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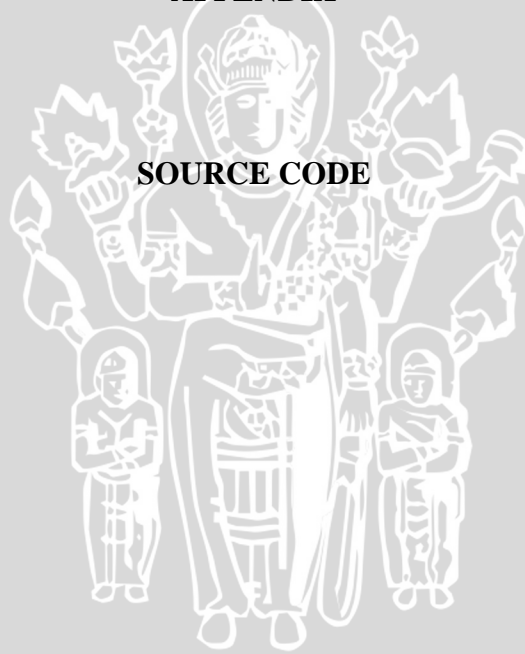




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**APPENDIX**

**SOURCE CODE**



## A1. Bang-bang Controller

```
#define LEDL 7
#define LEDM 4
#define LEDR 8
#define IRL 1
#define IRM 2
#define IRR 3
#define LEDL_ON digitalWrite(LEDL,HIGH)
#define LEDM_ON digitalWrite(LEDM,HIGH)
#define LEDR_ON digitalWrite(LEDR,HIGH)
#define LEDL_OFF digitalWrite(LEDL,LOW)
#define LEDM_OFF digitalWrite(LEDM,LOW)
#define LEDR_OFF digitalWrite(LEDR,LOW)
boolean IRL_STATUS, IRM_STATUS, IRR_STATUS;

double reading1, reading2,reading3;
int y=0;

void go_Forward(uint8_t speed1, uint8_t speed2) {
    speed1=map(speed1,0,100,0,150);
    speed2=map(speed2,0,100,0,150);
    //MOTOR1
    analogWrite(3,0); //PWM1
    analogWrite(5,speed1); //PWM2
    //MOTOR2
    analogWrite(6,speed2); //PWM3
    analogWrite(9,0); //PWM4
}

void go_Backward(uint8_t speed1, uint8_t speed2) {
    speed1=map(speed1,0,100,0,255);
    speed2=map(speed2,0,100,0,255);
    //MOTOR1
```

```

analogWrite(3,speed1); //PWM1
analogWrite(5,0); //PWM2
//MOTOR2
analogWrite(6,0); //PWM3
analogWrite(9,speed2); //PWM4
}

void go_Stop() {
//MOTOR1
analogWrite(3,0); //PWM1
analogWrite(5,0); //PWM2
//MOTOR2
analogWrite(6,0); //PWM3
analogWrite(9,0); //PWM4
}

void setup() {
// put your setup code here, to run once:
pinMode(LEDL,OUTPUT);
pinMode(LEDM,OUTPUT);
pinMode(LEDL,OUTPUT);
pinMode(2,INPUT);

pinMode(10,OUTPUT);pinMode(11,OUTPUT);pinMode(12,OUTPUT); pinMode(13,OUTPUT);
//DEBUG
Serial.begin(9600);
while(digitalRead(2)==HIGH) //Wait for user button
{
reading1 = analogRead(IRL);
reading2 = analogRead(IRM);
reading3 = analogRead(IRR);

Serial.print(reading1); Serial.print("\t");Serial.print(reading2);Serial.print("\t");
Serial.print(reading3); Serial.print("\t"); Serial.println(y);
}

```



```
}  
  
void loop() {  
  //READ SENSOR======  
  digitalWrite(10,HIGH);  
  uint8_t data_IRL = map(analogRead(IRL),0,1023,0,100);  
  uint8_t data_IRM = map(analogRead(IRM),0,1023,0,100);  
  uint8_t data_IRR = map(analogRead(IRR),0,1023,0,100);  
  Serial.print(data_IRL); Serial.print("\t"); Serial.print(data_IRM); Serial.print("\t");  
  Serial.println(data_IRR);  
  digitalWrite(10,LOW);  
  digitalWrite(11,HIGH);  
  if(data_IRL >3) {IRL_STATUS=HIGH; LEDL_ON;} else {IRL_STATUS=LOW; LEDL_OFF;}  
  if(data_IRM >3) {IRM_STATUS=HIGH; LEDM_ON;} else {IRM_STATUS=LOW;  
  LEDM_OFF;}  
  if(data_IRR >3) {IRR_STATUS=HIGH; LEDR_ON;} else {IRR_STATUS=LOW; LEDR_OFF;}  
  digitalWrite(11,LOW);  
  //MOTOR CONTROL======  
  digitalWrite(12,HIGH);  
  
  if(!((IRL_STATUS&&IRM_STATUS&&!IRR_STATUS)||(!IRL_STATUS&&IRM_STATUS&&IRR_STATUS)) go_Forward(100,70); //STRAIGHT  
  else if(IRL_STATUS&&IRM_STATUS&&!IRR_STATUS) go_Forward(80,100); //MOVE LEFT  
  else if(IRL_STATUS&&!IRM_STATUS&&!IRR_STATUS) go_Forward(0,100); //MOVE  
  HEAVY LEFT  
  else if(!IRL_STATUS&&IRM_STATUS&&IRR_STATUS) go_Forward(100,80); //MOVE  
  RIGHT  
  else if(!IRL_STATUS&&!IRM_STATUS&&IRR_STATUS) go_Forward(100,0); //MOVE  
  HEAVY RIGHT  
  
  if(!IRL_STATUS&&!IRM_STATUS&&!IRR_STATUS)  
  { go_Stop();  
  
  } //STOP  
  
  digitalWrite(12,LOW);  
}
```

## A2. PID Controller Digital Concept Sensors

```

#define LEDL 7
#define LEDM 4
#define LEDR 8
#define LEDL_ON digitalWrite(LEDL,HIGH)
#define LEDM_ON digitalWrite(LEDM,HIGH)
#define LEDR_ON digitalWrite(LEDR,HIGH)
#define LEDL_OFF digitalWrite(LEDL,LOW)
#define LEDM_OFF digitalWrite(LEDM,LOW)
#define LEDR_OFF digitalWrite(LEDR,LOW)

const int motorkiri = 3;
const int motorkanan = 9;
const int motorkiri2 = 5;
const int motorkanan2 = 6;
const int kiri = A1;
const int tengah = A2;
const int kanan = A3;

int PV = 0;
int error = 0;
int setPoint = 0;

boolean IRL_STATUS, IRM_STATUS, IRR_STATUS, steady, left, stoped;
double reading1, reading2,
reading3, dError, sError, lError, dTime, PID, errorTop, errorBot, kP, kI, kD, y2, y1;

long pwmMotor;
unsigned long now, lTime;

void setup ()
{
    pinMode(motorkiri,OUTPUT);
    pinMode(motorkanan,OUTPUT);

```



```

pinMode(LEDL,OUTPUT);
pinMode(LEDM,OUTPUT);
pinMode(LEDRL,OUTPUT);

pinMode(kiri,INPUT);
pinMode(tengah,INPUT);
pinMode(kanan,INPUT);

pinMode(2,INPUT);

pinMode(10,OUTPUT);pinMode(11,OUTPUT);pinMode(12,OUTPUT);
pinMode(13,OUTPUT); //DEBUG

Serial.begin(9600);
while(digitalRead(2)==HIGH) //Wait for user button
{
  Stop();
  reading1 = analogRead (kiri);
  reading2 = analogRead (tengah);
  reading3 = analogRead (kanan);
  Serial.print(reading1); Serial.print("\t"); Serial.print(reading2); Serial.print("\t");
  Serial.println(reading3);

  LEDL_OFF; LEDM_OFF; LEDR_OFF;
  delay(100);
  LEDL_ON; LEDM_ON; LEDR_ON;
  delay(100);
  LEDL_OFF; LEDM_OFF; LEDR_ON;
  delay(100);
  LEDL_OFF; LEDM_ON; LEDR_OFF;
  delay(100);
  LEDL_ON; LEDM_OFF; LEDR_OFF;
  delay(100);
  LEDL_ON; LEDM_ON; LEDR_ON;
  delay(100);
  LEDL_OFF; LEDM_OFF; LEDR_OFF;
  delay(100);
  LEDL_ON; LEDM_ON; LEDR_ON;
  delay(100);
}

```

```

LEDL_ON; LEDM_OFF; LEDR_OFF;
delay(100);
LEDL_OFF; LEDM_ON; LEDR_OFF;
delay (100);
LEDL_OFF; LEDM_OFF; LEDR_ON;
delay(100);
LEDL_ON; LEDM_ON; LEDR_ON;
delay(100);
}

error = 0;
dError = 0;
sError = 0;
IError = 0;
dTime = 0;
PID = 0;
steady = false;
left = false;

*****
parameter set
*****

setPoint = 0;
kP = 0.0433;
kI = 0.01;
kD = 0.0473;

}

void loop ()
{
digitalWrite(10,HIGH);

Serial.print(PV);
Serial.print("\n");
readsensor ();
compute ();
if(!IRL_STATUS&&!IRM_STATUS&&!IRR_STATUS)

```

```
{  
  Stop ();  
}  
else {  
  
  if (steady){  
    motor_lurus ();  
  }  
  
  else {  
    if (left){  
      setting_motor (1,pwmMotor);  
    }  
    else{  
      setting_motor (2,pwmMotor);  
    }  
  }  
}  
digitalWrite(10,LOW);  
delay(10);  
Serial.print(PV);  
}  
void Stop ()  
{  
  analogWrite (motorkiri, 0);  
  analogWrite (motorkiri2, 0);  
  analogWrite (motorkanan, 0);  
  analogWrite (motorkanan2, 0);  
}  
void motor_lurus ()  
{  
  analogWrite (motorkiri, 0);
```

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```
analogWrite (motorkiri2, 150);
    analogWrite (motorkanan, 0);
    analogWrite (motorkanan2, 150);
}
void setting_motor (int motor,int pwm)
{
    digitalWrite(11,HIGH);

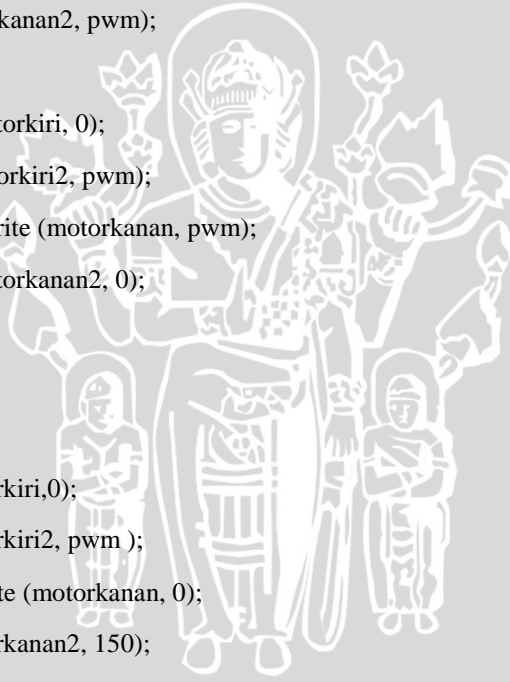
    if (motor==1){

        analogWrite (motorkiri, 0);
        analogWrite (motorkiri2, 150);
        analogWrite (motorkanan, 0);
        analogWrite (motorkanan2, pwm);

        // analogWrite (motorkiri, 0);
        // analogWrite (motorkiri2, pwm);
        //analogWrite (motorkanan, pwm);
        //analogWrite (motorkanan2, 0);
    }
    if (motor==2){

        analogWrite (motorkiri,0);
        analogWrite (motorkiri2, pwm );
        analogWrite (motorkanan, 0);
        analogWrite (motorkanan2, 150);

        //analogWrite (motorkiri, pwm);
        // analogWrite (motorkiri2, 0 );
        //analogWrite (motorkanan, 0);
        // analogWrite (motorkanan2, pwm);
    }
    digitalWrite(11,LOW);
}
```



```
void readsensor()
{
    digitalWrite(12,HIGH);

    //data sensors read
    reading1 = analogRead (kiri);
    reading2 = analogRead (tengah);
    reading3 = analogRead (kanan);

    if(reading1 >30) {IRL_STATUS=HIGH; LEDL_ON;} else {IRL_STATUS=LOW;
    LEDL_OFF;}

    if(reading2 >30) {IRM_STATUS=HIGH; LEDM_ON;} else {IRM_STATUS=LOW;
    LEDM_OFF;}

    if(reading3 >30) {IRR_STATUS=HIGH; LEDR_ON;} else {IRR_STATUS=LOW;
    LEDR_OFF;}

    if((IRL_STATUS&&IRM_STATUS&&IRR_STATUS)||(!IRL_STATUS&&IRM_STATU
    S&&!IRR_STATUS)) PV = 0; //STRAIGHT

    else if(IRL_STATUS&&IRM_STATUS&&!IRR_STATUS) PV = 1;
    else if(IRL_STATUS&&!IRM_STATUS&&!IRR_STATUS) PV = 2;
    else if(!IRL_STATUS&&IRM_STATUS&&IRR_STATUS) PV =-1;
    else if(!IRL_STATUS&&!IRM_STATUS&&IRR_STATUS) PV =-2;
    if(!IRL_STATUS&&!IRM_STATUS&&!IRR_STATUS) stopped=true;

    digitalWrite(12,LOW);
}

void compute ()
{
    digitalWrite(13,HIGH);

    now = millis();

    dTime =(double) (now-lTime);

    //calculate error
    error = setPoint-PV;

    //condition now
```

```
if (error>setPoint){
    steady = false;
    left = true;
}
else if (error<setPoint){
    steady = false;
    left = false;
}
else {
    steady =true;
}

//calculation PID signal
sError =(sError+error);
dError = (error-lError);
PID = (kP*error)+((kI*sError)*(dTime/500))+((kD*dError)/(dTime/500));

if (PID>150)
    pwmMotor= 150;
else if (PID<-150)
    pwmMotor = 150;
else{
    if (PID>0)
        pwmMotor = (int) PID;
    else
        pwmMotor = (int)(PID*(-1));
}

lError = error;
lTime = now;
digitalWrite(13,LOW);
}
```



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### A3. PID Controller Analog Concept Sensors

```
#define LEDL 7
#define LEDM 4
#define LEDR 8
#define LEDL_ON digitalWrite(LEDL,HIGH)
#define LEDM_ON digitalWrite(LEDM,HIGH)
#define LEDR_ON digitalWrite(LEDR,HIGH)
#define LEDL_OFF digitalWrite(LEDL,LOW)
#define LEDM_OFF digitalWrite(LEDM,LOW)
#define LEDR_OFF digitalWrite(LEDR,LOW)

const int motorkiri = 3;
const int motorkanan = 9;
const int motorkiri2 = 5;
const int motorkanan2 = 6;
const int kiri = A1;
const int tengah = A2;
const int kanan = A3;


int PV = 0;
int error = 0;
int setPoint = 0;

boolean IRL_STATUS, IRM_STATUS, IRR_STATUS,steady,left,stoped;
double reading1,reading2, reading3,dError,sError,lError,dTime,PID,errorTop,errorBot,kP,kl,kD;

float y1,y2,x11,x12,x21,x22,z1,z2,zhasil1,zhasil2;

long pwmMotor;
unsigned long now,lTime;

void setup ()
```



```

{
  pinMode(motorkiri,OUTPUT);
  pinMode(motorkanan,OUTPUT);
  pinMode(LEDL,OUTPUT);
  pinMode(LEDM,OUTPUT);
  pinMode(LEDK,OUTPUT);

  pinMode(kiri,INPUT);
  pinMode(tengah,INPUT);
  pinMode(kanan,INPUT);
  pinMode(2,INPUT);

  pinMode(10,OUTPUT);pinMode(11,OUTPUT);pinMode(12,OUTPUT);
  pinMode(13,OUTPUT); //DEBUG

  Serial.begin(9600);
  while(digitalRead(2)==HIGH) //Wait for user button
  {
    Stop();
    reading1 = analogRead (kiri);
    reading2 = analogRead (tengah);
    reading3 = analogRead (kanan);
    Serial.print(reading1); Serial.print("\t"); Serial.print(reading2); Serial.print("\t");
    Serial.println(reading3);
  }
  error = 0;
  dError = 0;
  sError = 0;
  lError = 0;
  dTime = 0;
  PID = 0;
  steady = false;
  left = false;
  *****
  parameter set
  *****
  setPoint = 0;

```

```
kP = 0.0433;
kI = 0.01;
kD = 0.0473;
}
void loop ()
{
  digitalWrite(10,HIGH);

  readsensor ();
  compute ();
  if(!IRL_STATUS&&!IRM_STATUS&&!IRR_STATUS)
  {
    Stop ();
  }
  else {

    if (steady){
      motor_lurus ();
    }

    else {
      if (left){
        setting_motor (1,pwmMotor);
      }
      else{
        setting_motor (2,pwmMotor);
      }
    }
  }
  digitalWrite(10,LOW);
}
```

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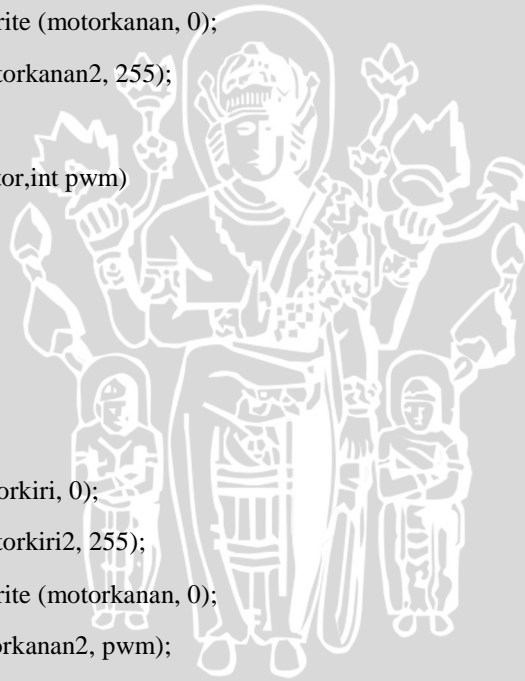
```
delay(10);
}
void Stop ()
{
    analogWrite (motorkiri, 0);
    analogWrite (motorkiri2, 0);
    analogWrite (motorkanan, 0);
    analogWrite (motorkanan2, 0);
}
void motor_lurus ()
{
    analogWrite (motorkiri, 0);
    analogWrite (motorkiri2, 255);
    analogWrite (motorkanan, 0);
    analogWrite (motorkanan2, 255);
}
void setting_motor (int motor,int pwm)
{
    digitalWrite(11,HIGH);

    if (motor==1){

        analogWrite (motorkiri, 0);
        analogWrite (motorkiri2, 255);
        analogWrite (motorkanan, 0);
        analogWrite (motorkanan2, pwm);

        // analogWrite (motorkiri, 0);
        // analogWrite (motorkiri2, pwm);
        //analogWrite (motorkanan, pwm);
        //analogWrite (motorkanan2, 0);
    }
    if (motor==2){

        analogWrite (motorkiri,0);
        analogWrite (motorkiri2, pwm );
```



```

        analogWrite (motorkanan, 0);
        analogWrite (motorkanan2, 255);

        //analogWrite (motorkiri, pwm);
        // analogWrite (motorkiri2, 0 );
        //analogWrite (motorkanan, 0);
        // analogWrite (motorkanan2, pwm);
    }
    digitalWrite(11,LOW);
}

void readsensor()
{
    digitalWrite(12,HIGH);
    //data sensors read
    reading1 = analogRead (kiri);
    reading2 = analogRead (tengah);
    reading3 = analogRead (kanan);

    if(reading1 >30) {IRL_STATUS=HIGH; LEDL_ON;} else {IRL_STATUS=LOW;
    LEDL_OFF;}
    if(reading2 >30) {IRM_STATUS=HIGH; LEDM_ON;} else {IRM_STATUS=LOW;
    LEDM_OFF;}
    if(reading3 >30) {IRR_STATUS=HIGH; LEDR_ON;} else {IRR_STATUS=LOW;
    LEDR_OFF;}

    if((IRL_STATUS&&IRM_STATUS&&IRR_STATUS)||(!IRL_STATUS&&IRM_STATU
    S&&!IRR_STATUS)) PV = 0; //STRAIGHT

    else if(IRL_STATUS&&IRM_STATUS&&!IRR_STATUS) PV = 1;
    else if(IRL_STATUS&&!IRM_STATUS&&!IRR_STATUS) PV = 2;
    else if(!IRL_STATUS&&IRM_STATUS&&IRR_STATUS) PV =-1;
    else if(!IRL_STATUS&&!IRM_STATUS&&IRR_STATUS) PV =-2;
    if(!IRL_STATUS&&!IRM_STATUS&&!IRR_STATUS) stoped=true;
}

```

```

if (reading1 <30) reading1 = 30;
else if (reading1 >180) reading1=180;
else {reading1=reading1;}

```

```

if (reading2 <30) reading2 = 30;
else if (reading2 >180) reading2=180;
else {reading2=reading2;}

```

```

if (reading3 <30) reading3 = 30;
else if (reading3 >180) reading3=180;
else {reading3=reading3;}
}

```

```

if ((reading1=30)&&(reading3>30))
{

```

```

    y1 = reading2-reading1;
    z1= 2302+(34.12*(120+y1));
    zhasil1 = sqrt(z1);
    x11=(47.98+z1)/17.06;
    x12=(47.98-z1)/17.06;

```

```

}
else if ((reading3=30)&&(reading1>30))
{

```

```

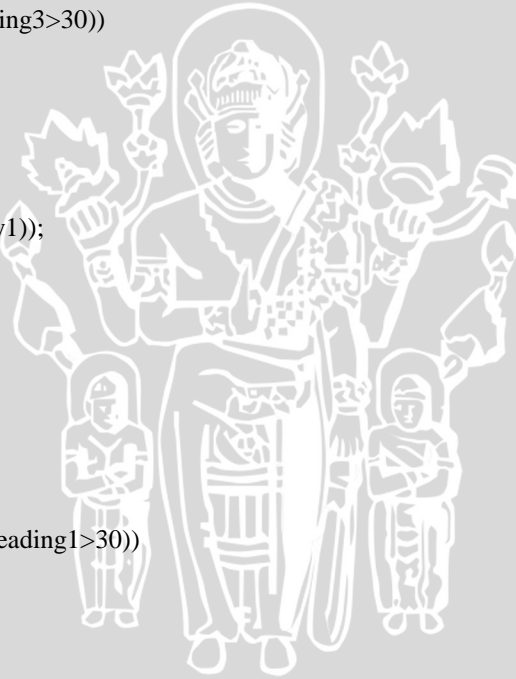
    y2 = reading2-reading3;
    z2= 2302+(34.12*(120+y2));
    zhasil2 = sqrt(z2);
    x21=(47.98+z2)/17.06;
    x22=(47.98-z2)/17.06;

```

```

}
digitalWrite(12,LOW);

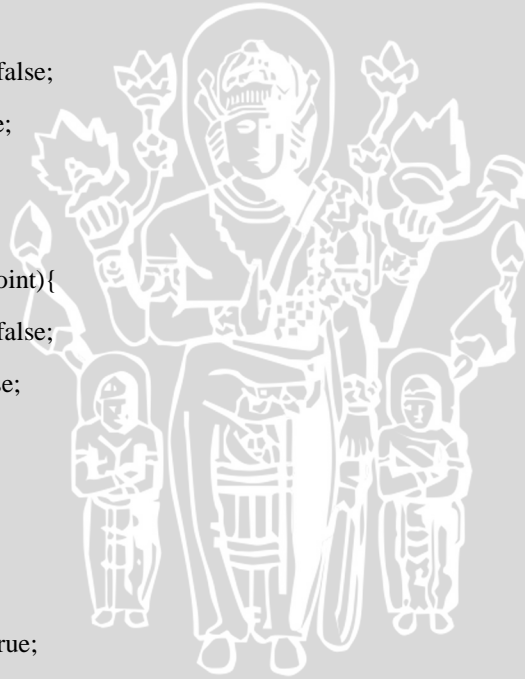
```





```
}  
void compute ()  
{  
    digitalWrite(13,HIGH);  
    now = millis();  
    dTime =(double) (now-lTime);  
  
    //calculate error  
    error = setPoint-PV;  
  
    //condition now  
    if (error>setPoint){  
        steady = false;  
        left = true;  
  
    }  
    else if (error<setPoint){  
        steady = false;  
        left = false;  
  
    }  
    else {  
  
        steady =true;  
  
    }  
  
    //calculation PID signal  
    sError =(sError+error);  
    dError = (error-lError);  
    PID = (kP*error)+((kI*sError)*(dTime/500))+((kD*dError)/(dTime/500));  
  
    if (PID>255)  
        pwmMotor= 255;
```

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```
else if (PID<-255)
    pwmMotor = 255;
else{
    if (PID>0)
        pwmMotor = (int) PID;
    else
        pwmMotor = (int)(PID*(-1));
}
Serial.print(PID);
IError = error;
ITime = now;
Serial.print("\t");
Serial.print("PID=");
Serial.print(PID);
Serial.print(" ");
Serial.print("\t");
Serial.print("PWM=");
Serial.print(pwmMotor);
Serial.print(" ");
Serial.print("\n");

digitalWrite(13,LOW);
}
```



#### A4. PID ChibiOS Real-Time (Digital Concept Sensors)

```

#include <ChibiOS_AVR.h>

#define LEDL      7
#define LEDM      4
#define LEDR      8
#define LEDL_ON   digitalWrite(LEDL,HIGH)
#define LEDM_ON   digitalWrite(LEDM,HIGH)
#define LEDR_ON   digitalWrite(LEDR,HIGH)
#define LEDL_OFF  digitalWrite(LEDL,LOW)
#define LEDM_OFF  digitalWrite(LEDM,LOW)
#define LEDR_OFF  digitalWrite(LEDR,LOW)

#define motorkiri  3
#define motorkanan 9
#define motorkiri2 5
#define motorkanan2 6

#define kiri       A1
#define tengah     A2
#define kanan      A3

int PV = 0;
int error = 0;
int setPoint = 0;

boolean IRL_STATUS, IRM_STATUS, IRR_STATUS, steady, left, stoped;
double reading1, reading2,
reading3, dError, sError, lError, dTime, PID, errorTop, errorBot, kP, kI, kD, y2, y1;

long pwmMotor;
unsigned long now, lTime;

void Stop ()
{

```





```

analogWrite (motorkiri, 0);
analogWrite (motorkiri2, 0);
        analogWrite (motorkanan, 0);
analogWrite (motorkanan2, 0);
    }
void motor_lurus ()
{
    analogWrite (motorkiri, 0);
    analogWrite (motorkiri2, 150);
        analogWrite (motorkanan, 0);
    analogWrite (motorkanan2, 150);
}
void setting_motor (int motor,int pwm)
{
    if (motor==1){
        analogWrite (motorkiri, 0);
        analogWrite (motorkiri2, 150);
            analogWrite (motorkanan, 0);
        analogWrite (motorkanan2, pwm);

        // analogWrite (motorkiri, 0);
        // analogWrite (motorkiri2, pwm);
            //analogWrite (motorkanan, pwm);
        //analogWrite (motorkanan2, 0);
    }
    if (motor==2){
        analogWrite (motorkiri,0);
        analogWrite (motorkiri2, pwm );
            analogWrite (motorkanan, 0);
        analogWrite (motorkanan2, 150);

        //analogWrite (motorkiri, pwm);
        // analogWrite (motorkiri2, 0 );
            //analogWrite (motorkanan, 0);
    }
}

```

```
// analogWrite (motorkanan2, pwm);  
  
}  
  
}  
  
void readsensor()  
{  
    //data sensors read  
    reading1 = analogRead (kiri);  
    reading2 = analogRead (tengah);  
    reading3 = analogRead (kanan);  
  
    if(reading1 >30) {IRL_STATUS=HIGH; } else {IRL_STATUS=LOW; }  
    if(reading2 >30) {IRM_STATUS=HIGH; } else {IRM_STATUS=LOW; }  
    if(reading3 >30) {IRR_STATUS=HIGH; } else {IRR_STATUS=LOW; }  
  
    if((IRL_STATUS&&IRM_STATUS&&IRR_STATUS)||(!IRL_STATUS&&IRM_STATU  
S&&!IRR_STATUS)) PV = 0; //STRAIGHT  
    else if(IRL_STATUS&&IRM_STATUS&&!IRR_STATUS) PV = 1;  
    else if(IRL_STATUS&&!IRM_STATUS&&!IRR_STATUS) PV = 2;  
    else if(!IRL_STATUS&&IRM_STATUS&&IRR_STATUS) PV =-1;  
    else if(!IRL_STATUS&&!IRM_STATUS&&IRR_STATUS) PV =-2;  
    if(!IRL_STATUS&&!IRM_STATUS&&!IRR_STATUS) stoped=true;  
  
}  
  
void compute ()  
{  
    now = millis();  
    dTime =(double) (now-lTime);
```

```
//calculate error
error = setPoint-PV;

//condition now
if (error>setPoint){
    steady = false;
    left = true;
}
else if (error<setPoint){
    steady = false;
    left = false;
}
else {

    steady =true;

}

//calculation PID signal
sError =(sError+error);
dError = (error-IError);
PID = (kP*error)+((kI*sError)*(dTime/1000))+((kD*dError)/(dTime/1000));

if (PID>255)
    pwmMotor= 255;
else if (PID<-255)
    pwmMotor = 255;
else{
    if (PID>0)
        pwmMotor = (int) PID;
    else
        pwmMotor = (int)(PID*(-1));
}
```



```
    IError = error;
    ITime = now;
}

//-----
//TASK1: READ LINE SENSOR
static WORKING_AREA(waTask1, 64); //SIZE OF WORKING MEMORY AREA

static msg_t Task1(void *arg) {
    while (1) {
        digitalWrite(10,HIGH);
        Serial.print("\n");
        Serial.print(PV);
        Serial.print("\n");

        readsensor ();
        digitalWrite(10,LOW);
        Serial.print(PV);
        chThdSleepMilliseconds(1); //DELAY 1ms
    }
    return 0;
}

//-----
//TASK2: PID CALCULATION
static WORKING_AREA(waTask2, 128);

static msg_t Task2(void *arg) {
    while (1) {
        digitalWrite(11,HIGH);
        compute ();
    }
}
```



```

digitalWrite(11,LOW);
chThdSleepMilliseconds(10);
}
return 0;
}
//-----

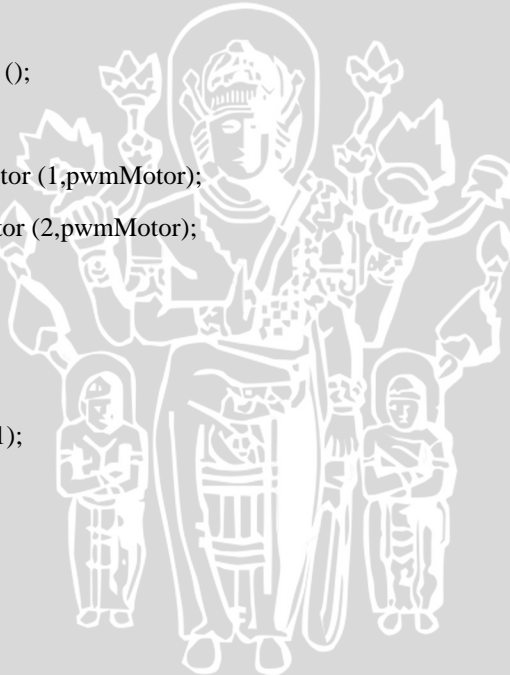
//TASK3: ROBOT MOTION
static WORKING_AREA(waTask3, 128);

static msg_t Task3(void *arg) {
while (1) {
digitalWrite(12,HIGH);
if(!IRL_STATUS&&!IRM_STATUS&&!IRR_STATUS) Stop ();
else{
if (steady) motor_lurus ();
else{
if (left) setting_motor (1,pwmMotor);
else setting_motor (2,pwmMotor);
}
}
digitalWrite(12,LOW);
chThdSleepMilliseconds(1);
}
return 0;
}
//-----

//TASK4: LIVE LED
static WORKING_AREA(waTask4, 64);

static msg_t Task4(void *arg) {
while (1) {
digitalWrite(13,HIGH);
LEDL_OFF; LEDM_OFF; LEDR_OFF;
chThdSleepMilliseconds(300);
LEDL_ON; LEDM_ON; LEDR_ON;
}
}

```



```
digitalWrite(13,LOW);
chThdSleepMilliseconds(300);
}
return 0;
}

//-----

void setup() {

  pinMode(10,OUTPUT);pinMode(11,OUTPUT);pinMode(12,OUTPUT); pinMode(13,OUTPUT);
  //DEBUG

  pinMode(motorkiri,OUTPUT);
  pinMode(motorkanan,OUTPUT);
  pinMode(LEDL,OUTPUT);
  pinMode(LEDM,OUTPUT);
  pinMode(LEDRL,OUTPUT);

  pinMode(kiri,INPUT);
  pinMode(tengah,INPUT);
  pinMode(kanan,INPUT);
  pinMode(2,INPUT);

  Serial.begin(9600);
  while(digitalRead(2)==HIGH) //Wait for user button
  {
    Stop();
    LEDL_ON; LEDM_ON; LEDR_ON;
  }

  error = 0;
  dError = 0;
  sError = 0;
  lError = 0;
  dTime = 0;
  PID = 0;
  steady = false;
```



```
left = false;
```

```
*****
```

```
parameter set
```

```
*****
```

```
setPoint = 0;
```

```
kP = 0.0433;
```

```
kI = 0.01;
```

```
kD = 0.0473;
```

```
chBegin(chSetup);
```

```
// chBegin never returns, main thread continues with mainThread()
```

```
while(1);
```

```
}
```

```
-----
```

```
// main thread runs at NORMALPRIO
```

```
void chSetup() {
```

```
// start blink thread
```

```
chThdCreateStatic(waTask1, sizeof(waTask1),
NORMALPRIO + 3, Task1, NULL);
```

```
chThdCreateStatic(waTask2, sizeof(waTask2),
NORMALPRIO + 2, Task2, NULL);
```

```
chThdCreateStatic(waTask3, sizeof(waTask3),
NORMALPRIO + 1, Task3, NULL);
```

```
chThdCreateStatic(waTask4, sizeof(waTask4),
NORMALPRIO , Task4, NULL);
```

```
}
```

```
-----
```

```
void loop() {
```

```
// not used
```

```
}
```