CODE MAIN.CPP

```
#include <Arduino.h>
#include <Wire.h>
#include <Adafruit_VL53L0X.h>
#include <Adafruit_TCS34725.h>
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h>
#include <WiFi.h>
#include <WebServer.h>
#include <ArduinoJson.h>

#define PIN_SW_POWER 13
#define PIN_LED1     16
#define PIN_LED2     18
#define PIN_ENA      5
#define PIN_IN1      4
#define PIN_IN2      2

Adafruit_SSD1306 display(128, 64, &Wire, -1);
Adafruit_VL53L0X lox = Adafruit_VL53L0X();
Adafruit_TCS34725 tcs = Adafruit_TCS34725(TCS34725_INTEGRATIONTIME_50MS,
TCS34725_GAIN_4X);

const char* ssid = "Bach";
const char* password = "123123123";
WebServer server(80);

int total = 0, blue = 0, red = 0;
float currentHeight = 0.0;
const int GROUND_DIST = 65;

bool tcsOK = false, loxOK = false, led1Status = false, led2Status = false;
bool hasCounted = false;
int lastColorDetected = 0;

void updateOLED(String status, bool isRunningView = false) {
  display.clearDisplay();
  display.setTextColor(SSD1306_WHITE);

  if (!isRunningView) {
    // --- MÀN HÌNH CHỜ ---
    display.setTextSize(1);
    display.setCursor(0,0);  display.println("HE THONG PHAN LOAI");
    display.setCursor(0, 15); display.print("GV: NGUYEN KIM SUYEN");
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    display.setCursor(0, 28); display.print("SV: KHOA - BACH");
    display.setCursor(0, 42); display.print("IP: ");
display.println(WiFi.localIP());

    // Hiển thị trạng thái cảm biến
    display.setCursor(0, 55);
    display.printf("LASER:%s | MAU:%s", loxOK?"OK":"ER", tcsOK?"OK":"ER");
  } else {
    // --- MÀN HÌNH CHẠY ---
    display.setTextSize(1);
    display.setCursor(0,0);  display.println("DANG HOAT DONG...");

    display.setTextSize(2);
    display.setCursor(0, 18); display.printf("T:%d", total);

    display.setTextSize(1);
    display.setCursor(70, 18); display.printf("DO :%d", red);
    display.setCursor(70, 30); display.printf("XANH:%d", blue);

    display.setCursor(0, 45);  display.printf("L1:%s | L2:%s",
led1Status?"ON":"OFF", led2Status?"ON":"OFF");
    display.setCursor(0, 56);  display.print("CAM BIEN: ON");
  }
  display.display();
}

void setup() {
  Serial.begin(115200);
  pinMode(PIN_SW_POWER, INPUT_PULLUP);
  pinMode(PIN_LED1, OUTPUT);
  pinMode(PIN_LED2, OUTPUT);
  pinMode(PIN_IN1, OUTPUT);
  pinMode(PIN_IN2, OUTPUT);
  ledcSetup(0, 100, 8); ledcAttachPin(PIN_ENA, 0);

  Wire.begin(21, 22);
  display.begin(SSD1306_SWITCHCAPVCC, 0x3C);
  if (tcs.begin(0x29, &Wire)) tcsOK = true;

  Wire1.begin(25, 26);
  if (lox.begin(0x29, false, &Wire1)) loxOK = true;

  WiFi.begin(ssid, password);
  while (WiFi.status() != WL_CONNECTED) { delay(500); Serial.print("."); }
```

```
  server.on("/data", [](){
    JsonDocument doc;
    doc["total"] = total;
    doc["red"] = red;
    doc["blue"] = blue;
    doc["h"] = currentHeight;
    doc["led1"] = led1Status;
    doc["led2"] = led2Status;
    String res; serializeJson(doc, res);
    server.sendHeader("Access-Control-Allow-Origin", "*");
    server.send(200, "application/json", res);
  });

  server.on("/led1", [](){ led1Status = !led1Status; digitalWrite(PIN_LED1,
led1Status); server.send(200, "text/plain", "OK"); });
  server.on("/led2", [](){ led2Status = !led2Status; digitalWrite(PIN_LED2,
led2Status); server.send(200, "text/plain", "OK"); });
  server.begin();
}

void loop() {
  if (WiFi.status() == WL_CONNECTED) server.handleClient();

  if (digitalRead(PIN_SW_POWER) == HIGH) {
    digitalWrite(PIN_IN1, LOW); digitalWrite(PIN_IN2, LOW); ledcWrite(0, 0);
    currentHeight = 0;
    updateOLED("STOP", false); return;
  }

  digitalWrite(PIN_IN1, HIGH); digitalWrite(PIN_IN2, LOW); ledcWrite(0, 200);
  updateOLED("RUNNING", true);

  // Nhận diện màu
  if (tcsOK && !hasCounted) {
    uint16_t r, g, b, c; tcs.getRawData(&r, &g, &b, &c);
    if (c > 50) {
      if (r > b && r > g) lastColorDetected = 1;
      else if (b > r && b > g) lastColorDetected = 2;
    }
  }

  // Nhận diện chiều cao và đếm
  if (loxOK) {
    int d = lox.readRange();
    float h_val = GROUND_DIST - d;
```

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    currentHeight = (h_val > 3) ? h_val : 0;

    if (d < 60 && !hasCounted && lastColorDetected != 0) {
      ledcWrite(0, 0);
      delay(300);

      if (lastColorDetected == 1) red++;
      else if (lastColorDetected == 2) blue++;

      total++;
      hasCounted = true;
      lastColorDetected = 0;

      delay(500);
      ledcWrite(0, 200);
      delay(1000);
    }

    if (d > 80) hasCounted = false;
  }
}
```

PLATFORMIO.INI

```
[env:esp32dev]
platform = espressif32
board = esp32dev
framework = arduino
monitor_speed = 115200
lib_deps =
    adafruit/Adafruit_VL53L0X @ ^1.2.4
    adafruit/Adafruit TCS34725 @ ^1.4.4
    adafruit/Adafruit SSD1306 @ ^2.5.9
    adafruit/Adafruit GFX Library @ ^1.11.9
    bblanchon/ArduinoJson @ ^7.0.4
```