERENCANAAN
PROGRAM PASCASARJANA MAGISTER TEKNIK**

PT BNI (PERSERO) MALANG
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**BERITA ACARA UJIAN SKRIPSI
FAKULTAS TEKNOLOGI INDUSTRI**

Nama : Herangga Dhani Utama
NIM : 1912021
Program Studi : Teknik Elektro S-1
Peminatan : Teknik Energi Listrik
Masa Bimbingan : Semester Genap 2022-2023
Judul Skripsi : **SISTEM PENGENDALI PUTARAN TURBIN UAP
BERBASIS FUZZY MENGGUNAKAN ARDUINO
PADA PEMBANGKIT LISTRIK TENAGA
SAMPAH SKALA MIKRO KAMPUS-II ITN
MALANG**

Diperlihatkan dihadapan Majelis Penguji Skripsi Jenjang Strata Satu (S-1) pada,
Hari : Rabu
Tanggal : 02 Agustus 2023
Nilai : **81.00**

Panitia Ujian Skripsi

Majelis Ketua Penguji

Sotyohadi, ST., MT.
NIP. Y. 1039700309

Sekretaris Majelis Penguji

Sotyohadi, ST., MT.
NIP. Y. 1039700309

Anggota Penguji

Dosen Penguji I

Awan Uji Krisyanto, ST., MT., Ph.D.
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Dosen Penguji II

Prof. Dr. Eng. Aryuanto Soetedjo, ST., MT.
NIP. Y. 1030800417



PERKUMPULAN PENGELOLA PENDIDIKAN UMUM DAN TEKNOLOGI NASIONAL MALANG
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Nomor Surat : ITN-108/EL-FTI/2023
Lampiran : -
Perihal : BIMBINGAN SKRIPSI (4 SKS)

5 Mei 2023

Kepada : Yth. Dr. Ir. Widodo Pudji Muljanto, MT.
Dosen Teknik Elektro S-1
ITN MALANG

Dengan Hormat,

Sesuai dengan persetujuan dan koordinasi pelaksanaan Skripsi Capstone Design, maka kami mohon kesediaan Bapak/Ibu Dosen sebagai Dosen Pembimbing 1 untuk mahasiswa:

Nama : Herangga Dhani Utama
NIM : 1912021
Fakultas : **Teknologi Industri**
Program Studi : **Teknik Elektro S-1**
Peminatan : T. Energi Listrik S1

Maka dengan ini pembimbingan tersebut kami serahkan sepenuhnya kepada Bapak/Ibu selama masa waktu :

“Semester Genap Tahun Akademik 2022/2023”

Demikian atas perhatian serta bantuannya kami sampaikan terima kasih



Kejua Program Studi Teknik Elektro S-1

Dr. Eng. I Komang Somawirata, ST, MT.
NIP. P. 1030100361



PERKUMPULAN PENGELOLA PENDIDIKAN UMUM DAN TEKNOLOGI NASIONAL MALANG
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Nomor Surat : ITN-108/EL-FTI/2023
Lampiran : -
Perihal : BIMBINGAN SKRIPSI (4 SKS)

5 Mei 2023

Kepada : Yth. Bima Romadhon Parada Dian Palevi, ST., MT.
Dosen Teknik Elektro S-1
ITN MALANG

Dengan Hormat,

Sesuai dengan persetujuan dan koordinasi pelaksanaan Skripsi Capstone Design, maka kami mohon kesediaan Bapak/Ibu Dosen sebagai Dosen Pembimbing 2 untuk mahasiswa mahasiswa:

Nama : Herangga Dhani Utama
NIM : 1912021
Fakultas : **Teknologi Industri**
Program Studi : **Teknik Elektro S-1**
Peminatan : T. Energi Listrik S1

Maka dengan ini pembimbingan tersebut kami serahkan sepenuhnya kepada Bapak/Ibu selama masa waktu :

“Semester Genap Tahun Akademik 2022/2023”

Demikian atas perhatian serta bantuannya kami sampaikan terima kasih



Ketua Program Studi Teknik Elektro S-1

D. Eng. I Komang Somawirata, ST, MT.
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LEMBAR PERSETUJUAN PERBAIKAN SKRIPSI

Nama : Herangga Dhani Utama
 NIM : 1912021
 Program Studi : Teknik Elektro S-1
 Peminatan : Teknik Energi Listrik
 Masa Bimbingan : Semester Genap 2022-2023
 Judul Skripsi : **SISTEM PENGENDALI PUTARAN TURBIN UAP BERBASIS FUZZY MENGGUNAKAN ARDUINO PADA PEMBANGKIT LISTRIK TENAGA SAMPAH SKALA MIKRO KAMPUS-II ITN MALANG**

Tanggal	Uraian	Paraf
Penguji I (03-08-2023)	<ul style="list-style-type: none"> • Flowchart • Referensi logika fuzzy • Bagaimana menghitung error ? • Bagaimana menghitung settling time ? • Blok diagram 	

Disetujui,
Dosen Penguji I

Awan Uji Krismanto, ST., MT., Ph.D.
 NIP. 19800301 200501 1 002

Mengetahui,

Dosen Pembimbing I

Dosen Pembimbing II

Dr. Ir. Widodo Pudi Muljanto, MT.
 NIP. P. 1028700171

Bima Romadhon Parada Dian Palevi, ST., MT.
 NIP. P. 1031900575





LEMBAR PERSETUJUAN PERBAIKAN SKRIPSI

Nama : Herangga Dhani Utama
 NIM : 1912021
 Program Studi : Teknik Elektro S-1
 Peminatan : Teknik Energi Listrik
 Masa Bimbingan : Semester Genap 2022-2023
 Judul Skripsi : **SISTEM PENGENDALI PUTARAN TURBIN UAP BERBASIS FUZZY MENGGUNAKAN ARDUINO PADA PEMBANGKIT LISTRIK TENAGA SAMPAH SKALA MIKRO KAMPUS-II ITN MALANG**

Tanggal	Uraian	Paraf
Penguji II (03-08-2023)	Di cek kembali percobaan & pengujian terkait "ketidaklinieran" triac	
	Perbedaan dengan rekan satu tim	

Disetujui,
Dosen Penguji II

Prof. Dr. Eng. Arvianto Soetedjo, ST., MT.
 NIP. Y. 1030800417

Dosen Pembimbing I

Mengetahui,

Dosen Pembimbing II

Dr. Ir. Widodo Rudi Muljanto, MT.
 NIP. P. 1028700171

Bima Romadhon Parada Dian Palevi, ST., MT.
 NIP. P. 1031900575



MONITORING BIMBINGAN SKRIPSI
SEMESTER GENAP TAHUN AKADEMIK 2022/2023

Nama : Herangga Dhani Utama
NIM : 1912021
Nama Pembimbing : Dr. Ir. Widodo Pudji Muljanto, MT.
Judul Skripsi : Sistem Pengendali Putaran Turbin Uap Berbasis Fuzzy Menggunakan Arduino pada Pembangkit Listrik Tenaga Sampah Skala Mikro Kampus II ITN Malang

No	Hari, Tanggal	Materi Bimbingan	Paraf
1	Rabu 05 - 04 - 2023	<ul style="list-style-type: none">Bab 1, 2, 3	
2	Selasa 16 - 05 - 2023	<ul style="list-style-type: none">Seminar ProgressFlowchart Alur pengerjaan	
3	Selasa 30 - 05 - 2023	<ul style="list-style-type: none">Bimbingan Bab 3 & 4Revisi flowchart	
4	Selasa 13 - 06 - 2023	<ul style="list-style-type: none">Revisi kesimpulan	
5	Selasa 20 - 06 - 2023	<ul style="list-style-type: none">Revisi bab 2	

Malang, September 2023

Dosen Pembimbing I

Dr. Ir. Widodo Pudji Muljanto, MT.

NIP. Y. 1028700171

SKRIPSI – ENERGI LISTRIK SISTEM PENGENDALI PUTARAN TURBIN UAP BERBASIS FUZZY MENGGUNAKAN ARDUINO PADA PEMBANGKIT LISTRIK TENAGA SAMPAH SKALA MIKRO KAMPUS-II ITN MALANG

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```
// Library

#include <WiFi.h>
#include <Fuzzy.h>
#include <WebServer.h>
#include <WiFiManager.h>
#include <LiquidCrystal_I2C.h>

// Configuration - Web Server
LiquidCrystal_I2C lcd (0x27, 16, 2);
WebServer server(80);
const char* WIFI_SSID = "ESP32PARAMETER";
const char* WIFI_PASS = "SKRIPSI2023";

//Pin I&O
const char Sensor    = 13; // arduino 2
const int  pwmOutputPin = 12; // arduino 6

//Variable
long      ERRORTOTAL    = 0;
float     pwm           = 0;
float     PWM           = 0;
float     outputPWM     = 0;
```

```
float    setpoint    = 0;
float    error       = 0;
const byte numRead   = 10;
const byte PulsaPerRev = 2;
unsigned int PulseCounter = 1;
unsigned int JumBacaan = 1;
unsigned int DeBouncing;
unsigned long avg;
unsigned long RPM;
unsigned long total;
unsigned long average;
unsigned long PeriodSum;
unsigned long readIndex;
unsigned long FrequencyRaw;
unsigned long FrequencyReal;
unsigned long Read[numRead];
unsigned long WaktuMicro = micros();
const unsigned long TimeOut = 100000;
volatile unsigned long UkurTerakhir;
volatile unsigned long PeriodAverage = TimeOut + 1000;
volatile unsigned long PeriodBetweenPulses = TimeOut + 1000;
unsigned long SiklusAkhir = UkurTerakhir;
```


<pre>//INPUT AGAKLAMBAT AGAK Minus unsigned long InputAGAKLambat1 = 1000; InputAGAKMinus1 = -3000; unsigned long InputAGAKLambat2 = 2000; InputAGAKMinus2 = -1500; unsigned long InputAGAKLambat3 = 2000; InputAGAKMinus3 = -1500; unsigned long InputAGAKLambat4 = 2930; InputAGAKMinus4 = 0;</pre>	<pre>//INPUT long long long long</pre>
<pre>//INPUT STABIL</pre>	<pre>//INPUT SEDANG</pre>
<pre>unsigned long InputStabil1 = 2000; InputSetPointE1 = -1500; unsigned long InputStabil2 = 3000; InputSetPointE2 = 0; unsigned long InputStabil3 = 3000; InputSetPointE3 = 0; unsigned long InputStabil4 = 4000; InputSetPointE4 = 1500;</pre>	<pre>long long long long</pre>
<pre>//INPUT AGAKKENCANG AGAKPlus</pre>	<pre>//INPUT</pre>
<pre>unsigned long InputAGAKKencang1 = 3070; InputAGAKPlus1 = 0; unsigned long InputAGAKKencang2 = 4000; InputAGAKPlus2 = 1500;</pre>	<pre>long long</pre>

```
unsigned long InputAGAKKencang3 = 4000;           long
InputAGAKPlus3 = 3000;
```

```
unsigned long InputAGAKKencang4 = 5000;           long
InputAGAKPlus4 = 3000;
```

```
//INPUT KENCANG                                     //INPUT Plus
```

```
unsigned long InputKencang1 = 4000;               long
InputPlus1 = 1500;
```

```
unsigned long InputKencang2 = 5000;               long
InputPlus2 = 2600;
```

```
unsigned long InputKencang3 = 6000;               long
InputPlus3 = 3000;
```

```
unsigned long InputKencang4 = 6000;               long
InputPlus4 = 3000;
```

```
//Deklarasi Parameter Fuzzy OUTPUT MEMBERSHIP PWM
```

```
//OUTPUT RENDAH
```

```
unsigned long OutputLow1 = 0;
```

```
unsigned long OutputLow2 = 0;
```

```
unsigned long OutputLow3 = 0;
```

```
unsigned long OutputLow4 = 10;
```

```
//OUTPUT AGAK RENDAH
```

```
unsigned long OutputAGAKLow1 = 0;
```

```
unsigned long OutputAGAKLow2 = 64;
```



```
unsigned long OutputAGAKLow3 = 64;  
unsigned long OutputAGAKLow4 = 128;
```

```
//OUTPUT MEDIUM
```

```
unsigned long OutputMedium1 = 64;  
unsigned long OutputMedium2 = 128;  
unsigned long OutputMedium3 = 128;  
unsigned long OutputMedium4 = 192;
```

```
//OUTPUT AGAKTINGGI
```

```
unsigned long OutputAGAKHigh1 = 128;  
unsigned long OutputAGAKHigh2 = 192;  
unsigned long OutputAGAKHigh3 = 192;  
unsigned long OutputAGAKHigh4 = 255;
```

```
//OUTPUT TINGGI
```

```
unsigned long OutputHigh1 = 245;  
unsigned long OutputHigh2 = 255;  
unsigned long OutputHigh3 = 255;  
unsigned long OutputHigh4 = 255;
```

```
// Fuzzy
```

```
Fuzzy *fuzzy = new Fuzzy();
```

```
// FUZZY INPUT RPM
```

```
FuzzySet *RPM_lambat = new FuzzySet(InputLambat1,  
InputLambat2, InputLambat3, InputLambat4);
```

```
FuzzySet *RPM_AGAKlambat = new FuzzySet(InputAGAKLambat1,  
InputAGAKLambat2, InputAGAKLambat3, InputAGAKLambat4);
```

```
FuzzySet *RPM_stabil = new FuzzySet(InputStabil1, InputStabil2,  
InputStabil3, InputStabil4);
```

```
FuzzySet *RPM_AGAKkencang = new FuzzySet(InputAGAKKencang1,  
InputAGAKKencang2, InputAGAKKencang3, InputAGAKKencang4);
```

```
FuzzySet *RPM_kencang = new FuzzySet(InputKencang1,  
InputKencang2, InputKencang3, InputKencang4);
```

```
// FUZZY INPUT Error
```

```
FuzzySet *ERROR_minus = new FuzzySet(InputMinus1,  
InputMinus2, InputMinus3, InputMinus4);
```

```
FuzzySet *ERROR_AGAKminus = new FuzzySet(InputAGAKMinus1,  
InputAGAKMinus2, InputAGAKMinus3, InputAGAKMinus4);
```

```
FuzzySet *ERROR_setpointe = new FuzzySet(InputSetPointE1,  
InputSetPointE2, InputSetPointE3, InputSetPointE4);
```

```
FuzzySet *ERROR_AGAKplus = new FuzzySet(InputAGAKPlus1,  
InputAGAKPlus2, InputAGAKPlus3, InputAGAKPlus4);
```

```
FuzzySet *ERROR_plus = new FuzzySet(InputPlus1, InputPlus2,  
InputPlus3, InputPlus4);
```

```

// Fuzzy Output PWM

FuzzySet *PWM_rendah = new FuzzySet(OutputLow1, OutputLow2,
OutputLow3, OutputLow4);

FuzzySet *PWM_AGAKrendah = new FuzzySet(OutputAGAKLow1,
OutputAGAKLow2, OutputAGAKLow3, OutputAGAKLow4);

FuzzySet *PWM_sedang = new FuzzySet(OutputMedium1,
OutputMedium2, OutputMedium3, OutputMedium4);

FuzzySet *PWM_AGAKtinggi = new FuzzySet(OutputAGAKHigh1,
OutputAGAKHigh2, OutputAGAKHigh3, OutputAGAKHigh4);

FuzzySet *PWM_tinggi = new FuzzySet(OutputHigh1, OutputHigh2,
OutputHigh3, OutputHigh4);

void setup() {
  Serial.begin(115200);

  lcd.init();

  lcd.backlight();

  lcd.setCursor(0, 0);

  lcd.print(" Jangan Lupa ");

  lcd.setCursor(0, 1);

  lcd.print(" Bismillah Dulu ");

  delay(1000);

  attachInterrupt(digitalPinToInterrupt(Sensor), Pulse_Event, FALLING);

```

```

// Set up PWM Output Pin

pinMode(pwmOutputPin, OUTPUT);

// Define Membership Function

// FuzzyInput - RPM
Error // FuzzyInput -

FuzzyInput *rpmInput = new FuzzyInput(1);
FuzzyInput *errorInput = new FuzzyInput(2);

rpmInput->addFuzzySet(RPM_lambat);
errorInput->addFuzzySet(ERROR_minus);

rpmInput->addFuzzySet(RPM_AGAKlambat);
errorInput->addFuzzySet(ERROR_AGAKminus);

rpmInput->addFuzzySet(RPM_stabil);
errorInput->addFuzzySet(ERROR_setpointe);

rpmInput->addFuzzySet(RPM_AGAKkencang);
errorInput->addFuzzySet(ERROR_AGAKplus);

rpmInput->addFuzzySet(RPM_kencang);
errorInput->addFuzzySet(ERROR_plus);

fuzzy->addFuzzyInput(rpmInput);
fuzzy->addFuzzyInput(errorInput);

FuzzyOutput *pwmOutput = new FuzzyOutput(1);
pwmOutput->addFuzzySet(PWM_rendah);
pwmOutput->addFuzzySet(PWM_AGAKrendah);
pwmOutput->addFuzzySet(PWM_sedang);

```

```

pwmOutput->addFuzzySet(PWM_AGAKtinggi);
pwmOutput->addFuzzySet(PWM_tinggi);
fuzzy->addFuzzyOutput(pwmOutput);

//RULES

// Aturan jika RPM LAMBAT1 SESUAI
FuzzyRuleAntecedent *ifRPM_LAMBAT1 = new
FuzzyRuleAntecedent();
ifRPM_LAMBAT1->joinWithAND(RPM_lambat, ERROR_setpointe);
FuzzyRuleConsequent *thenPWM_RENDAH1 = new
FuzzyRuleConsequent();
thenPWM_RENDAH1->addOutput(PWM_rendah);
FuzzyRule *ruleRPM_LAMBAT1 = new FuzzyRule(1,
ifRPM_LAMBAT1, thenPWM_RENDAH1);
fuzzy->addFuzzyRule(ruleRPM_LAMBAT1);

// Aturan jika RPM LAMBAT2 SESUAI
FuzzyRuleAntecedent *ifRPM_LAMBAT2 = new
FuzzyRuleAntecedent();
ifRPM_LAMBAT2->joinWithAND(RPM_lambat,
ERROR_AGAKminus);
FuzzyRuleConsequent *thenPWM_AGAKTINGGI1 = new
FuzzyRuleConsequent();
thenPWM_AGAKTINGGI1->addOutput(PWM_AGAKtinggi);

```

```

FuzzyRule *ruleRPM_LAMBAT2 = new FuzzyRule(2,
ifRPM_LAMBAT2, thenPWM_AGAKTINGGI1);

fuzzy->addFuzzyRule(ruleRPM_LAMBAT2);

// Aturan jika RPM LAMBAT3 SESUAI

FuzzyRuleAntecedent *ifRPM_LAMBAT3 = new
FuzzyRuleAntecedent();

ifRPM_LAMBAT3->joinWithAND(RPM_lambat, ERROR_minus);

FuzzyRuleConsequent *thenPWM_TINGGI1 = new
FuzzyRuleConsequent();

thenPWM_TINGGI1->addOutput(PWM_tinggi);

FuzzyRule *ruleRPM_LAMBAT3 = new FuzzyRule(3,
ifRPM_LAMBAT3, thenPWM_TINGGI1);

fuzzy->addFuzzyRule(ruleRPM_LAMBAT3);

// Aturan jika RPM LAMBAT4 SESUAI

FuzzyRuleAntecedent *ifRPM_LAMBAT4 = new
FuzzyRuleAntecedent();

ifRPM_LAMBAT4->joinWithAND(RPM_lambat,
ERROR_AGAKplus);

FuzzyRuleConsequent *thenPWM_AGAKRENDAH1 = new
FuzzyRuleConsequent();

thenPWM_AGAKRENDAH1->addOutput(PWM_AGAKrendah);

FuzzyRule *ruleRPM_LAMBAT4 = new FuzzyRule(4,
ifRPM_LAMBAT4, thenPWM_AGAKRENDAH1);

```

```

fuzzy->addFuzzyRule(ruleRPM_LAMBAT4);

// Aturan jika RPM LAMBAT5 SESUAI
FuzzyRuleAntecedent *ifRPM_LAMBAT5 = new
FuzzyRuleAntecedent();

ifRPM_LAMBAT5->joinWithAND(RPM_lambat, ERROR_plus);

FuzzyRuleConsequent *thenPWM_RENDAH2 = new
FuzzyRuleConsequent();

thenPWM_RENDAH2->addOutput(PWM_rendah);

FuzzyRule *ruleRPM_LAMBAT5 = new FuzzyRule(5,
ifRPM_LAMBAT5, thenPWM_RENDAH2);

fuzzy->addFuzzyRule(ruleRPM_LAMBAT5);

// Aturan jika RPM AGAK LAMBAT1 SESUAI
FuzzyRuleAntecedent *ifRPM_AGAKLAMBAT1 = new
FuzzyRuleAntecedent();

ifRPM_AGAKLAMBAT1->joinWithAND(RPM_AGAKlambat,
ERROR_setpointe);

FuzzyRuleConsequent *thenPWM_AGAKRENDAH2 = new
FuzzyRuleConsequent();

thenPWM_AGAKRENDAH2->addOutput(PWM_AGAKrendah);

FuzzyRule *ruleRPM_AGAKLAMBAT1 = new FuzzyRule(6,
ifRPM_AGAKLAMBAT1, thenPWM_AGAKRENDAH2);

fuzzy->addFuzzyRule(ruleRPM_AGAKLAMBAT1);

```

```
// Aturan jika RPM AGAK LAMBAT2 SESUAI
```

```
FuzzyRuleAntecedent *ifRPM_AGAKLAMBAT2 = new  
FuzzyRuleAntecedent();
```

```
ifRPM_AGAKLAMBAT2->joinWithAND(RPM_AGAKlambat,  
ERROR_AGAKminus);
```

```
FuzzyRuleConsequent *thenPWM_SEDANG1 = new  
FuzzyRuleConsequent();
```

```
thenPWM_SEDANG1->addOutput(PWM_sedang);
```

```
FuzzyRule *ruleRPM_AGAKLAMBAT2 = new FuzzyRule(7,  
ifRPM_AGAKLAMBAT2, thenPWM_SEDANG1);
```

```
fuzzy->addFuzzyRule(ruleRPM_AGAKLAMBAT2);
```

```
// Aturan jika RPM AGAK LAMBAT3 SESUAI
```

```
FuzzyRuleAntecedent *ifRPM_AGAKLAMBAT3 = new  
FuzzyRuleAntecedent();
```

```
ifRPM_AGAKLAMBAT3->joinWithAND(RPM_AGAKlambat,  
ERROR_AGAKplus);
```

```
FuzzyRuleConsequent *thenPWM_SEDANG2 = new  
FuzzyRuleConsequent();
```

```
thenPWM_SEDANG2->addOutput(PWM_sedang);
```

```
FuzzyRule *ruleRPM_AGAKLAMBAT3 = new FuzzyRule(8,  
ifRPM_AGAKLAMBAT3, thenPWM_SEDANG2);
```

```
fuzzy->addFuzzyRule(ruleRPM_AGAKLAMBAT3);
```

```
// Aturan jika RPM AGAK LAMBAT4 SESUAI
```



```
FuzzyRuleAntecedent *ifRPM_AGAKLAMBAT4 = new
FuzzyRuleAntecedent();

ifRPM_AGAKLAMBAT4->joinWithAND(RPM_AGAKlambat,
ERROR_minus);

FuzzyRuleConsequent *thenPWM_AGAKTINGGI2 = new
FuzzyRuleConsequent();

thenPWM_AGAKTINGGI2->addOutput(PWM_AGAKtinggi);

FuzzyRule *ruleRPM_AGAKLAMBAT4 = new FuzzyRule(9,
ifRPM_AGAKLAMBAT4, thenPWM_AGAKTINGGI2);

fuzzy->addFuzzyRule(ruleRPM_AGAKLAMBAT4);
```

// Aturan jika RPM AGAK LAMBAT5 SESUAI

```
FuzzyRuleAntecedent *ifRPM_AGAKLAMBAT5 = new
FuzzyRuleAntecedent();

ifRPM_AGAKLAMBAT5->joinWithAND(RPM_AGAKlambat,
ERROR_plus);

FuzzyRuleConsequent *thenPWM_AGAKTINGGI3 = new
FuzzyRuleConsequent();

thenPWM_AGAKTINGGI3->addOutput(PWM_AGAKtinggi);

FuzzyRule *ruleRPM_AGAKLAMBAT5 = new FuzzyRule(10,
ifRPM_AGAKLAMBAT5, thenPWM_AGAKTINGGI3);

fuzzy->addFuzzyRule(ruleRPM_AGAKLAMBAT5);
```

// Aturan jika RPM STABIL1 SESUAI

```
FuzzyRuleAntecedent *ifRPM_STABIL1 = new
FuzzyRuleAntecedent();
```

```

ifRPM_STABIL1->joinWithAND(RPM_stabil, ERROR_setpointe);

FuzzyRuleConsequent *thenPWM_RENDAH3 = new
FuzzyRuleConsequent();

thenPWM_RENDAH3->addOutput(PWM_rendah);

FuzzyRule *ruleRPM_STABIL1 = new FuzzyRule(11,
ifRPM_AGAKLAMBAT5, thenPWM_RENDAH3);

fuzzy->addFuzzyRule(ruleRPM_STABIL1);

// Aturan jika RPM STABIL2 SESUAI

FuzzyRuleAntecedent *ifRPM_STABIL2 = new
FuzzyRuleAntecedent();

ifRPM_STABIL2->joinWithAND(RPM_stabil, ERROR_AGAKminus);

FuzzyRuleConsequent *thenPWM_RENDAH5 = new
FuzzyRuleConsequent();

thenPWM_RENDAH5->addOutput(PWM_rendah);

FuzzyRule *ruleRPM_STABIL2 = new FuzzyRule(12,
ifRPM_STABIL2, thenPWM_RENDAH5);

fuzzy->addFuzzyRule(ruleRPM_STABIL2);

// Aturan jika RPM STABIL3 SESUAI

FuzzyRuleAntecedent *ifRPM_STABIL3 = new
FuzzyRuleAntecedent();

ifRPM_STABIL3->joinWithAND(RPM_stabil, ERROR_AGAKplus);

FuzzyRuleConsequent *thenPWM_RENDAH6 = new
FuzzyRuleConsequent();

```

```

thenPWM_RENDAH6->addOutput(PWM_rendah);

FuzzyRule *ruleRPM_STABIL3 = new FuzzyRule(13,
ifRPM_STABIL3, thenPWM_RENDAH6);

fuzzy->addFuzzyRule(ruleRPM_STABIL3);

// Aturan jika RPM STABIL4 SESUAI

FuzzyRuleAntecedent *ifRPM_STABIL4 = new
FuzzyRuleAntecedent();

ifRPM_STABIL4->joinWithAND(RPM_stabil, ERROR_minus);

FuzzyRuleConsequent *thenPWM_RENDAH7 = new
FuzzyRuleConsequent();

thenPWM_RENDAH7->addOutput(PWM_rendah);

FuzzyRule *ruleRPM_STABIL4 = new FuzzyRule(14,
ifRPM_STABIL4, thenPWM_RENDAH7);

fuzzy->addFuzzyRule(ruleRPM_STABIL4);

// Aturan jika RPM STABIL5 SESUAI

FuzzyRuleAntecedent *ifRPM_STABIL5 = new
FuzzyRuleAntecedent();

ifRPM_STABIL5->joinWithAND(RPM_stabil, ERROR_plus);

FuzzyRuleConsequent *thenPWM_RENDAH8 = new
FuzzyRuleConsequent();

thenPWM_RENDAH8->addOutput(PWM_rendah);

FuzzyRule *ruleRPM_STABIL5 = new FuzzyRule(15,
ifRPM_STABIL5, thenPWM_RENDAH8);

```

```

fuzzy->addFuzzyRule(ruleRPM_STABIL5);

// Aturan jika RPM AGAK KENCANG1 SESUAI

FuzzyRuleAntecedent *ifRPM_AGAKKENCANG1 = new
FuzzyRuleAntecedent();

ifRPM_AGAKKENCANG1->joinWithAND(RPM_AGAKkencang,
ERROR_setpointe);

FuzzyRuleConsequent *thenPWM_SEDANG3 = new
FuzzyRuleConsequent();

thenPWM_SEDANG3->addOutput(PWM_sedang);

FuzzyRule *ruleRPM_AGAKKENCANG1 = new FuzzyRule(16,
ifRPM_AGAKKENCANG1, thenPWM_SEDANG3);

fuzzy->addFuzzyRule(ruleRPM_AGAKKENCANG1);

// Aturan jika RPM AGAK KENCANG2 SESUAI

FuzzyRuleAntecedent *ifRPM_AGAKKENCANG2 = new
FuzzyRuleAntecedent();

ifRPM_AGAKKENCANG2->joinWithAND(RPM_AGAKkencang,
ERROR_AGAKminus);

FuzzyRuleConsequent *thenPWM_AGAKRENDAH3 = new
FuzzyRuleConsequent();

thenPWM_AGAKRENDAH3->addOutput(PWM_AGAKrendah);

FuzzyRule *ruleRPM_AGAKKENCANG2 = new FuzzyRule(17,
ifRPM_AGAKKENCANG2, thenPWM_AGAKRENDAH3);

fuzzy->addFuzzyRule(ruleRPM_AGAKKENCANG2);

```

```

// Aturan jika RPM AGAK KENCANG3 SESUAI

FuzzyRuleAntecedent *ifRPM_AGAKKENCANG3 = new
FuzzyRuleAntecedent();

ifRPM_AGAKKENCANG3->joinWithAND(RPM_AGAKkencang,
ERROR_minus);

FuzzyRuleConsequent *thenPWM_RENDAH4 = new
FuzzyRuleConsequent();

thenPWM_RENDAH4->addOutput(PWM_rendah);

FuzzyRule *ruleRPM_AGAKKENCANG3 = new FuzzyRule(18,
ifRPM_AGAKKENCANG2, thenPWM_RENDAH4);

fuzzy->addFuzzyRule(ruleRPM_AGAKKENCANG3);

// Aturan jika RPM AGAK KENCANG4 SESUAI

FuzzyRuleAntecedent *ifRPM_AGAKKENCANG4 = new
FuzzyRuleAntecedent();

ifRPM_AGAKKENCANG4->joinWithAND(RPM_AGAKkencang,
ERROR_AGAKplus);

FuzzyRuleConsequent *thenPWM_AGAKTINGGI6 = new
FuzzyRuleConsequent();

thenPWM_AGAKTINGGI6->addOutput(PWM_AGAKtinggi);

FuzzyRule *ruleRPM_AGAKKENCANG4 = new FuzzyRule(19,
ifRPM_AGAKKENCANG4, thenPWM_AGAKTINGGI6);

fuzzy->addFuzzyRule(ruleRPM_AGAKKENCANG4);

```

```
// Aturan jika RPM AGAK KENCANG5 SESUAI
```

```
FuzzyRuleAntecedent *ifRPM_AGAKKENCANG5 = new  
FuzzyRuleAntecedent();
```

```
ifRPM_AGAKKENCANG5->joinWithAND(RPM_AGAKkencang,  
ERROR_plus);
```

```
FuzzyRuleConsequent *thenPWM_TINGGI4 = new  
FuzzyRuleConsequent();
```

```
thenPWM_TINGGI4->addOutput(PWM_tinggi);
```

```
FuzzyRule *ruleRPM_AGAKKENCANG5 = new FuzzyRule(20,  
ifRPM_AGAKKENCANG4, thenPWM_TINGGI4);
```

```
fuzzy->addFuzzyRule(ruleRPM_AGAKKENCANG5);
```

```
// Aturan jika RPM KENCANG1 SESUAI
```

```
FuzzyRuleAntecedent *ifRPM_KENCANG1 = new  
FuzzyRuleAntecedent();
```

```
ifRPM_KENCANG1->joinWithAND(RPM_kencang,  
ERROR_setpointe);
```

```
FuzzyRuleConsequent *thenPWM_SEDANG4 = new  
FuzzyRuleConsequent();
```

```
thenPWM_SEDANG4->addOutput(PWM_sedang);
```

```
FuzzyRule *ruleRPM_KENCANG1 = new FuzzyRule(21,  
ifRPM_KENCANG1, thenPWM_SEDANG4);
```

```
fuzzy->addFuzzyRule(ruleRPM_KENCANG1);
```

```
// Aturan jika RPM KENCANG2 SESUAI
```

```
FuzzyRuleAntecedent *ifRPM_KENCANG2 = new
FuzzyRuleAntecedent();

ifRPM_KENCANG2->joinWithAND(RPM_kencang,
ERROR_AGAKplus);

FuzzyRuleConsequent *thenPWM_TINGGI5 = new
FuzzyRuleConsequent();

thenPWM_TINGGI5->addOutput(PWM_tinggi);

FuzzyRule *ruleRPM_KENCANG2 = new FuzzyRule(22,
ifRPM_KENCANG2, thenPWM_TINGGI5);

fuzzy->addFuzzyRule(ruleRPM_KENCANG2);
```

// Aturan jika RPM KENCANG3 SESUAI

```
FuzzyRuleAntecedent *ifRPM_KENCANG3 = new
FuzzyRuleAntecedent();

ifRPM_KENCANG3->joinWithAND(RPM_kencang, ERROR_plus);

FuzzyRuleConsequent *thenPWM_TINGGI6 = new
FuzzyRuleConsequent();

thenPWM_TINGGI6->addOutput(PWM_tinggi);

FuzzyRule *ruleRPM_KENCANG3 = new FuzzyRule(23,
ifRPM_KENCANG3, thenPWM_TINGGI6);

fuzzy->addFuzzyRule(ruleRPM_KENCANG3);
```

// Aturan jika RPM KENCANG4 SESUAI

```
FuzzyRuleAntecedent *ifRPM_KENCANG4 = new
FuzzyRuleAntecedent();
```

```
ifRPM_KENCANG4->joinWithAND(RPM_kencang,
ERROR_AGAKminus);

FuzzyRuleConsequent *thenPWM_SEDANG5 = new
FuzzyRuleConsequent();

thenPWM_SEDANG5->addOutput(PWM_sedang);

FuzzyRule *ruleRPM_KENCANG4 = new FuzzyRule(24,
ifRPM_KENCANG3, thenPWM_SEDANG5);

fuzzy->addFuzzyRule(ruleRPM_KENCANG4);

// Aturan jika RPM KENCANG5 SESUAI

FuzzyRuleAntecedent *ifRPM_KENCANG5 = new
FuzzyRuleAntecedent();

ifRPM_KENCANG5->joinWithAND(RPM_kencang, ERROR_minus);

FuzzyRuleConsequent *thenPWM_SEDANG6 = new
FuzzyRuleConsequent();

thenPWM_SEDANG6->addOutput(PWM_sedang);

FuzzyRule *ruleRPM_KENCANG5 = new FuzzyRule(25,
ifRPM_KENCANG3, thenPWM_SEDANG6);

fuzzy->addFuzzyRule(ruleRPM_KENCANG5);

//SetUp WiFi

// WiFi.begin(ssid, password);

WiFi.mode(WIFI_STA);

delay(1000);

WiFiManager wm;
```



```
bool res;

res = wm.autoConnect("ESP32PARAMETER", "SKRIPSI2023"); //
password protected ap

if (!res) {
    Serial.println("Failed to connect");
    // ESP.restart();
}
else {
    //if you get here you have connected to the WiFi
    Serial.println("connected...yeey :)");
}

// while (WiFi.status() != WL_CONNECTED) {
//   delay(500);
//   Serial.print(".");
// }

Serial.println("");
Serial.println("WiFi connected");
Serial.println("ESP32 IP Address: " + WiFi.localIP().toString());
lcd.clear();
```

```
lcd.setCursor(0, 0);  
lcd.println("WiFi Koneksi IP");  
lcd.setCursor(0, 1);  
lcd.println(WiFi.localIP().toString());  
delay(10000);
```

```
//Untuk Membuka dan Update Web(Rute EndPoint)
```

```
server.on("/", HTTP_GET, handleRoot);  
server.on("/update_IL", HTTP_POST, handleUpdateIL);  
server.on("/update_IAL", HTTP_POST, handleUpdateIAL);  
server.on("/update_IS", HTTP_POST, handleUpdateIS);  
server.on("/update_IAK", HTTP_POST, handleUpdateIAK);  
server.on("/update_IK", HTTP_POST, handleUpdateIK);  
  
server.on("/update_IEM", HTTP_POST, handleUpdateIEM);  
server.on("/update_IEAM", HTTP_POST, handleUpdateIEAM);  
server.on("/update_IES", HTTP_POST, handleUpdateIES);  
server.on("/update_IEAP", HTTP_POST, handleUpdateIEAP);  
server.on("/update_IEP", HTTP_POST, handleUpdateIEP);  
  
server.on("/update_OL", HTTP_POST, handleUpdateOL);  
server.on("/update_OAL", HTTP_POST, handleUpdateOAL);
```

```

server.on("/update_OM", HTTP_POST, handleUpdateOM);
server.on("/update_OAH", HTTP_POST, handleUpdateOAH);
server.on("/update_OH", HTTP_POST, handleUpdateOH);
server.on("/update_REMAPPWM", HTTP_POST,
handleUpdateRemapPWM);
server.on("/update_REMAPRPM", HTTP_POST,
handleUpdateRemapRPM);

//Memulai server
server.begin();

Serial.println("HTTP Server Berjalan");

delay(500);

lcd.clear();
}

void loop() {
    unsigned long waktuS;
    unsigned long waktuSeb;
    SiklusAkhir = UkurTerakhir;
    WaktuMicro = micros();
    if (WaktuMicro < SiklusAkhir)
    {
        SiklusAkhir = WaktuMicro;
    }
}

```

```
if (millis() - waktuS >= 500) {  
    //kalkulasi Frekuensi  
    FrequencyRaw = 10000000000 / PeriodAverage;  
  
    if (PeriodBetweenPulses > TimeOut - DeBouncing || WaktuMicro -  
SiklusAkhir > TimeOut - DeBouncing)  
    {  
        FrequencyRaw = 0;  
        DeBouncing = 2000;  
    }  
    else  
    {  
        DeBouncing = 0;  
    }  
  
    FrequencyReal = FrequencyRaw / 10000;  
  
    // perhitungan RPM:  
    RPM = FrequencyRaw / PulsaPerRev * 60;  
    RPM = RPM / 100000;  
  
    // Stabilitas RPM:  
    total = total - Read[readIndex];
```

```

Read[readIndex] = RPM;

total = total + Read[readIndex];

readIndex = readIndex + 1;

if (readIndex >= numRead)
{
    readIndex = 0;
}

// perhitungan average:
average = total / numRead;

avg = map(average, RealMinRPM, RealMaxRPM, MapMinRPM,
MapMaxRPM);

// Set input RPM pada fuzzy logic dengan Lib
fuzzy->setInput(1, avg); // Menggunakan nilai rata-rata sebagai input
fuzzy

fuzzy->setInput(2, error); // Menggunakan nilai rata-rata sebagai input
fuzzy

// Lakukan fuzzifikasi
fuzzy->fuzzify();

```

```
// Lakukan defuzzifikasi dan dapatkan output PWM
pwm = fuzzy->defuzzify(1);

// Batasi nilai PWM antara 0 dan 150
PWM = map(pwm, RealMinPWM, RealMaxPWM, MapMinPWM,
MapMaxPWM);
PWM = constrain(PWM, MapMinPWM, MapMaxPWM);

// Hitung nilai error
if (avg > 0) {
    setpoint = 3000;
    error = avg - setpoint;
}
else {
    error = 0;
}

// Set nilai PWM pada pin output
analogWrite(pwmOutputPin, PWM);
waktuS = millis();
}
```

```
if (millis() - waktuSeb >= 1000) {  
  // SerialMonitor();  
  lcd.clear();  
  lcd.setCursor(0, 0);  
  lcd.print("RPM:");  
  lcd.print(avg);  
  lcd.print(" ");  
  lcd.setCursor(10, 0);  
  lcd.print(error);  
  lcd.print(" ");  
  lcd.setCursor(0, 1);  
  lcd.print("PWM:");  
  lcd.print(PWM);  
  lcd.print(" ");  
  delay(500);  
  server.handleClient();  
  waktuSeb = millis();  
}  
  
}  
  
void Pulse_Event()  
{
```

```

PeriodBetweenPulses = micros() - UkurTerakhir;
UkurTerakhir = micros();
if (PulseCounter >= JumBacaan)
{
    PeriodAverage = PeriodSum / JumBacaan;
    PulseCounter = 1;
    PeriodSum = PeriodBetweenPulses;
    int RemapedJumBacaan = map(PeriodBetweenPulses, 40000, 1000, 1,
10);
    RemapedJumBacaan = constrain(RemapedJumBacaan, 1, 10);
    JumBacaan = RemapedJumBacaan;
}
else
{
    PulseCounter++;
    PeriodSum = PeriodSum + PeriodBetweenPulses;
}
}

```

```
//Tampilan WEB untuk Input Parameter
```

```

void handleRoot() {
    String html = "<html><head><style>";
    //Judul

```



```

html += "body { font-family: Arial, sans-serif; margin: 20px; }";
html += ".container { display: flex; justify-content: space-between; }";
html += ".column { flex-basis: 45%; }";
html += "h1 { margin-bottom: 30px; }";
html += "h2 { margin-top: 40px; }";
html += "form { margin-top: 10px; }";
html += "input[type='number'] { width: 150px; padding: 5px; }";
html += "input[type='submit'] { padding: 10px 20px; background-color:
#4CAF50; color: white; border: none; cursor: pointer; }";
html += "</style></head><body>";
html += "<h1>Parameter Parameter Control RPM</h1>";
html += "<div class='container'>";

//Kolom 1
html += "<div class='column'>";

html += "<h2>FUZZY INPUT LAMBAT</h2>";
html += "<form action='/update_IL' method='post'>";
html += "<p>Nilai Titik A : " + String(InputLambat1) + "</p>";
html += "<input type='number' name='InputLambat1' value='" +
String(InputLambat1) + "'><br><br>";
html += "<p>Nilai Titik B : " + String(InputLambat2) + "</p>";

```

```
html += "<input type='number' name='InputLambat2' value='" +  
String(InputLambat2) + "'><br><br>";
```

```
html += "<p>Nilai Titik C : " + String(InputLambat3) + "</p>";
```

```
html += "<input type='number' name='InputLambat3' value='" +  
String(InputLambat3) + "'><br><br>";
```

```
html += "<p>Nilai Titik D : " + String(InputLambat4) + "</p>";
```

```
html += "<input type='number' name='InputLambat4' value='" +  
String(InputLambat4) + "'><br><br>";
```

```
html += "<input type='submit' value='Submit'>";
```

```
html += "</form>";
```

```
html += "<h2>FUZZY INPUT AGAK LAMBAT</h2>";
```

```
html += "<form action='/update_IAL' method='post'>";
```

```
html += "<p>Nilai Titik A : " + String(InputAGAKLambat1) + "</p>";
```

```
html += "<input type='number' name='InputAGAKLambat1' value='" +  
String(InputAGAKLambat1) + "'><br><br>";
```

```
html += "<p>Nilai Titik B : " + String(InputAGAKLambat2) + "</p>";
```

```
html += "<input type='number' name='InputAGAKLambat2' value='" +  
String(InputAGAKLambat2) + "'><br><br>";
```

```
html += "<p>Nilai Titik C : " + String(InputAGAKLambat3) + "</p>";
```

```
html += "<input type='number' name='InputAGAKLambat3' value='" +  
String(InputAGAKLambat3) + "'><br><br>";
```

```
html += "<p>Nilai Titik D : " + String(InputAGAKLambat4) + "</p>";
```

```
html += "<input type='number' name='InputAGAKLambat4' value='" +  
String(InputAGAKLambat4) + "'><br><br>";
```

```
html += "<input type='submit' value='Submit'>";
```

```
html += "</form>";
```

```
html += "<h2>FUZZY INPUT STABIL</h2>";
```

```
html += "<form action='/update_IS' method='post'>";
```

```
html += "<p>Nilai Titik A : " + String(InputStabil1) + "</p>";
```

```
html += "<input type='number' name='InputStabil1' value='" +  
String(InputStabil1) + "'><br><br>";
```

```
html += "<p>Nilai Titik B : " + String(InputStabil2) + "</p>";
```

```
html += "<input type='number' name='InputStabil2' value='" +  
String(InputStabil2) + "'><br><br>";
```

```
html += "<p>Nilai Titik C : " + String(InputStabil3) + "</p>";
```

```
html += "<input type='number' name='InputStabil3' value='" +  
String(InputStabil3) + "'><br><br>";
```

```
html += "<p>Nilai Titik D : " + String(InputStabil4) + "</p>";
```

```
html += "<input type='number' name='InputStabil4' value='" +  
String(InputStabil4) + "'><br><br>";
```

```
html += "<input type='submit' value='Submit'>";
```

```
html += "</form>";
```

```
html += "<h2>FUZZY INPUT AGAK KENCANG</h2>";
```

```
html += "<form action='/update_IAK' method='post'>";
```

```
html += "<p>Nilai Titik A : " + String(InputAGAKKencang1) + "</p>";
```

```
html += "<input type='number' name='InputAGAKKencang1' value='" +  
String(InputAGAKKencang1) + "'><br><br>";
```

```
html += "<p>Nilai Titik B : " + String(InputAGAKKencang2) + "</p>";
```

```
html += "<input type='number' name='InputAGAKKencang2' value='" +  
String(InputAGAKKencang2) + "'><br><br>";
```

```
html += "<p>Nilai Titik C : " + String(InputAGAKKencang3) + "</p>";
```

```
html += "<input type='number' name='InputAGAKKencang3' value='" +  
String(InputAGAKKencang3) + "'><br><br>";
```

```
html += "<p>Nilai Titik D : " + String(InputAGAKKencang4) + "</p>";
```

```
html += "<input type='number' name='InputAGAKKencang4' value='" +  
String(InputAGAKKencang4) + "'><br><br>";
```

```
html += "<input type='submit' value='Submit'>";
```

```
html += "</form>";
```

```
html += "<h2>FUZZY INPUT KENCANG</h2>";
```

```
html += "<form action='/update_IK' method='post'>";
```

```
html += "<p>Nilai Titik A : " + String(InputKencang1) + "</p>";
```

```
html += "<input type='number' name='InputKencang1' value='" +  
String(InputKencang1) + "'><br><br>";
```

```
html += "<p>Nilai Titik B : " + String(InputKencang2) + "</p>";
```

```
html += "<input type='number' name='InputKencang2' value='" +  
String(InputKencang2) + "'><br><br>";
```

```
html += "<p>Nilai Titik C : " + String(InputKencang3) + "</p>";
```

```
html += "<input type='number' name='InputKencang3' value='" +  
String(InputKencang3) + "'><br><br>";
```

```
html += "<p>Nilai Titik D : " + String(InputKencang4) + "</p>";

html += "<input type='number' name='InputKencang4' value='" +
String(InputKencang4) + "'><br><br>";

html += "<input type='submit' value='Submit'>";

html += "</form>";

html += "<h2>REMAP RPM</h2>";

html += "<form action='/update_REMAPRPM' method='post'>";

html += "<p>Nilai Real Min : " + String(RealMinRPM) + "</p>";

html += "<input type='number' name='RMinR' value='" +
String(RealMinRPM) + "'><br><br>";

html += "<p>Nilai Real Max : " + String(RealMaxRPM) + "</p>";

html += "<input type='number' name='RMaxR' value='" +
String(RealMaxRPM) + "'><br><br>";

html += "<p>Nilai Remap Min : " + String(MapMinRPM) + "</p>";

html += "<input type='number' name='MMinR' value='" +
String(MapMinRPM) + "'><br><br>";

html += "<p>Nilai Remap Max : " + String(MapMaxRPM) + "</p>";

html += "<input type='number' name='MMaxR' value='" +
String(MapMaxRPM) + "'><br><br>";

html += "<input type='submit' value='Submit'>";

html += "</form>";

html += "</div>";
```

```
//Kolom 2
```

```
html += "<div class='column'>";
```

```
html += "<h2>FUZZY INPUT ERROR MINUS</h2>";
```

```
html += "<form action='/update_IEM' method='post'>";
```

```
html += "<p>Nilai Titik A : " + String(InputMinus1) + "</p>";
```

```
html += "<input type='number' name='InputMinus1' value='" +  
String(InputMinus1) + "'><br><br>";
```

```
html += "<p>Nilai Titik B : " + String(InputMinus2) + "</p>";
```

```
html += "<input type='number' name='InputMinus2' value='" +  
String(InputMinus2) + "'><br><br>";
```

```
html += "<p>Nilai Titik C : " + String(InputMinus3) + "</p>";
```

```
html += "<input type='number' name='InputMinus3' value='" +  
String(InputMinus3) + "'><br><br>";
```

```
html += "<p>Nilai Titik D : " + String(InputMinus4) + "</p>";
```

```
html += "<input type='number' name='InputMinus4' value='" +  
String(InputMinus4) + "'><br><br>";
```

```
html += "<input type='submit' value='Submit'>";
```

```
html += "</form>";
```

```
html += "<h2>FUZZY INPUT ERROR AGAK MINUS</h2>";
```

```
html += "<form action='/update_IEAM' method='post'>";
```

```
html += "<p>Nilai Titik A : " + String(InputAGAKMinus1) + "</p>";
```

```
html += "<input type='number' name='InputAGAKMinus1' value='" +  
String(InputAGAKMinus1) + "'><br><br>";
```

```
html += "<p>Nilai Titik B : " + String(InputAGAKMinus2) + "</p>";
```

```
html += "<input type='number' name='InputAGAKMinus2' value='" +  
String(InputAGAKMinus2) + "'><br><br>";
```

```
html += "<p>Nilai Titik C : " + String(InputAGAKMinus3) + "</p>";
```

```
html += "<input type='number' name='InputAGAKMinus3' value='" +  
String(InputAGAKMinus3) + "'><br><br>";
```

```
html += "<p>Nilai Titik D : " + String(InputAGAKMinus4) + "</p>";
```

```
html += "<input type='number' name='InputAGAKMinus4' value='" +  
String(InputAGAKMinus4) + "'><br><br>";
```

```
html += "<input type='submit' value='Submit'>";
```

```
html += "</form>";
```

```
html += "<h2>FUZZY INPUT ERROR SETPOINT</h2>";
```

```
html += "<form action='/update_IES' method='post'>";
```

```
html += "<p>Nilai Titik A : " + String(InputSetPointE1) + "</p>";
```

```
html += "<input type='number' name='InputSetPointE1' value='" +  
String(InputSetPointE1) + "'><br><br>";
```

```
html += "<p>Nilai Titik B : " + String(InputSetPointE2) + "</p>";
```

```
html += "<input type='number' name='InputSetPointE2' value='" +  
String(InputSetPointE2) + "'><br><br>";
```

```
html += "<p>Nilai Titik C : " + String(InputSetPointE3) + "</p>";
```

```
html += "<input type='number' name='InputSetPointE3' value='" +  
String(InputSetPointE3) + "'><br><br>";
```

```
html += "<p>Nilai Titik D : " + String(InputSetPointE4) + "</p>";  
  
html += "<input type='number' name='InputSetPointE4' value='" +  
String(InputSetPointE4) + "'><br><br>";  
  
html += "<input type='submit' value='Submit'>";  
  
html += "</form>";  
  
  
html += "<h2>FUZZY INPUT ERROR AGAK PLUS</h2>";  
  
html += "<form action='/update_IEAP' method='post'>";  
  
html += "<p>Nilai Titik A : " + String(InputAGAKPlus1) + "</p>";  
  
html += "<input type='number' name='InputAGAKPlus1' value='" +  
String(InputAGAKPlus1) + "'><br><br>";  
  
html += "<p>Nilai Titik B : " + String(InputAGAKPlus2) + "</p>";  
  
html += "<input type='number' name='InputAGAKPlus2' value='" +  
String(InputAGAKPlus2) + "'><br><br>";  
  
html += "<p>Nilai Titik C : " + String(InputAGAKPlus3) + "</p>";  
  
html += "<input type='number' name='InputAGAKPlus3' value='" +  
String(InputAGAKPlus3) + "'><br><br>";  
  
html += "<p>Nilai Titik D : " + String(InputAGAKPlus4) + "</p>";  
  
html += "<input type='number' name='InputAGAKPlus4' value='" +  
String(InputAGAKPlus4) + "'><br><br>";  
  
html += "<input type='submit' value='Submit'>";  
  
html += "</form>";  
  
  
html += "<h2>FUZZY INPUT ERROR PLUS</h2>";
```



```
html += "<form action='/update_IEP' method='post'>";
html += "<p>Nilai Titik A : " + String(InputPlus1) + "</p>";
html += "<input type='number' name='InputPlus1' value='" +
String(InputPlus1) + "'><br><br>";
html += "<p>Nilai Titik B : " + String(InputPlus2) + "</p>";
html += "<input type='number' name='InputPlus2' value='" +
String(InputPlus2) + "'><br><br>";
html += "<p>Nilai Titik C : " + String(InputPlus3) + "</p>";
html += "<input type='number' name='InputPlus3' value='" +
String(InputPlus3) + "'><br><br>";
html += "<p>Nilai Titik D : " + String(InputPlus4) + "</p>";
html += "<input type='number' name='InputPlus4' value='" +
String(InputPlus4) + "'><br><br>";
html += "<input type='submit' value='Submit'>";
html += "</form>";

html += "<h2>REMAP PWM</h2>";
html += "<form action='/update_REMAPPWM' method='post'>";
html += "<p>Nilai Real Min : " + String(RealMinPWM) + "</p>";
html += "<input type='number' name='RMinP' value='" +
String(RealMinPWM) + "'><br><br>";
html += "<p>Nilai Real Max : " + String(RealMaxPWM) + "</p>";
html += "<input type='number' name='RMaxP' value='" +
String(RealMaxPWM) + "'><br><br>";
html += "<p>Nilai Remap Min : " + String(MapMinPWM) + "</p>";
```

```
html += "<input type='number' name='MMinP' value='" +  
String(MapMinPWM) + "'><br><br>";  
  
html += "<p>Nilai Remap Max : " + String(MapMaxPWM) + "</p>";  
  
html += "<input type='number' name='MMaxP' value='" +  
String(MapMaxPWM) + "'><br><br>";  
  
html += "<input type='submit' value='Submit'>";  
  
html += "</form>";
```

```
html += "</div>";
```

```
//Kolom 3
```

```
html += "<div class='column'>";  
  
html += "<h2>FUZZY OUTPUT RENDAH</h2>";  
  
html += "<form action='/update_OL' method='post'>";  
  
html += "<p>Nilai Titik A : " + String(OutputLow1) + "</p>";  
  
html += "<input type='number' name='OutputLow1' value='" +  
String(OutputLow1) + "'><br><br>";  
  
html += "<p>Nilai Titik B : " + String(OutputLow2) + "</p>";  
  
html += "<input type='number' name='OutputLow2' value='" +  
String(OutputLow2) + "'><br><br>";  
  
html += "<p>Nilai Titik C : " + String(OutputLow3) + "</p>";  
  
html += "<input type='number' name='OutputLow3' value='" +  
String(OutputLow3) + "'><br><br>";
```

```
html += "<p>Nilai Titik D :"+ String(OutputLow4) + "</p>";  
  
html += "<input type='number' name='OutputLow4' value='" +  
String(OutputLow4) + "'><br><br>";  
  
html += "<input type='submit' value='Submit'>";  
  
html += "</form>";  
  
  
html += "<h2>FUZZY OUTPUT AGAK RENDAH</h2>";  
  
html += "<form action='/update_OAL' method='post'>";  
  
html += "<p>Nilai Titik A :"+ String(OutputAGAKLow1) + "</p>";  
  
html += "<input type='number' name='OutputAGAKLow1' value='" +  
String(OutputAGAKLow1) + "'><br><br>";  
  
html += "<p>Nilai Titik B :"+ String(OutputAGAKLow2) + "</p>";  
  
html += "<input type='number' name='OutputAGAKLow2' value='" +  
String(OutputAGAKLow2) + "'><br><br>";  
  
html += "<p>Nilai Titik C :"+ String(OutputAGAKLow3) + "</p>";  
  
html += "<input type='number' name='OutputAGAKLow3' value='" +  
String(OutputAGAKLow3) + "'><br><br>";  
  
html += "<p>Nilai Titik D :"+ String(OutputAGAKLow4) + "</p>";  
  
html += "<input type='number' name='OutputAGAKLow4' value='" +  
String(OutputAGAKLow4) + "'><br><br>";  
  
html += "<input type='submit' value='Submit'>";  
  
html += "</form>";  
  
  
html += "<h2>FUZZY OUTPUT SEDANG</h2>";
```

```
html += "<form action='/update_OM' method='post'>";
html += "<p>Nilai Titik A : " + String(OutputMedium1) + "</p>";
html += "<input type='number' name='OutputMedium1' value='" +
String(OutputMedium1) + "'><br><br>";
html += "<p>Nilai Titik B : " + String(OutputMedium2) + "</p>";
html += "<input type='number' name='OutputMedium2' value='" +
String(OutputMedium2) + "'><br><br>";
html += "<p>Nilai Titik C : " + String(OutputMedium3) + "</p>";
html += "<input type='number' name='OutputMedium3' value='" +
String(OutputMedium3) + "'><br><br>";
html += "<p>Nilai Titik D : " + String(OutputMedium4) + "</p>";
html += "<input type='number' name='OutputMedium4' value='" +
String(OutputMedium4) + "'><br><br>";
html += "<input type='submit' value='Submit'>";
html += "</form>";
```

```
html += "<h2>FUZZY OUTPUT AGAK TINGGI</h2>";
html += "<form action='/update_OAH' method='post'>";
html += "<p>Nilai Titik A : " + String(OutputAGAKHigh1) + "</p>";
html += "<input type='number' name='OutputAGAKHigh1' value='" +
String(OutputAGAKHigh1) + "'><br><br>";
html += "<p>Nilai Titik B : " + String(OutputAGAKHigh2) + "</p>";
html += "<input type='number' name='OutputAGAKHigh2' value='" +
String(OutputAGAKHigh2) + "'><br><br>";
html += "<p>Nilai Titik C : " + String(OutputAGAKHigh3) + "</p>";
```

```
html += "<input type='number' name='OutputAGAKHigh3' value='" +  
String(OutputAGAKHigh3) + "'><br><br>";
```

```
html += "<p>Nilai Titik D : " + String(OutputAGAKHigh4) + "</p>";
```

```
html += "<input type='number' name='OutputAGAKHigh4' value='" +  
String(OutputAGAKHigh4) + "'><br><br>";
```

```
html += "<input type='submit' value='Submit'>";
```

```
html += "</form>";
```

```
html += "<h2>FUZZY OUTPUT TINGGI</h2>";
```

```
html += "<form action='/update_OH' method='post'>";
```

```
html += "<p>Nilai Titik A : " + String(OutputHigh1) + "</p>";
```

```
html += "<input type='number' name='OutputHigh1' value='" +  
String(OutputHigh1) + "'><br><br>";
```

```
html += "<p>Nilai Titik B : " + String(OutputHigh2) + "</p>";
```

```
html += "<input type='number' name='OutputHigh2' value='" +  
String(OutputHigh2) + "'><br><br>";
```

```
html += "<p>Nilai Titik C : " + String(OutputHigh3) + "</p>";
```

```
html += "<input type='number' name='OutputHigh3' value='" +  
String(OutputHigh3) + "'><br><br>";
```

```
html += "<p>Nilai Titik D : " + String(OutputHigh4) + "</p>";
```

```
html += "<input type='number' name='OutputHigh4' value='" +  
String(OutputHigh4) + "'><br><br>";
```

```
html += "<input type='submit' value='Submit'>";
```

```
html += "</form>";
```

```
html += "</div>";

html += "</div>"; // end container
html += "</body></html>";
server.send(200, "text/html", html);
}

void handleUpdateRemapRPM() {
    if (server.hasArg("RMinR")) {
        RealMinRPM = server.arg("RMinR").toInt();
    }
    if (server.hasArg("RMaxR")) {
        RealMaxRPM = server.arg("RMaxR").toInt();
    }
    if (server.hasArg("MMinR")) {
        MapMinRPM = server.arg("MMinR").toInt();
    }
    if (server.hasArg("MMaxR")) {
        MapMaxRPM = server.arg("MMaxR").toInt();
    }
    server.setHeader("Location", String("/"));
    server.send(302);
}
```

```
}
```

```
void handleUpdateRemapPWM() {  
    if (server.hasArg("RMinP")) {  
        RealMinPWM = server.arg("RMinP").toInt();  
    }  
    if (server.hasArg("RMaxP")) {  
        RealMaxPWM = server.arg("RMaxP").toInt();  
    }  
    if (server.hasArg("MMinP")) {  
        MapMinPWM = server.arg("MMinP").toInt();  
    }  
    if (server.hasArg("MMaxP")) {  
        MapMaxPWM = server.arg("MMaxP").toInt();  
    }  
    server.sendHeader("Location", String("/"));  
    server.send(302);  
}
```

```
//INPUT RPM
```

```
void handleUpdateIL() {  
    if (server.hasArg("InputLambat1")) {
```

```
    InputLambat1 = server.arg("InputLambat1").toInt();
}
if (server.hasArg("InputLambat2")) {
    InputLambat2 = server.arg("InputLambat2").toInt();
}
if (server.hasArg("InputLambat3")) {
    InputLambat3 = server.arg("InputLambat3").toInt();
}
if (server.hasArg("InputLambat4")) {
    InputLambat4 = server.arg("InputLambat4").toInt();
}
server.setHeader("Location", String("/"));
server.send(302);
}
```

```
void handleUpdateIAL() {
    if (server.hasArg("InputAGAKLambat1")) {
        InputAGAKLambat1 = server.arg("InputAGAKLambat1").toInt();
    }
    if (server.hasArg("InputAGAKLambat2")) {
        InputAGAKLambat2 = server.arg("InputAGAKLambat2").toInt();
    }
}
```



```
if (server.hasArg("InputAGAKLambat3")) {  
    InputAGAKLambat3 = server.arg("InputAGAKLambat3").toInt();  
}  
if (server.hasArg("InputAGAKLambat4")) {  
    InputAGAKLambat4 = server.arg("InputAGAKLambat4").toInt();  
}  
server.setHeader("Location", String("/"));  
server.send(302);  
}
```

```
void handleUpdateIS() {  
    if (server.hasArg("InputStabil1")) {  
        InputStabil1 = server.arg("InputStabil1").toInt();  
    }  
    if (server.hasArg("InputStabil2")) {  
        InputStabil2 = server.arg("InputStabil2").toInt();  
    }  
    if (server.hasArg("InputStabil3")) {  
        InputStabil3 = server.arg("InputStabil3").toInt();  
    }  
    if (server.hasArg("InputStabil4")) {  
        InputStabil4 = server.arg("InputStabil4").toInt();  
    }  
}
```

```
}  
  
server.setHeader("Location", String("/"));  
server.send(302);  
  
}  
  
void handleUpdateIAK() {  
    if (server.hasArg("InputAGAKKencang1")) {  
        InputAGAKKencang1 = server.arg("InputAGAKKencang1").toInt();  
    }  
    if (server.hasArg("InputAGAKKencang2")) {  
        InputAGAKKencang2 = server.arg("InputAGAKKencang2").toInt();  
    }  
    if (server.hasArg("InputAGAKKencang3")) {  
        InputAGAKKencang3 = server.arg("InputAGAKKencang3").toInt();  
    }  
    if (server.hasArg("InputAGAKKencang4")) {  
        InputAGAKKencang4 = server.arg("InputAGAKKencang4").toInt();  
    }  
    server.setHeader("Location", String("/"));  
    server.send(302);  
}
```

```
void handleUpdateIK() {
    if (server.hasArg("InputKencang1")) {
        InputKencang1 = server.arg("InputKencang1").toInt();
    }
    if (server.hasArg("InputKencang2")) {
        InputKencang2 = server.arg("InputKencang2").toInt();
    }
    if (server.hasArg("InputKencang3")) {
        InputKencang3 = server.arg("InputKencang3").toInt();
    }
    if (server.hasArg("InputKencang4")) {
        InputKencang4 = server.arg("InputKencang4").toInt();
    }
    server.setHeader("Location", String("/"));
    server.send(302);
}
```

//INPUT ERROR

```
void handleUpdateIEM() {
    if (server.hasArg("InputMinus1")) {
        InputMinus1 = server.arg("InputMinus1").toInt();
    }
}
```

```
if (server.hasArg("InputMinus2")) {
    InputMinus2 = server.arg("InputMinus2").toInt();
}
if (server.hasArg("InputMinus3")) {
    InputMinus3 = server.arg("InputMinus3").toInt();
}
if (server.hasArg("InputMinus4")) {
    InputMinus4 = server.arg("InputMinus4").toInt();
}
server.setHeader("Location", String("/"));
server.send(302);
}

void handleUpdateIEAM() {
    if (server.hasArg("InputAGAKMinus1")) {
        InputAGAKMinus1 = server.arg("InputAGAKMinus1").toInt();
    }
    if (server.hasArg("InputAGAKMinus2")) {
        InputAGAKMinus2 = server.arg("InputAGAKMinus2").toInt();
    }
    if (server.hasArg("InputAGAKMinus3")) {
        InputAGAKMinus3 = server.arg("InputAGAKMinus3").toInt();
    }
}
```

```
}  
if (server.hasArg("InputAGAKMinus4")) {  
    InputAGAKMinus4 = server.arg("InputAGAKMinus4").toInt();  
}  
server.setHeader("Location", String("/"));  
server.send(302);  
}
```

```
void handleUpdateIES() {  
    if (server.hasArg("InputSetPointE1")) {  
        InputSetPointE1 = server.arg("InputSetPointE1").toInt();  
    }  
    if (server.hasArg("InputSetPointE2")) {  
        InputSetPointE2 = server.arg("InputSetPointE2").toInt();  
    }  
    if (server.hasArg("InputSetPointE3")) {  
        InputSetPointE3 = server.arg("InputSetPointE3").toInt();  
    }  
    if (server.hasArg("InputSetPointE4")) {  
        InputSetPointE4 = server.arg("InputSetPointE4").toInt();  
    }  
    server.setHeader("Location", String("/"));  
}
```

```
server.send(302);
}

void handleUpdateIEAP() {
    if (server.hasArg("InputAGAKPlus1")) {
        InputAGAKPlus1 = server.arg("InputAGAKPlus1").toInt();
    }
    if (server.hasArg("InputAGAKPlus2")) {
        InputAGAKPlus2 = server.arg("InputAGAKPlus2").toInt();
    }
    if (server.hasArg("InputAGAKPlus3")) {
        InputAGAKPlus3 = server.arg("InputAGAKPlus3").toInt();
    }
    if (server.hasArg("InputAGAKPlus4")) {
        InputAGAKPlus4 = server.arg("InputAGAKPlus4").toInt();
    }
    server.setHeader("Location", String("/"));
    server.send(302);
}

void handleUpdateIEP() {
    if (server.hasArg("InputPlus1")) {
```

```
    InputPlus1 = server.arg("InputPlus1").toInt();
}
if (server.hasArg("InputPlus2")) {
    InputPlus2 = server.arg("InputPlus2").toInt();
}
if (server.hasArg("InputPlus3")) {
    InputPlus3 = server.arg("InputPlus3").toInt();
}
if (server.hasArg("InputPlus4")) {
    InputPlus4 = server.arg("InputPlus4").toInt();
}
server.setHeader("Location", String("/"));
server.send(302);
}
```

//OUTPUT PWM

```
void handleUpdateOL() {
    if (server.hasArg("OutputLow1")) {
        OutputLow1 = server.arg("OutputLow1").toInt();
    }
    if (server.hasArg("OutputLow2")) {
        OutputLow2 = server.arg("OutputLow2").toInt();
    }
}
```

```
}  
if (server.hasArg("OutputLow3")) {  
    OutputLow3 = server.arg("OutputLow3").toInt();  
}  
if (server.hasArg("OutputLow4")) {  
    OutputLow4 = server.arg("OutputLow4").toInt();  
}  
server.setHeader("Location", String("/"));  
server.send(302);  
}  
  
void handleUpdateOAL() {  
    if (server.hasArg("OutputAGAKLow1")) {  
        OutputAGAKLow1 = server.arg("OutputAGAKLow1").toInt();  
    }  
    if (server.hasArg("OutputAGAKLow2")) {  
        OutputAGAKLow2 = server.arg("OutputAGAKLow2").toInt();  
    }  
    if (server.hasArg("OutputAGAKLow3")) {  
        OutputAGAKLow3 = server.arg("OutputAGAKLow3").toInt();  
    }  
    if (server.hasArg("OutputAGAKLow4")) {
```



```
    OutputAGAKLow4 = server.arg("OutputAGAKLow4").toInt();
}
server.setHeader("Location", String("/"));
server.send(302);
}

void handleUpdateOM() {
    if (server.hasArg("OutputMedium1")) {
        OutputMedium1 = server.arg("OutputMedium1").toInt();
    }
    if (server.hasArg("OutputMedium2")) {
        OutputMedium2 = server.arg("OutputMedium2").toInt();
    }
    if (server.hasArg("OutputMedium3")) {
        OutputMedium3 = server.arg("OutputMedium3").toInt();
    }
    if (server.hasArg("OutputMedium4")) {
        OutputMedium4 = server.arg("OutputMedium4").toInt();
    }
    server.setHeader("Location", String("/"));
    server.send(302);
}
```

```
void handleUpdateOAH() {
    if (server.hasArg("OutputAGAKHigh1")) {
        OutputAGAKHigh1 = server.arg("OutputAGAKHigh1").toInt();
    }
    if (server.hasArg("OutputAGAKHigh2")) {
        OutputAGAKHigh2 = server.arg("OutputAGAKHigh2").toInt();
    }
    if (server.hasArg("OutputAGAKHigh3")) {
        OutputAGAKHigh3 = server.arg("OutputAGAKHigh3").toInt();
    }
    if (server.hasArg("OutputAGAKHigh4")) {
        OutputAGAKHigh4 = server.arg("OutputAGAKHigh4").toInt();
    }
    server.setHeader("Location", String("/"));
    server.send(302);
}
```

```
void handleUpdateOH() {
    if (server.hasArg("OutputHigh1")) {
        OutputHigh1 = server.arg("OutputHigh1").toInt();
    }
}
```

```
if (server.hasArg("OutputHigh2")) {  
    OutputHigh2 = server.arg("OutputHigh2").toInt();  
}  
if (server.hasArg("OutputHigh3")) {  
    OutputHigh3 = server.arg("OutputHigh3").toInt();  
}  
if (server.hasArg("OutputHigh4")) {  
    OutputHigh4 = server.arg("OutputHigh4").toInt();  
}  
server.setHeader("Location", String("/"));  
server.send(302);  
}
```

```
void SerialMonitor() {  
    Serial.print("Period: ");  
    Serial.print(PeriodBetweenPulses);  
    Serial.print("\tFrequency: ");  
    Serial.print(FrequencyReal);  
    Serial.print("\tRPM Real: ");  
    Serial.print(average);  
    Serial.print("\tPWM Real: ");  
    Serial.print(pwm);  
}
```

```
Serial.print("\tRPM Sensor: ");
Serial.println(RPM);
Serial.println();

Serial.print("ERROR: ");
Serial.print(error);
Serial.print("\tRPM Remap: ");
Serial.print(avg);
Serial.print("\tPWM Remap: ");
Serial.println(PWM);
Serial.println();
// delay(500);
}
```

