LAMPIRAN *CODDING*

“HASIL *CODDING* MODEL AGV *LINE FOLLOWER*”

```
//************************************//
// author: lukman hakim
// date:01/08/2018
// rev 1
//************************************//

#include "hardware_config.h"
#include "button_and_motor.h"
#include "variable.h"
#include "sensor.h"
#include "panel.h"
#include "plan.h"
#include "running.h"

Ultrasonic ultrasonic(20,21);

void setup() {
  init_button();
  init_sensor();
  pinMode(pin_LCDRW, OUTPUT);
  pinMode(pin_LCDLED, OUTPUT);
  digitalWrite(pin_LCDRW, LOW);
  digitalWrite(pin_LCDLED, HIGH);
  pinMode(pin_OUTPUT_EXT, OUTPUT);
  digitalWrite(pin_OUTPUT_EXT, HIGH);
  lcd.begin(16, 2);
  lcd.clear();
  delay(100);
  lcd.setCursor(0, 0);
  lcd.print("Ryan Saputra");
  lcd.setCursor(0, 1);
```

```
  lcd.print("UMU");
  delay(1000);
  lcd.clear();

  EEPROM.get(0, ee);

  reset_default();
  plan_input();

}

void loop() {
  displayHomeScreen();
  if (!button_START) {
    check_XOR();
    Running();
  }
  if (!button_MENU) {
    calibrate_sensor();
  }
}

void Running() {
  lcd.clear();
  lcd.print("GOOOO....");
  delay(200);
  lcd.clear();
  digitalWrite(pin_LCDLED, LOW);

  index = ee.path.cp[ee.path.index_cp];
```

```
temp_timer = 0;
tick = 0;

setMotor(speed_delay_start, speed_delay_start);
delay(delay_start);

while (1) {
 sensor_running = readSensor();
 if (temp_timer > 0) {
  lcd_backlightOn;
  tick++;
  if (tick > 4) {
   temp_timer--;
   tick = 0;
  }
  speed = ee.path.SA[ee.setting.plan][index];
 }
 else {
  lcd_backlightOff;
  temp_timer = ee.path.TA[ee.setting.plan][index];
  ee.path.TA[ee.setting.plan][index] = 0;
  tick = 0;
  speed = ee.setting.speed;

  if (index == stop_index) break;

  solve_path();
 }

 lcd.setCursor(0, 1);
 lcd.print(index);
```

```
    follow_line();
    if ( ultrasonic.Ranging(CM)<=20) {
      setMotor(0,0);
      delay(2000);
    }
    if (!button_START) {
      break;
    }
  }
  setMotor(0, 0);
  digitalWrite(pin_LCDLED, HIGH);
  lcd.clear();
  lcd.print("Completed....");
  delay(2000);
  lcd.clear();
  EEPROM.get(0, ee);
  reset_default();
  plan_input();
}
```

- Button_and_motor.h

```
//************************************//
// author: lukman hakim
// date:01/08/2018
// rev 1
//************************************//

#define button_UPL digitalRead(pin_button_UPL)
#define button_DOWNL digitalRead(pin_button_DOWNL)
#define button_UPR digitalRead(pin_button_UPR)
#define button_DOWNR digitalRead(pin_button_DOWNR)
#define button_START digitalRead(pin_button_START)
```

```
#define button_MENU digitalRead(pin_button_MENU)

void init_button() {
  pinMode(pin_button_UPL, INPUT_PULLUP);
  pinMode(pin_button_DOWNL, INPUT_PULLUP);
  pinMode(pin_button_UPR, INPUT_PULLUP);
  pinMode(pin_button_DOWNR, INPUT_PULLUP);
  pinMode(pin_button_START, INPUT_PULLUP);
  pinMode(pin_button_MENU, INPUT_PULLUP);
}

void setMotor(int L, int R) {
  if (L > 0) {
    digitalWrite(pin_MOTOR_DIRL, LOW);
  } else {
    digitalWrite(pin_MOTOR_DIRL, HIGH);
    L = 255 + L;
  }
  analogWrite(pin_MOTOR_PWML, L);
  if (R > 0) {
    digitalWrite(pin_MOTOR_DIRR, LOW);
  } else {
    digitalWrite(pin_MOTOR_DIRR, HIGH);
    R = 255 + R;
  }
  analogWrite(pin_MOTOR_PWMR, R);
}

void setMotorT(int L, int R) {
  if (L < 0) {
    L = 255 + L;
```

```
    analogWrite(PWM_naik, L);
    digitalWrite(dir_naik, 1);
   } else {
    analogWrite(PWM_naik, L);
    digitalWrite(dir_naik, 0);
   }
   if (R < 0) {
    R = 255 + R;
    analogWrite(PWM_maju, R);
    digitalWrite(dir_maju, 1);
   } else {
    analogWrite(PWM_maju, R);
    digitalWrite(dir_maju, 0);
   }
}
```

- Hardware_config.h

```
//*************************************//
// author: lukman hakim
// date:01/08/2018
// rev 1
//*************************************//

// config for ichibot ultimate arduino
#define PWM_naik      45
#define dir_naik      47
#define PWM_maju      46
#define dir_maju      48

#define pin_button_UPL      A8
#define pin_button_DOWNL    8
```

```
#define pin_button_UPR      11
#define pin_button_DOWNR    12
#define pin_button_START    10
#define pin_button_MENU     9

#define pin_LCDRS           34
#define pin_LCDRW           111
#define pin_LCDE            32
#define pin_LCDD4           30
#define pin_LCDD5           28
#define pin_LCDD6           26
#define pin_LCDD7           24
#define pin_LCDLED          22

#define lcd_backlightOn     digitalWrite(pin_LCDLED, HIGH)
#define lcd_backlightOff    digitalWrite(pin_LCDLED, LOW)

#define pin_MOTOR_DIRL      7
#define pin_MOTOR_PWML      6
#define pin_MOTOR_DIRR      5
#define pin_MOTOR_PWMR      4

#define pin_ENABLE_SENSORL  A1
#define pin_ENABLE_SENSORR  A0

#define pin_OUTPUT_EXT      15

#define max_sensor          12

const int pin_ADC_SENSOR[max_sensor] = {A2, A3, A4, A5, A6, A7, A7, A6,
A5, A4, A3, A2};
```

```
#include <Ultrasonic.h>
#include <LiquidCrystal.h>;
LiquidCrystal lcd(pin_LCDRS, pin_LCDE, pin_LCDD4, pin_LCDD5, pin_LCDD6, pin_LCDD7);
```

- Panel.h

```
//************************************//
// author: lukman hakim
// date:01/08/2018
// rev 1
//************************************//


void displayHomeScreen() {
  int i;
  char buff[16];
  readSensor();
  lcd.setCursor(11, 1);
  sprintf(buff, "V:%3d", ee.setting.speed);
  lcd.print(buff);
  lcd.setCursor(0, 1);
  sprintf(buff, "CP%d", ee.path.index_cp);
  lcd.print(buff);

  if (!button_UPL) {
    if (++ee.path.index_cp >= 6)ee.path.index_cp = 0;
    EEPROM.put(0, ee);
    delay(200);
  }
  if (!button_DOWNL) {
```

```
   if (--ee.path.index_cp < 0)ee.path.index_cp = 5;
   EEPROM.put(0, ee);
   delay(200);
  }

  if (!button_UPR) {
   if (++ee.setting.speed > 255) ee.setting.speed = 0;
   EEPROM.put(0, ee);
   delay(200);
  }
  if (!button_DOWNR) {
   if (--ee.setting.speed < 0) ee.setting.speed = 255;
   EEPROM.put(0, ee);
   delay(200);
  }
  lcd.setCursor(0, 1);
}
```

- Plan.h

```
//************************************//
// author: lukman hakim
// date:01/08/2018
// rev 1
//************************************//


#define lft   left
#define fwd   forward
#define rgt   right
#define on    action_on
#define off   action_off
#define on1   action_on1
```

```
#define off1  action_off1

//plan_set (plan, index, action, mode sensor, brake, delay, pwm L, pwm R, SA, TA)

int speed_delay_start = 80;
int delay_start = 200;

/*Mode Sensor
  pertigaan T/perempatan  mode 3      XOR 111000000111
                          mode 4      XOR 110000000011
  pertigaan Kiri          mode 5      XOR 110011110000
                          mode 7      XOR 100011110000
  pertigaan Kanan         mode 6      XOR 000011110011
                          mode 8      XOR 000011110001
  SISI KIRI => untuk mendeteksi tikungan di kiri, misal siku
                          mode 11     OR  100000000000
                          mode 13     OR  110000000000
  SISI KANAN => untuk mendeteksi tikungan di kanan, misal siku
                          mode 12     OR  000000000001
                          mode 14     OR  000000000011
  anywhere                mode 17     OR  111111111111
  kosong                  mode 18     =   000000000000
*/

//plan_set (plan, index, action, mode sensor, brake, delay, pwm L, pwm R, SA, TA)

int stop_index = 5;

void plan_input() {
  //setting kecepatan default robot
  ee.setting.speed = 170;
```

```
  //PID
  kp = 7;
  kd = 55;

  //setting checkpoint
  ee.path.cp[0] = 0; ee.path.cp[1] = 10; ee.path.cp[2] = 20; ee.path.cp[3] = 30;
ee.path.cp[4] = 40; ee.path.cp[5] = 50;

  //setting plan
  //lap 1
  plan_set(1, 0, fwd, 0, 0, 0, 0, 0, 150, 3);  //start
  plan_set(1, 1, fwd, 3, 0, 0, 0, 0, 150, 5);  //maju titik 3
  plan_set(1, 2, on1, 3, 50, 50, 0, 0, 0, 10); //motor 1 naik
  plan_set(1, 3, off1, 3, 50, 50, 0, 0, 0, 10); //motor 1 turun
  plan_set(1, 4, fwd, 17, 10, 100, 0, 0, 150, 15); // maju setelah motor 1 naik turun
  plan_set(1, 5, on, 3, 50, 50, 0, 0, 0, 10); //muat
  plan_set(1, 6, off, 17, 50, 50, 0, 0, 0, 10); //bongkar
  plan_set(1, 7, fwd, 17, 10, 0, 0, 0, 150, 5); // maju setelah bongkar
  //lap 2
  plan_set(1, 8, fwd, 3, 0, 0, 0, 0, 150, 5);  //maju titik 3
  plan_set(1, 9, on1, 3, 50, 50, 0, 0, 0, 10); //motor 1 naik
  plan_set(1, 10, off1, 3, 50, 50, 0, 0, 0, 10); //motor 1 turun
  plan_set(1, 11, fwd, 17, 10, 100, 0, 0, 150, 15); // maju setelah motor 1 naik turun
  plan_set(1, 12, on, 3, 50, 50, 0, 0, 0, 10); //muat
  plan_set(1, 13, off, 17, 50, 50, 0, 0, 0, 10); //bongkar
  plan_set(1, 14, fwd, 17, 10, 0, 0, 0, 150, 5); // maju setelah bongkar
  plan_set(1, 15, fwd, 3, 0, 0, 0, 0, 150, 3);//finish
}
```

- Running.h

```
//************************************//
```

```
// author: lukman hakim
// date:01/08/2018
// rev 1
//************************************//
void delay_action(int pwmLeft, int pwmRight) {
  setMotor(-speed, -speed);
  delay(ee.path.B[ee.setting.plan][index]);
  setMotor(pwmLeft, pwmRight);
  delay(ee.path.D[ee.setting.plan][index]);
}

void turn(int dir, int pwmLeft, int pwmRight) {
  unsigned int sensor_value = 0;
  delay_action(pwmLeft, pwmRight);
  if (dir == left) {
    do {
      setMotor(pwmLeft * 0.3, pwmRight * 0.3);
      sensor_value = readSensor();
    }
    while (!(sensor_value & 0b011111111000));
  }
  else if (dir == right) {
    do {
      setMotor(pwmLeft * 0.3, pwmRight * 0.3);
      sensor_value = readSensor();
    }
    while (!(sensor_value & 0b000111111110));
  }
}

void get_junction() {
```

```
  temp_timer = 0;
  lcd_backlightOn;
  if (index < max_index) {
    index++;
    if (ee.path.action[ee.setting.plan][index] == forward ||
ee.path.action[ee.setting.plan][index] == left ||
ee.path.action[ee.setting.plan][index] == right) {
      turn(forward, ee.path.F[ee.setting.plan][index],
ee.path.R[ee.setting.plan][index]);
      lcd.setCursor(5, 1);
      lcd.print("ACT");
    }
    else if (ee.path.action[ee.setting.plan][index] == action_on) {
      delay_action(ee.path.F[ee.setting.plan][index],
ee.path.R[ee.setting.plan][index]);
      setMotorT(250, 0);
      delay(4000);
      setMotorT(0, 100);
      delay(1500);
      lcd.setCursor(5, 1);
      lcd.print("ON");
    }
    else if (ee.path.action[ee.setting.plan][index] == action_off) {
      delay_action(ee.path.F[ee.setting.plan][index],
ee.path.R[ee.setting.plan][index]);
      setMotorT(0, -100);
      delay(1500);
      setMotorT(-250, 0);
      delay(3800);
      setMotorT(0, 0);
      delay(0);
```

```
      lcd.setCursor(5, 1);
      lcd.print("OFF");
    }
    else if (ee.path.action[ee.setting.plan][index] == action_on1) {
      delay_action(ee.path.F[ee.setting.plan][index],
ee.path.R[ee.setting.plan][index]);
      setMotorT(250, 0);
      delay(4000);
      lcd.setCursor(5, 1);
      lcd.print("ON1");
    }
    else if (ee.path.action[ee.setting.plan][index] == action_off1) {
      delay_action(ee.path.F[ee.setting.plan][index],
ee.path.R[ee.setting.plan][index]);
      setMotorT(-250, 0);
      delay(3800);
      setMotorT(0, 0);
      delay(0);
      lcd.setCursor(5, 1);
      lcd.print("OFF1");
    }
  }
  temp_timer = ee.path.TA[ee.setting.plan][index];
}

void solve_path() {
  if  (ee.setting.count_mode[ee.path.mode_sensor[ee.setting.plan][index  +  1]]  ==
OR) {
    if                                  (sensor_running                                  &
ee.sensor.counter[ee.path.mode_sensor[ee.setting.plan][index + 1]]) {
      get_junction();
```

```
    }
  }
  else if (ee.setting.count_mode[ee.path.mode_sensor[ee.setting.plan][index + 1]]
== sama_dengan) {
    if (sensor_running ==
ee.sensor.counter[ee.path.mode_sensor[ee.setting.plan][index + 1]]) {
      get_junction();
    }
  }
  else if (ee.setting.count_mode[ee.path.mode_sensor[ee.setting.plan][index + 1]]
== XOR) {
    if (sensor_running &
sensor_counterXOR[ee.path.mode_sensor[ee.setting.plan][index + 1]]) {
      if (sensor_running &
sensor_counterXOR1[ee.path.mode_sensor[ee.setting.plan][index + 1]]) {
        get_junction();
      }
    }
  }
}

void follow_line() {
  int sensor = sensor_running;
  switch (sensor) {
    case 0b000000000001: error = -18; break;
    case 0b000000000011: error = -14; break;
    case 0b000000000010: error = -11; break;
    case 0b000000000110: error = -9; break;
    case 0b000000000100: error = -7; break;
    case 0b000000001100: error = -6; break;
    case 0b000000001000: error = -5; break;
```

```
case 0b000000011000: error = -4; break;
case 0b000000010000: error = -3; break;
case 0b000000110000: error = -2; break;
case 0b000000100000: error = -1; break;
case 0b000001100000: error = 0; break;
case 0b000001000000: error = 1; break;
case 0b000011000000: error = 2; break;
case 0b000010000000: error = 3; break;
case 0b000110000000: error = 4; break;
case 0b000100000000: error = 5; break;
case 0b001100000000: error = 6; break;
case 0b001000000000: error = 7; break;
case 0b011000000000: error = 9; break;
case 0b010000000000: error = 11; break;
case 0b110000000000: error = 14; break;
case 0b100000000000: error = 18; break;

case 0b000000000111: error = -11; break;
case 0b000000001111: error = -9; break;
case 0b000000001110: error = -7; break;
case 0b000000011110: error = -6; break;
case 0b000000011100: error = -5; break;
case 0b000000111100: error = -4; break;
case 0b000000111000: error = -3; break;
case 0b000001111000: error = -2; break;
case 0b000001110000: error = -1; break;

case 0b000011110000: error = 0; break;

case 0b000011100000: error = 1; break;
case 0b000111100000: error = 2; break;
```

```
  case 0b000111000000: error = 3; break;
  case 0b001111000000: error = 4; break;
  case 0b001110000000: error = 5; break;
  case 0b011110000000: error = 6; break;
  case 0b011100000000: error = 7; break;
  case 0b111100000000: error = 9; break;
  case 0b111000000000: error = 11; break;
 }

 int rateError = error - lastError;
 lastError = error;
 int moveVal = (int) (error * kp) + (rateError * kd);
 int moveLeft = speed - moveVal;
 int moveRight = speed + moveVal;
 int minSpeed = -150;
 int maxSpeed = 230;
 moveLeft = constrain(moveLeft, minSpeed, maxSpeed);
 moveRight = constrain(moveRight, minSpeed, maxSpeed);
 setMotor(moveLeft, moveRight);
}
```

- Sensor.h

```
//************************************//
// author: lukman hakim
// date:01/08/2018
// rev 1
//************************************//


void enableSensor(int L, int R) {
 digitalWrite(pin_ENABLE_SENSORL, L);
 digitalWrite(pin_ENABLE_SENSORR, R);
```

```
  delayMicroseconds(50);
}

void init_sensor() {
  int i = 0;
  for (i = 0; i < max_sensor; i++) {
    pinMode(pin_ADC_SENSOR[i], INPUT);
  }
  pinMode(pin_ENABLE_SENSORL, OUTPUT);
  pinMode(pin_ENABLE_SENSORR, OUTPUT);
  enableSensor(0, 0);
}

int readSensor() {
  int bitSensor = 0;
  int i;
  int xpos[12] = {2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13};
  enableSensor(1, 0);
  for (i = 0; i < 6; i++) {
    if (analogRead(pin_ADC_SENSOR[i]) > ee.setting.limit_value_sensor[i]) {
      bitSensor = bitSensor | (0b100000000000 >> i);
      lcd.setCursor(xpos[i], 0);
      lcd.write(255);
    }
    else {
      lcd.setCursor(xpos[i], 0);
      lcd.print("_");
    }
  }
  delayMicroseconds(150);
  enableSensor(0, 1);
```

```
  for (i = 6; i < 12; i++) {
    if (analogRead(pin_ADC_SENSOR[i]) > ee.setting.limit_value_sensor[i]) {
      bitSensor = bitSensor | ( 0b100000000000 >> i);
      lcd.setCursor(xpos[i], 0);
      lcd.write(255);
    }
    else {
      lcd.setCursor(xpos[i], 0);
      lcd.print("_");
    }
  }
  delayMicroseconds(150);
  enableSensor(0, 0);

  //invert
  //bitSensor &= 0b111111111111;
  //bitSensor = 0b111111111111 - bitSensor;

  return bitSensor;
}

int calibrate_sensor() {
  int i, valSensor, xCursor = 0;
  int minVal[max_sensor], maxVal[max_sensor];
  delay(300);
  lcd.clear();
  for (i = 0; i < max_sensor; i++) {
    minVal[i] = 1023;
    maxVal[i] = 0;
  }
  while (1) {
```

```
enableSensor(1, 0);
for (i = 0; i < 6; i++) {
  valSensor = analogRead(pin_ADC_SENSOR[i]);
  if (valSensor > maxVal[i]) {
    maxVal[i]  = valSensor;
  }
  if (valSensor < minVal[i]) {
    minVal[i]  = valSensor;
  }
}
delay(1);
enableSensor(0, 1);
for (i = 6; i < 12; i++) {
  valSensor = analogRead(pin_ADC_SENSOR[i]);
  if (valSensor > maxVal[i]) {
    maxVal[i]  = valSensor;
  }
  if (valSensor < minVal[i]) {
    minVal[i]  = valSensor;
  }
}
delay(1);
enableSensor(0, 0);
if (!button_MENU) {
  break;
}
lcd.setCursor(0, 0);
lcd.print("Scanning Sensor");

if (millis() % 25 == 0) {
  lcd.setCursor(xCursor, 1);
```

```
      lcd.write(0xff);
      if (++xCursor > 15) {
        xCursor = 0;
        lcd.clear();
      }
    }
  }
  for (i = 0; i < max_sensor; i++) {
    ee.setting.limit_value_sensor[i] = ((maxVal[i] - minVal[i]) * 25 / 100) +
minVal[i];
  }
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Saving...");
  EEPROM.put(0, ee);
  delay(500);
  lcd.clear();
}

void check_XOR() {
  unsigned int i, x;
  for (i = 0; i < max_modeSensor; i++) {
    unsigned int temp_sensor = ee.sensor.counter[i];
    sensor_counterXOR[i] = 0;
    sensor_counterXOR1[i] = 0;
    x = 0;
    do {
      data_bit = (temp_sensor & (1 << x));
      sensor_counterXOR[i] |= data_bit;
      x++;
    }
```

```
    while (data_bit == 0 && x < max_sensor);
    do {
      data_bit = (temp_sensor & (1 << x));
      sensor_counterXOR[i] |= data_bit;
      x++;
    }
    while (data_bit > 0 && x < max_sensor);
    do {
      data_bit = (temp_sensor & (1 << x));
      sensor_counterXOR1[i] |= data_bit;
      x++;
    }
    while (x < max_sensor);
  }
}
```

- Variabel.h

```
//************************************//
// author: lukman hakim
// date:01/08/2018
// rev 1
//************************************//


#include <EEPROM.h>

#define max_plan        2
#define max_index       99
#define max_modeSensor  25

enum {forward, left, right, action_on, action_off, action_on1, action_off1};
enum {on, off, on1, off1};
```

```
enum {OR, sama_dengan, XOR};
int index;
int temp_timer = 0;
int tick = 0;
int error = 0;

int lastError = 0;
int kp;
int kd;
int speed;
unsigned long sensor_running;

unsigned int data_bit;
unsigned int sensor_counterXOR[max_modeSensor + 1];
unsigned int sensor_counterXOR1[max_modeSensor + 1];
int temp_limit_value_sensor[max_sensor];

struct EE_path {
  int action[max_plan][max_index];
  int mode_sensor[max_plan][max_index];
  int B[max_plan][max_index];
  int D[max_plan][max_index];
  int F[max_plan][max_index];
  int R[max_plan][max_index];
  int SA[max_plan][max_index];
  int TA[max_plan][max_index];
  int cp[6];
  int index_cp;
};

struct EE_sensor {
```

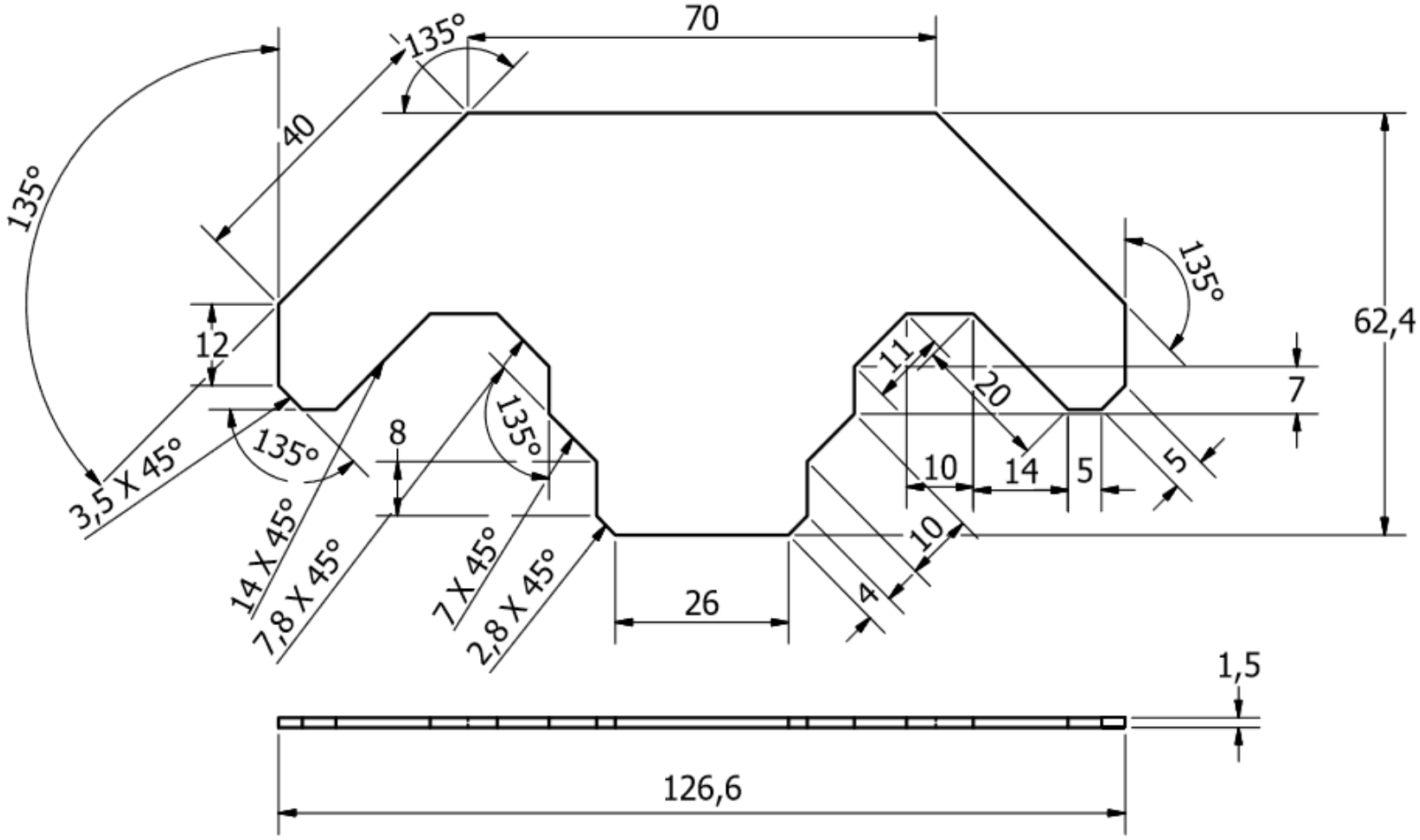
```
  unsigned int counter[max_modeSensor + 1];
};

struct EE_setting {
  int speed;
  int limit_value_sensor[max_sensor];
  int count_mode[max_modeSensor + 1];
  int plan;
};

struct eeprom_data {
  EE_path path;
  EE_setting setting;
  EE_sensor sensor;
};
eeprom_data ee;

void plan_set(int Plan, int Index, int action, int mode_sensor, int brake, int delay,
int forward, int reverse, int speed_a, int timer_a) {
  ee.path.action[Plan - 1][Index] = action;
  ee.path.mode_sensor[Plan - 1][Index] = mode_sensor;
  ee.path.B[Plan - 1][Index] = brake;
  ee.path.D[Plan - 1][Index] = delay;
  ee.path.F[Plan - 1][Index] = forward;
  ee.path.R[Plan - 1][Index] = reverse;
  ee.path.SA[Plan - 1][Index] = speed_a;
  ee.path.TA[Plan - 1][Index] = timer_a;
}

void reset_default() {
  lcd.clear();
```

```
lcd.setCursor(0, 0);
lcd.print("Init EEPROM data");
ee.setting.plan = 0;

ee.setting.count_mode[0]  =  sama_dengan;
ee.sensor.counter[0] =  0b001100001100;
ee.setting.count_mode[1]  =  XOR;
ee.sensor.counter[1] =  0b111110011111;
ee.setting.count_mode[2] =  XOR;
ee.sensor.counter[2] =  0b111100001111;
ee.setting.count_mode[3] =  XOR;
ee.sensor.counter[3] =  0b111000000111;
ee.setting.count_mode[4] =  XOR;
ee.sensor.counter[4] =  0b110000000011;
ee.setting.count_mode[5] =  XOR;
ee.sensor.counter[5] =  0b110011110000;
ee.setting.count_mode[6] =  XOR;
ee.sensor.counter[6] =  0b000011110011;
ee.setting.count_mode[7] =  XOR;
ee.sensor.counter[7] =  0b100011110000;
ee.setting.count_mode[8] =  XOR;
ee.sensor.counter[8] =  0b000011110001;
ee.setting.count_mode[9] =  XOR;
ee.sensor.counter[9] =  0b111001111000;
ee.setting.count_mode[10] =  XOR;
ee.sensor.counter[10] =  0b000111100111;
ee.setting.count_mode[11] =  OR;
ee.sensor.counter[11] =  0b100000000000;
ee.setting.count_mode[12] =  OR;
ee.sensor.counter[12] =  0b000000000001;
ee.setting.count_mode[13] =  OR;
```

```
  ee.sensor.counter[13] =  0b110000000000;
  ee.setting.count_mode[14] =  OR;
  ee.sensor.counter[14] =  0b000000000011;
  ee.setting.count_mode[15] =  OR;
  ee.sensor.counter[15] =  0b111000000000;
  ee.setting.count_mode[16] =  OR;
  ee.sensor.counter[16] =  0b000000000111;
  ee.setting.count_mode[17] =  OR;
  ee.sensor.counter[17] =  0b111111111111;
  ee.setting.count_mode[18] =  sama_dengan;
  ee.sensor.counter[18] =  0b000000000000;

  EEPROM.put(0, ee);
  lcd.setCursor(0, 1);
  lcd.print("Completed");
  delay(1000);
  lcd.clear();
}
```

LAMPIRAN

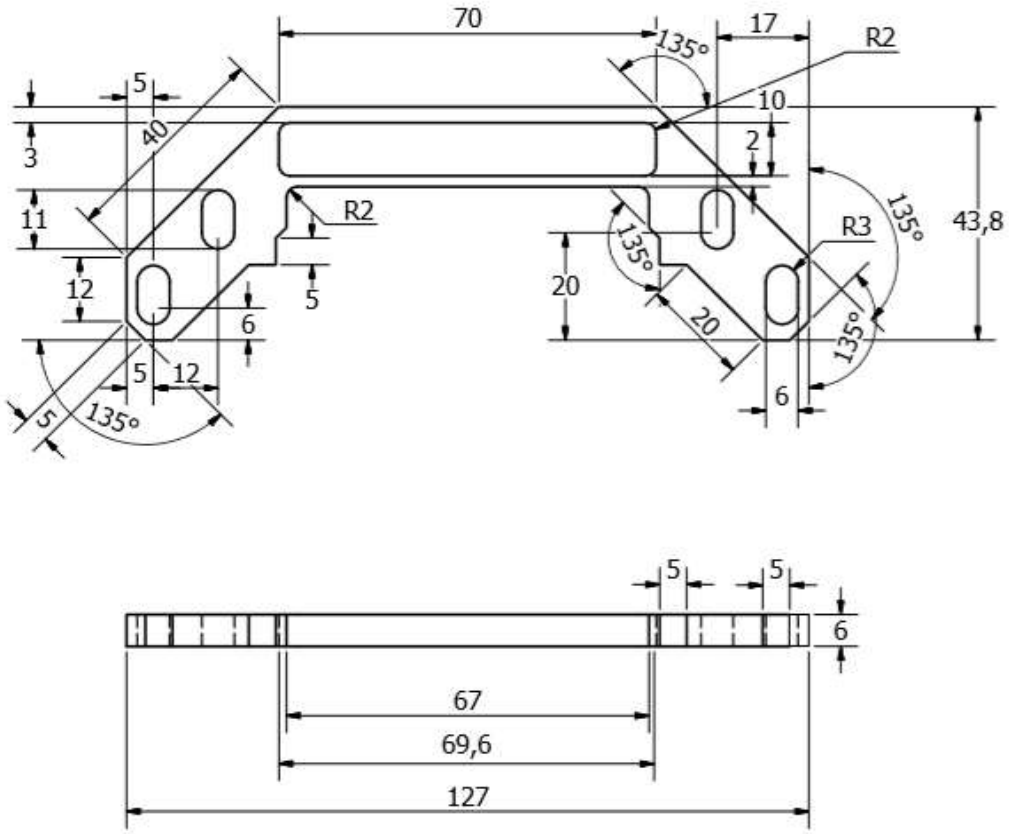
GAMBAR KERJA 2D



PARTS LIST				
NO.	PART NAME	MATERIAL	DESCRIPTION	QTY
1.	BOARD SENSOR CAHAYA	FOAM		1

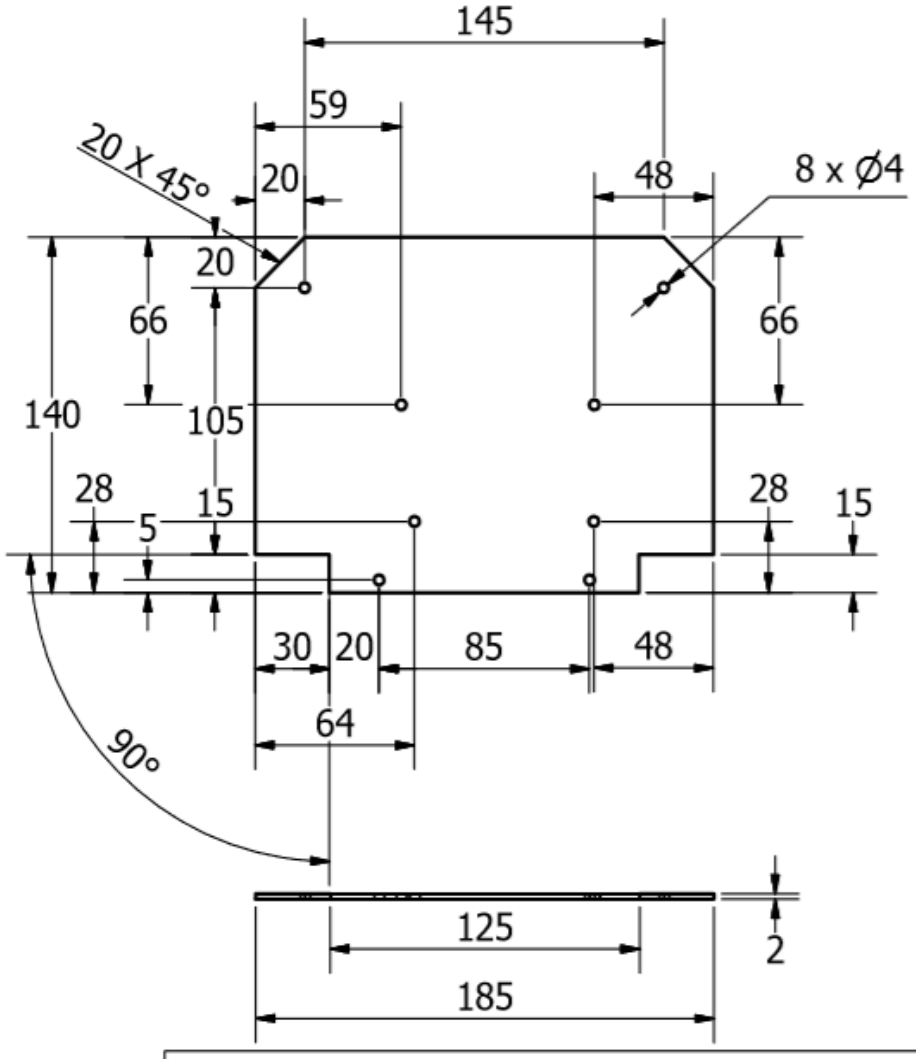
	Skala : 1:2	Digambar : Lukman H.	Signature:
	Satuan : mm	NIM : 20140130153	
	Tanggal : 20 Juli 2018	Dilihat :	

TEKNIK MESIN UMY	BOARD SENSOR CAHAYA	NO. 1	A4



PARTS LIST				
NO.	PART NAME	MATERIAL	DESCRIPTION	QTY
1.	PELINDUNG SENSOR CAHAYA	ACRILLIC		1

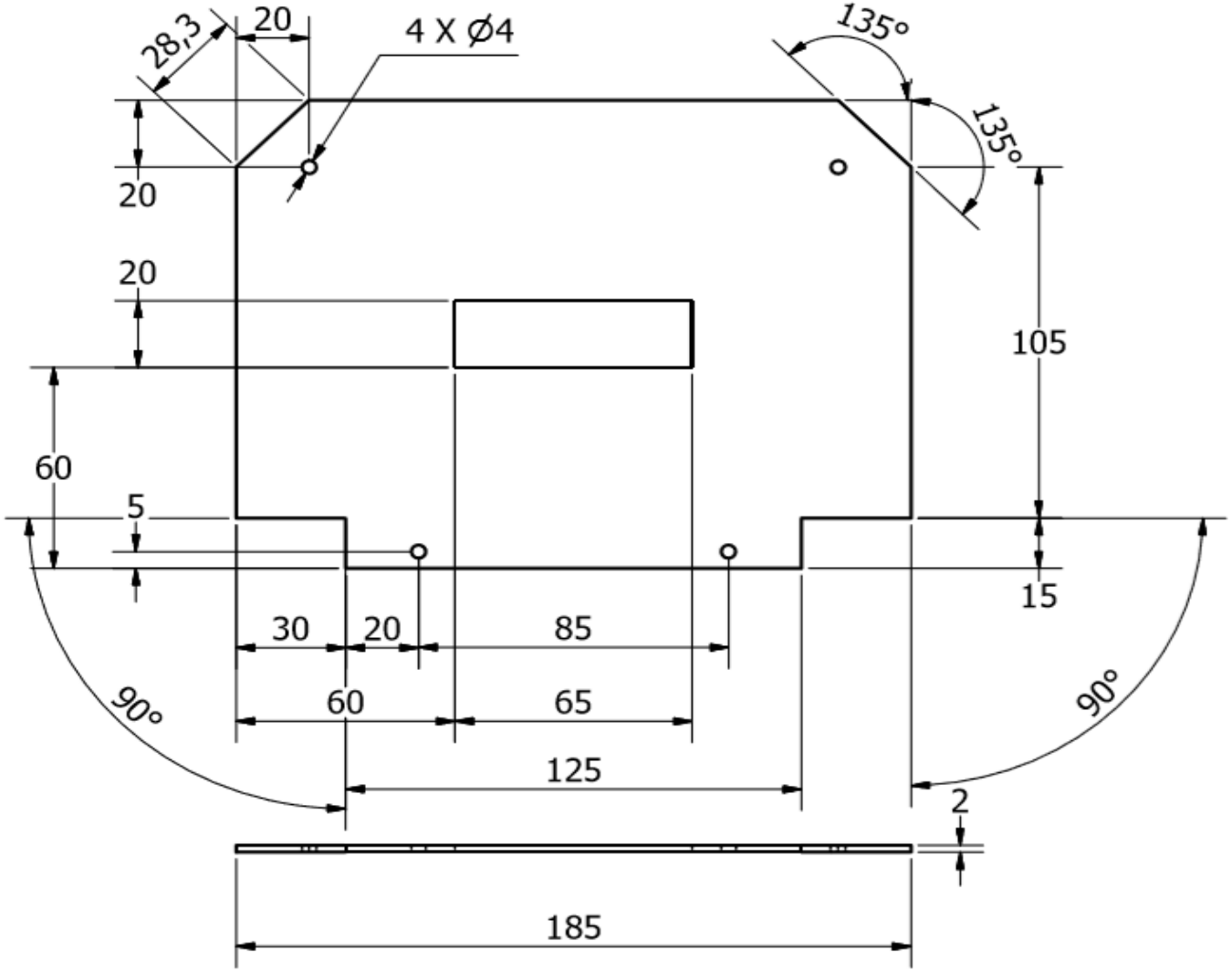
Skala : 1:1	Digambar : Lukman H.	Signature:	
Satuan : mm	NIM : 20140130153		
Tanggal : 20 Juli 2018	Dilihat :		
TEKNIK MESIN UMY	PELINDUNG SENSOR CAHAYA	NO. 2	A3



PARTS LIST				
NO.	PART NAME	MATERIAL	DESCRIPTION	QTY
1.	BODI BAWAH	ACRILLIC		1

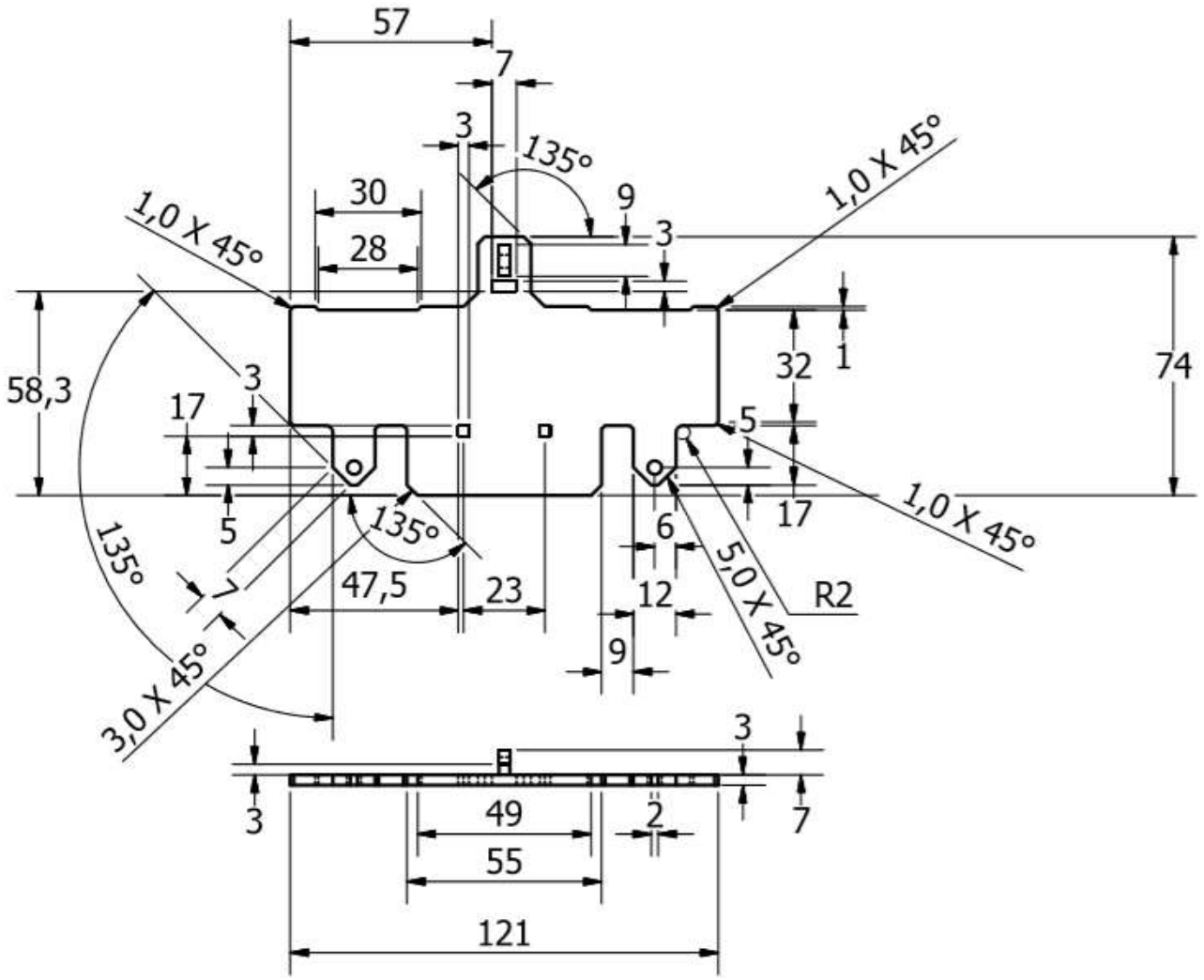
	Skala : 1:3	Digambar : Lukman H.	Signature:
	Satuan : mm	NIM : 20140130153	
	Tanggal : 20 Juli 2018	Dilihat :	

TEKNIK MESIN UMY	BODI BAWAH	NO. 3	A4



PARTS LIST				
NO.	PART NAME	MATERIAL	DESCRIPTION	QTY
1.	BODI ATAS	ACRILLIC		1

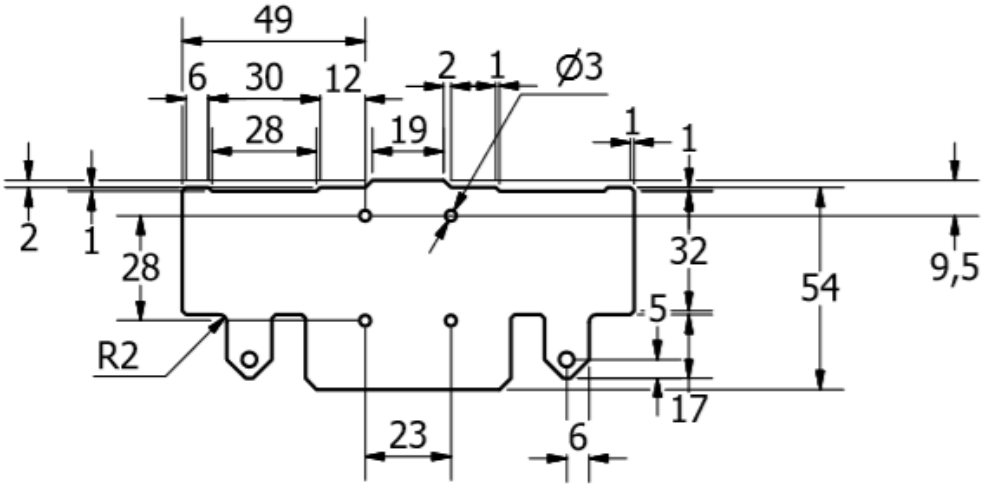
Skala : 1:2	Digambar : Lukman H.	Signature:	
Satuan : mm	NIM : 20140130153		
Tanggal : 20 Juli 2018	Dilihat :		
TEKNIK MESIN UMY	BODI ATAS	NO. 4	A4

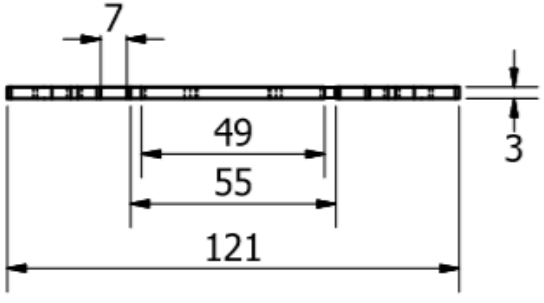


PARTS LIST				
NO.	PART NAME	MATERIAL	DESCRIPTION	QTY
1.	DUDUKAN MOTOR DC	ACRILLIC		1

Skala : 1:2	Digambar : Lukman H.	Signature:	
Satuan : mm	NIM : 20140130153		
Tanggal : 20 Juli 2018	Dilihat :		

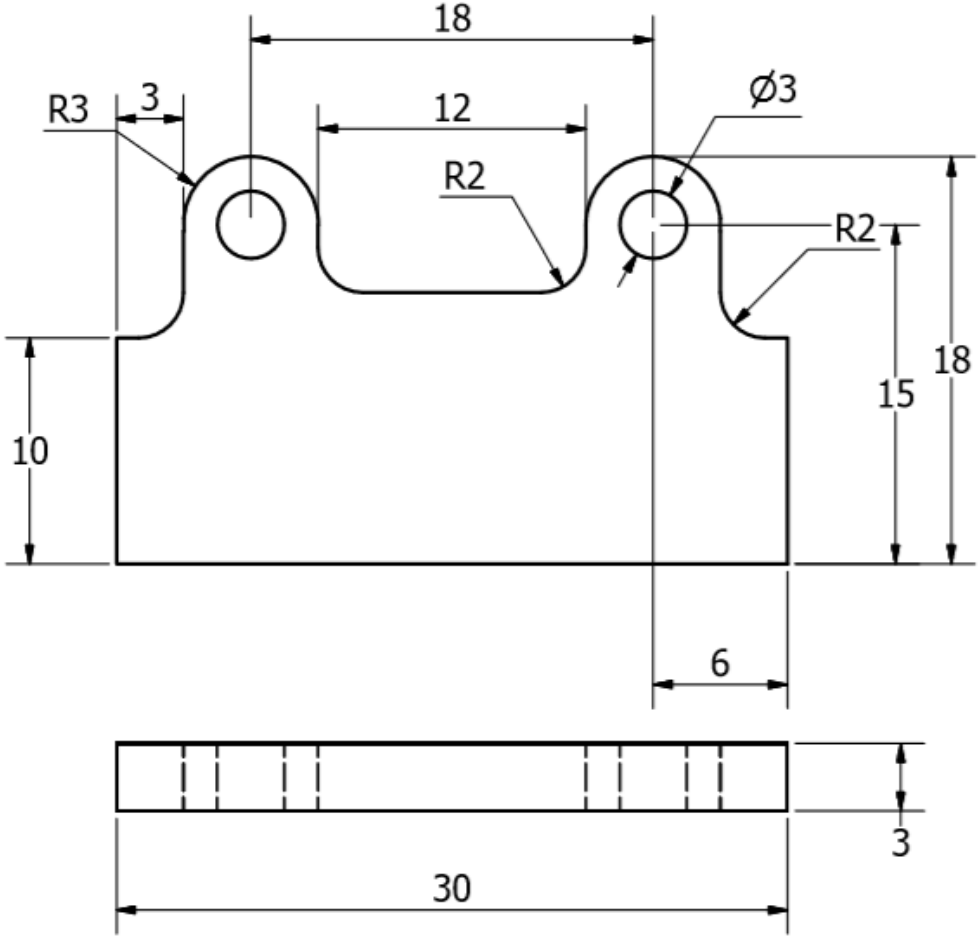
TEKNIK MESIN UMY	DUDUKAN MOTOR DC	NO. 5	A4





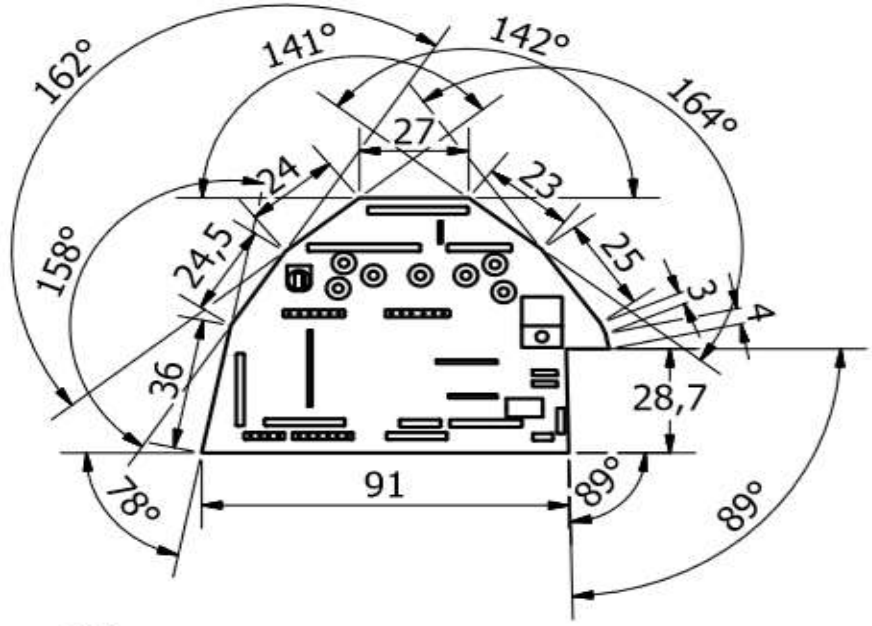
PARTS LIST				
NO.	PART NAME	MATERIAL	DESCRIPTION	QTY
1.	DUDUKAN BATERAI	ACRILLIC		1

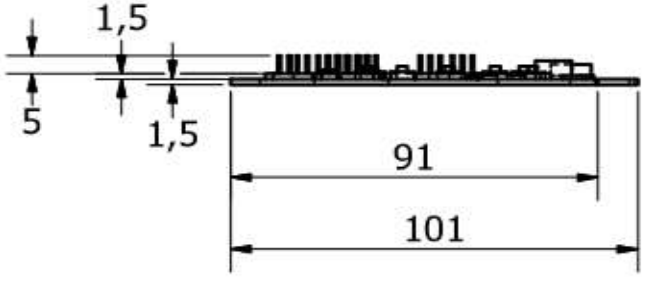
Skala : 1:2	Digambar : Lukman H.	Signature:	
Satuan : mm	NIM : 20140130153		
Tanggal : 20 Juli 2018	Dilihat :		
TEKNIK MESIN UMY	DUDUKAN BATERAI	NO. 6	A4



PARTS LIST				
NO.	PART NAME	MATERIAL	DESCRIPTION	QTY
1.	DUDUKAN AS MOTOR DC	ACRILLIC		1

Skala : 3:1	Digambar : Lukman H.	Signature:	
Satuan : mm	NIM : 20140130153		
Tanggal : 20 Juli 2018	Dilihat :		
TEKNIK MESIN UMY	DUDUKAN AS MOTOR DC	NO. 7	A4

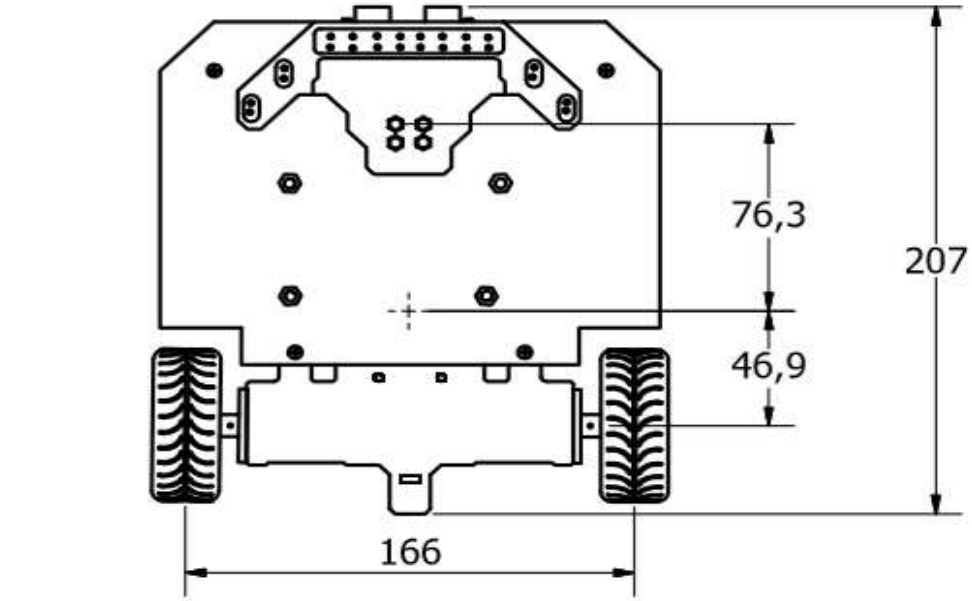


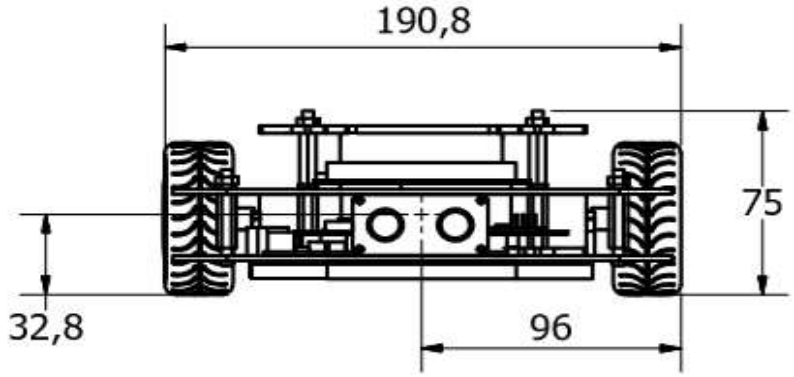


PARTS LIST			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	Board Support	

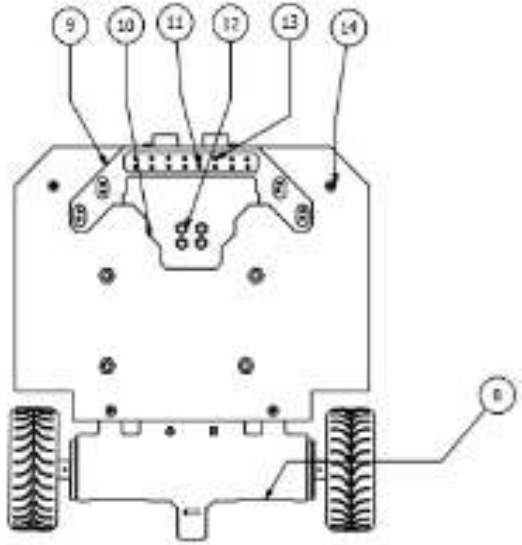
	Skala : 1:2	Digambar : Lukman H.	Signature:
	Satuan : mm	NIM : 20140130153	
	Tanggal : 20 Juli 2018	Dilihat :	

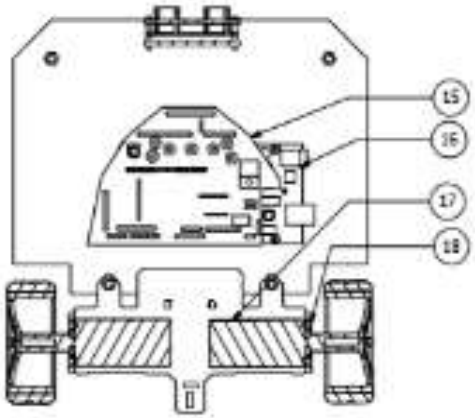
TEKNIK MESIN UMY	BOARD SUPPORT	NO. 8	A4



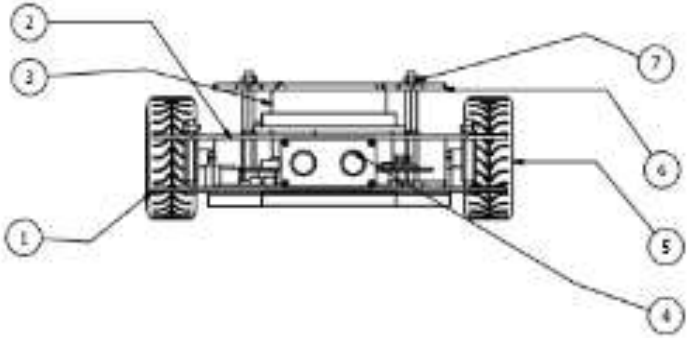


	Skala : 1:3	Digambar : Lukman H.	Signature:
	Satuan : mm	NIM : 20140130153	
	Tanggal : 20 Juli 2018	Dilihat :	
TEKNIK MESIN UMY	FULL ASSEMBLY OF AGV	NO. 8	A4





SECTION B-B
SCALE 1 / 2



PARTS LIST

NO.	PART NAME	MATERIAL	DESCRIPTION	QTY
1.	BODI BAWAH	ACRILLIC	DIBUAT	1
2.	BODI ATAS	ACRILLIC	DIBUAT	1
3.	BATERAI LIPPO 4S 12 VOLT	LITHIUM	DIBELI	1
4.	HC-SR04	PLASTIC	DIBELI	1
5.	BAN DIAMETER 60 MM	KARET	DIBELI	2
6.	BODI ATAS	ACRILLIC	DIBUAT	1
7.	MUR HEX M3	SS AISI 304	DIBELI	22
8.	DUDUKAN MOTOR DC	ACRILLIC	DIBUAT	1
9.	PELINDUNG SENSOR GARIS	FOAM	DIBUAT	1
10.	BOARD SENSOR GARIS	ACRILLIC	DIBUAT	1
11.	BALL CASTER	METAL	DIBELI	4
12.	LED SUERBRIGHT	GALLIUM	DIBELI	12
13.	PHOTODIODE	SILICONE	DIBELI	12
14.	BAUT M3 1,5 X 5	SS AISI 304	DIBELI	6
15.	BOARD SUPPORT	ACRILLIC	DIBUAT	1
16.	ARDUINO MEGA 2560	PLATFORM	DIBELI	1
17.	MOTOR DC	GENERIC	DIBELI	1
18.	DUDUKAN AS MOTOR DC	ACRILLIC	DIBUAT	1

Skala : 1 : 2
Satuan : mm
Tanggal : 28 Juli 2018

Nama : Luiman Hakim
NIM : 2016030158
Dilihat :

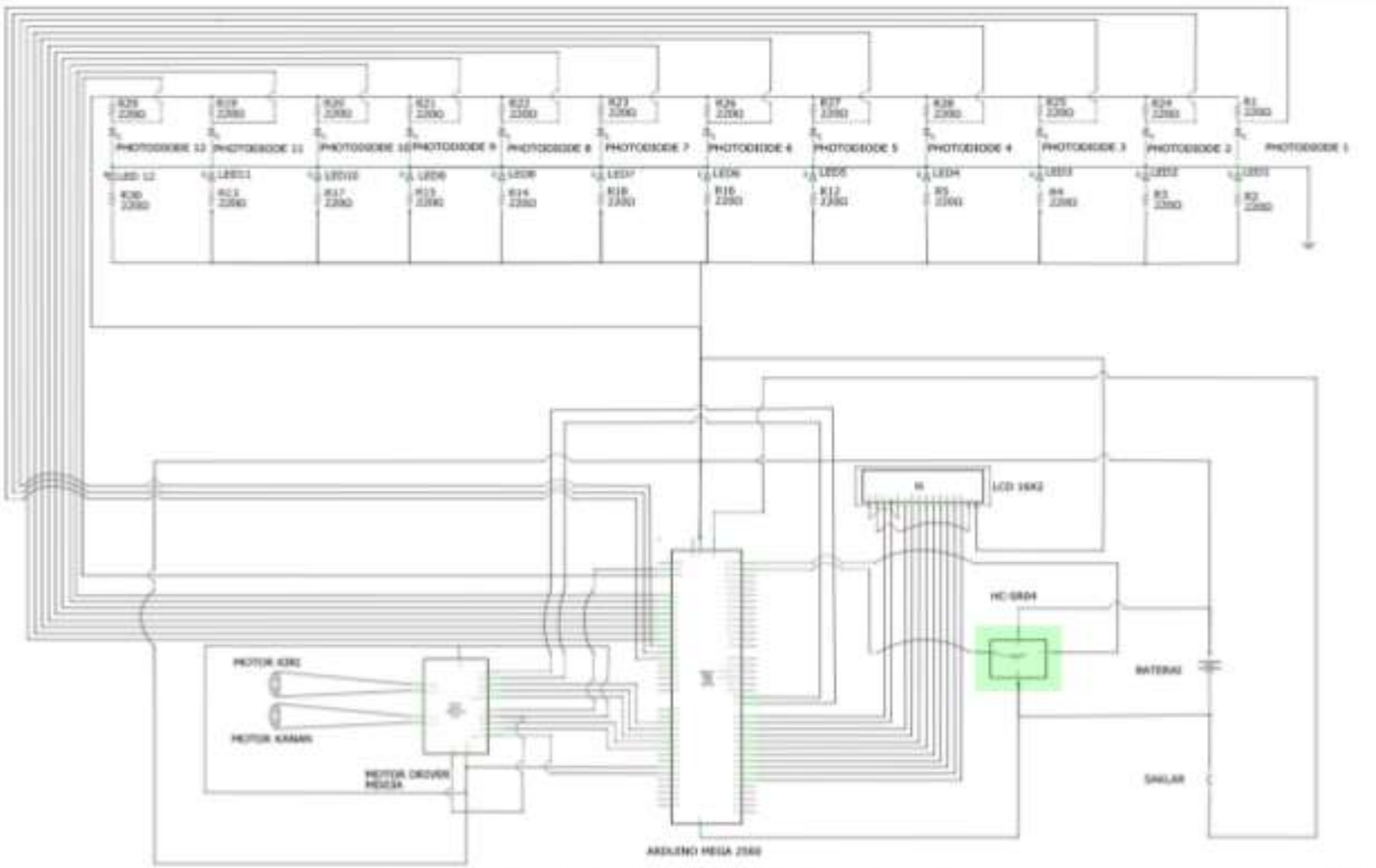
Signature

TEKNIK MESIN

Plat List (3 Model) AGV
Line Follower

NO. 9

A2



Gambar Kelistrikan (*Drawing Schematic*) Model AGV *Line Follower*

Program Studi Teknik Mesin

Lembar Persetujuan Naskah Publikasi dan Abstrak Tugas Akhir (TA)

Judul TA:	PERANCANGAN MODEL AGV *LINE FOLLOWER* UNTUK *MATERIAL HANDLING*
Judul Naskah Publikasi:	**PERANCANGAN MODEL AGV *LINE FOLLOWER* UNTUK *MATERIAL HANDLING***
Nama Mahasiswa:	**Lukman Hakim**
NIM:	**20140130153**
Pembimbing 1:	**Dr. Bambang Riyanta, S.T., M.T.**
Pembimbing 2:	**Cahyo Budiyantoro, S.T., M.Sc.**

Hal yang dimintakan pesetujuan *:

☑ Abstrak berbahasa Indonesia	☑ Naskah Publikasi	☐	☐ .....
☑ Abstrak berbahasa Inggris	☐	☐	☐ .....

**beri tanda √ di kotak yang sesuai*

Lukman Hakim — *5 September 2018*

Persetujuan Dosen Pembimbing dan Program Studi

☑ Disetujui

Dr. Bambang Riyanta, S.T., M.T. — *5 September 2018*

Berli Paripurna Kamiel, S.T., M.Eng Sc., Ph.D — *5 September 2018*

Formulir persetujuan ini mohon diletakkan pada lampiran terakhir pada naskah TA.