DETAILED DESCRIPTION OF ELECTRICAL DIAGRAM

1. POWER SYSTEM

Main Power Source

- **Battery**: 12V DC
- **Main Switch (SW1)**: Controls entire system power via ON/OFF switch that interrupts battery positive terminal

Voltage Regulation

- **LM2596 Step-Down Module**:
  - Input: 12V from main bus (after switch)
  - Output: Adjustable 5V via potentiometer
  - Type: Buck switching converter (high efficiency ~92%)
  - Includes operation indicator LED
  - Powers servo motor exclusively

Power Distribution

- **12V Bus**: Directly powers:
  - L298N Motor Driver (VS terminal)
  - Arduino R4 WiFi (via DC Jack)
  - LM2596 regulator input
- **Arduino 5V Bus**: Powers:
  - 3 HC-SR04 sensors
  - Pixy Camera
  - Start button pull-up

2. MAIN CONTROLLER

Arduino UNO R4 WiFi

- Processor: Renesas RA4M1 (ARM Cortex-M4 @ 48MHz)
- Integrated WiFi connectivity
- Power: 12V via DC Jack (internal regulation to 5V)
- Provides regulated 5V for peripherals

3. MOTION SYSTEM

DC Motor

- Controlled by L298N driver

- L298N Connections:
  - **ENB** → Pin D6 (PWM speed control)
  - **IN3** → Pin D8 (direction)
  - **IN4** → Pin D7 (direction)
  - **OUT3/OUT4** → DC motor terminals
  - **VS** → 12V from main bus
  - **GND** → Common ground

Servo Motor SG90

- Vehicle steering control
- Connections:
  - **PWM** → Pin D9 (control signal)
  - **VCC** → 5V from LM2596 regulator (dedicated power)
  - **GND** → Common ground

4. SENSOR SYSTEM

Three HC-SR04 Ultrasonic Sensors

1. RIGHT Sensor:

- TRIG → Pin D2
- ECHO → Pin D3
- VCC → Arduino 5V
- GND → Common ground

2. LEFT Sensor:

- TRIG → Pin D4
- ECHO → Pin D5
- VCC → Arduino 5V
- GND → Common ground

3. FRONT Sensor:

- TRIG → Pin A1
- ECHO → Pin A2
- VCC → Arduino 5V
- GND → Common ground

Pixy Camera (CMUcam5)

- SPI interface for computer vision
- SPI Connections:
  - **MISO** → Pin D12

- **MOSI** → Pin D11
- **SCK** → Pin D13
- **SS** → Pin A0
- **VCC** → Arduino 5V
- **GND** → Common ground

5. CONTROL SYSTEM

START Button

- Connected to Pin D10
- 10kΩ pull-up resistor to 5V
- Pressing connects pin to ground (inverse logic)
- Allows robot program initialization

6. DETAILED CONNECTIONS

Digital Pins Used:

- D2: Right sensor TRIG
- D3: Right sensor ECHO
- D4: Left sensor TRIG
- D5: Left sensor ECHO
- D6: Motor ENB (PWM)
- D7: Motor IN4
- D8: Motor IN3
- D9: Servo PWM
- D10: Start button
- D11: MOSI (SPI - Pixy)
- D12: MISO (SPI - Pixy)
- D13: SCK (SPI - Pixy)

Analog Pins Used:

- A0: SS (Pixy Camera)
- A1: Front sensor TRIG
- A2: Front sensor ECHO

7. POWER FLOW

1. **12V Battery → ON/OFF Switch → 12V Bus**
2. **12V Bus** splits to:
   - → **Arduino DC Jack** (internal regulation)
   - → **L298N VS** (motor power)
   - → **LM2596 IN** (to generate 5V)
3. **Arduino 5V pin → HC-SR04 Sensors + Pixy + Pull-up**

4. **LM2596 OUT → Servo motor** (dedicated 5V)

8. IMPORTANT FEATURES

Common Ground (GND)

- All components share same ground reference
- Ground bus connects: battery, Arduino, L298N, LM2596, sensors, servo, and Pixy

Protections

- Main switch for complete power cutoff
- Separate regulation for servo (prevents voltage drops)
- Pull-up on Start button (prevents erratic readings)

Diagram Color Codes

- **Thick black**: Main power lines
- **Thin black**: Digital signals
- **Blue**: Motor control signals
- **Green**: Ultrasonic sensor signals
- **Orange**: Servo PWM signal
- **Purple**: Pixy SPI bus
- **Red**: 5V from regulator to servo

9. DESIGN ADVANTAGES

1. **Robust power supply**: Separate regulation prevents interference
2. **Modular**: Easy to add/remove components
3. **Diagnostics**: LED on LM2596 indicates operation
4. **Flexibility**: Integrated WiFi allows remote control
5. **Safety**: Main switch cuts all power
6. **Complete navigation**: 3 sensors cover 180° vision

This design enables an autonomous navigation robot capable of detecting obstacles in three directions, with computer vision and precise motion control, all with a robust and well-organized electrical architecture.