ELE 301 - Electromagnet Position Control System

This document contains the complete wiring summary and the final Arduino code skeleton of an Arduino Mega 2560 based electromagnet position control system. Main system components: - 4 electromagnets (4 coils) - 2 L298N H-bridge driver boards - VL53L0X ToF (Time of Flight) distance sensor - RepRap Discount Smart Controller 20x4 LCD (EXP1/EXP2) - 4x4 matrix keypad - PID controller and Ziegler–Nichols Auto-Tune algorithm

Wiring Summary (Pin Mapping)

```
1. Power Connections
- 12V DC: L298N #1 VIN, L298N #2 VIN
- 5V DC: Arduino Mega 5V, VL53L0X VCC, LCD 5V
- GND: All boards and sensors share a common ground

2. VL53L0X Distance Sensor
- SDA -> D20 (SDA)
- SCL -> D21 (SCL)
- VCC -> 5V
- GND -> GND

3. RepRap Smart LCD (EXP1 - 20x4)
- RS  -> D16
- EN  -> D17
- D4  -> D23
- D5  -> D25
- D6  -> D27
- D7  -> D29
- +5V -> 5V
- GND -> GND
(Note: Pins D31, D33, D41, D49, D50, D51, D52, D53 coming from EXP2
are used for SD card and the encoder in typical 3D printer setups
and are not used in this project.)

4. L298N Driver Boards

L298N #1
- ENA -> D2 (PWM)
- IN1 -> D22
- IN2 -> D26
- ENB -> D4 (PWM)
- IN3 -> D28
- IN4 -> D30

L298N #2
- ENA -> D6 (PWM)
- IN1 -> D24
- IN2 -> D32
- ENB -> D8 (PWM)
- IN3 -> D34
- IN4 -> D36

5. 4x4 Keypad
Rows:
- R1 -> D40
- R2 -> D42
- R3 -> D44
- R4 -> D46

Columns:
- C1 -> D38
- C2 -> D39
- C3 -> D43
- C4 -> D45
```

Block Diagram

```
Block Diagram (Textual):

[12V PSU] --> [L298N #1] --> [Coil 1, Coil 2]
```

```
          \-> [L298N #2] --> [Coil 3, Coil 4]

[5V Regulator] --> [Arduino Mega 2560]
                \-> [VL53L0X ToF Sensor]
                \-> [RepRap Smart LCD (20x4)]

Arduino Mega:
- D2,D4,D6,D8,D22,D24,D26,D28,D30,D32,D34,D36 -> Inputs of both L298N drivers
- D16,D17,D23,D25,D27,D29 -> LCD data and control lines
- D20,D21 -> VL53L0X I2C bus
- D38,D39,D40,D42,D43,D44,D45,D46 -> Keypad row/column lines
```

Arduino Code Skeleton

```
// Full Arduino sketch (PID + Auto-Tune + LCD + Keypad + VL53L0X)
// should be taken from the ChatGPT output section titled
// 'Guncellenmis Tam Kod' / 'Updated Full Code'.
// Here we only show the high-level structure for documentation.

void setup() {
  // Configure pin modes, start VL53L0X, initialize LCD and serial port, etc.
}

void loop() {
  // Handle keypad menu, update LCD, read distance sensor,
  // compute PID outputs, drive the coils via L298N drivers,
  // and run Auto-Tune when requested.
}
```