

Advanced Driver-Assistance Systems

SW252 - Course Project – Phase 2

Ahmed Wael 202201415

A. Component List

1. Arduino Uno Rev3 with CH340 Uploader
2. Breadboard 400 points
3. Bluetooth Module HC-05
4. L298 Motor Driver Module
5. 4 DC Geared Motor Dual Shaft 3:6VDC 450 rpm with Wheel (D: 65mm X W: 26mm)
6. HC-SR04 Ultrasonic Wave Detector Sensor 3.3V~5V
7. 4 Li-ion Battery 3.7V Rechargeable (Recycled) 18650-1200mAh
8. Dip Switch 8 Way
9. Photo-resistor LDR Light Sensor Module
10. Character LCD 2x16 Blue with Soldering Serial interface IIC/I2C Module
11. Red LED 5mm
12. Green LED 5mm

B. System architecture schematic

Connections Overview

1. Bluetooth Communication
 - HC-05 TX → Arduino Pin 10
 - HC-05 RX → Arduino Pin 11
 - Used to receive:
 - Movement commands (F, B, L, R, S)
 - Speed levels (0–9, q)
 - Used to send report for the connected device about:
 - Speed
 - Distance
 - Safety Status
2. Motor Control (L298 Module)
 - ENA (PWM speed control) → Arduino Pin 3
 - ENB (PWM speed control) → Arduino Pin 9
 - IN1 → Arduino Pin 5
 - IN2 → Arduino Pin 4
 - IN3 → Arduino Pin 7
 - IN4 → Arduino Pin 6

These pins control:

- Forward / backward movement
- Left / right turning
- Smooth acceleration and deceleration using PWM

3. Ultrasonic Sensor (HC-SR04)

- Trig → Arduino Pin 12
- Echo → Arduino Pin 8

Used to:

- Measure distance to obstacles
- Calculate Time-To-Collision (TTC)
- Reduce speed automatically when unsafe

4. Light Detection System

- LDR Output → Arduino A0
- Headlight LED → Arduino Pin 2

If ambient light is low, headlights turn ON automatically.

5. LCD Display (I2C)

- SDA → Arduino A4
- SCL → Arduino A5

Displays:

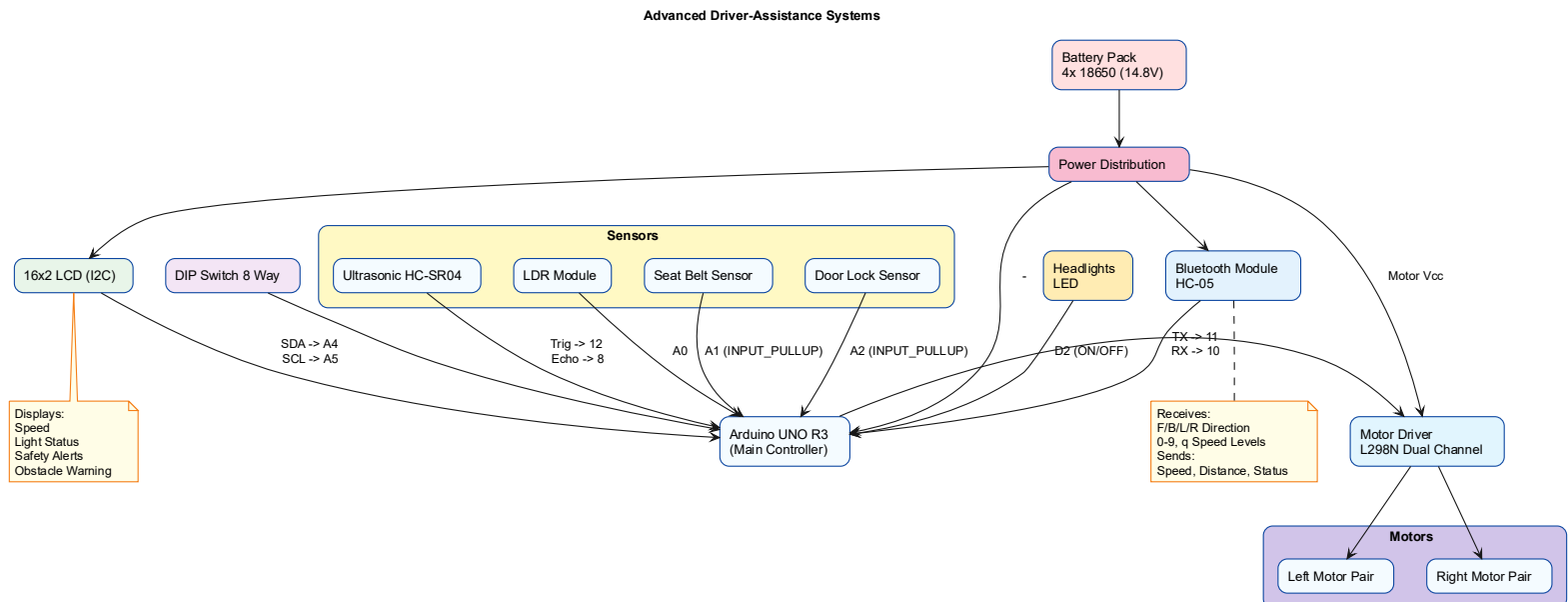
- Speed value
- Light status
- Obstacle safety state

6. Power Supply

- 4× Li-ion batteries
- Motor driver powered directly
- Arduino powered through regulated input

7. Safety Buttons Sensors

- Seat Belt Sensor → A1
- Door Lock Sensor → A2



Program Modules with Comments

1. Initialization Module (setup())

- Initialize serial communication
- Initialize Bluetooth
- Initialize LCD
- Configure all I/O pins
- Display startup message

2. Main Control Loop (loop())

- Read Bluetooth command (direction + speed)
- Read LDR for light level
- Read ultrasonic sensor for distance
- Apply incremental speed update
- Perform safety validation
- Execute movement (Forward / Reverse / Turn / Stop)
- Update LCD with system status
- Send Bluetooth telemetry logs

3. Bluetooth Command Processing

- Receives Bluetooth command characters
- Converts characters 0–9 and q into PWM speed values
- Stores target speed in Speed variable
- Does NOT move the car — only updates speed reference
- Send report to the connected device about (speed, light and safety state)

4. Ultrasonic Distance & Safety Module

- Measure obstacle distance
- Calculate Time To Collision (TTC)
- Reduce speed automatically when TTC is unsafe

5. Speed Control Module (Smooth Acceleration)

- Adjust motor speed
- Updates every 40 ms to ensure smooth motion
- Prevent sudden braking
- Uses PWM on ENA and ENB pins

6. Movement Control Module

Command	Action
F	Move forward
B	Move backward
L	Turn left
R	Turn right
S / default	Stop

Motor Direction Logic:

Implemented using IN1–IN4 pin combinations.

7. LDR

- Detect surrounding light
- Turn headlights ON/OFF automatically

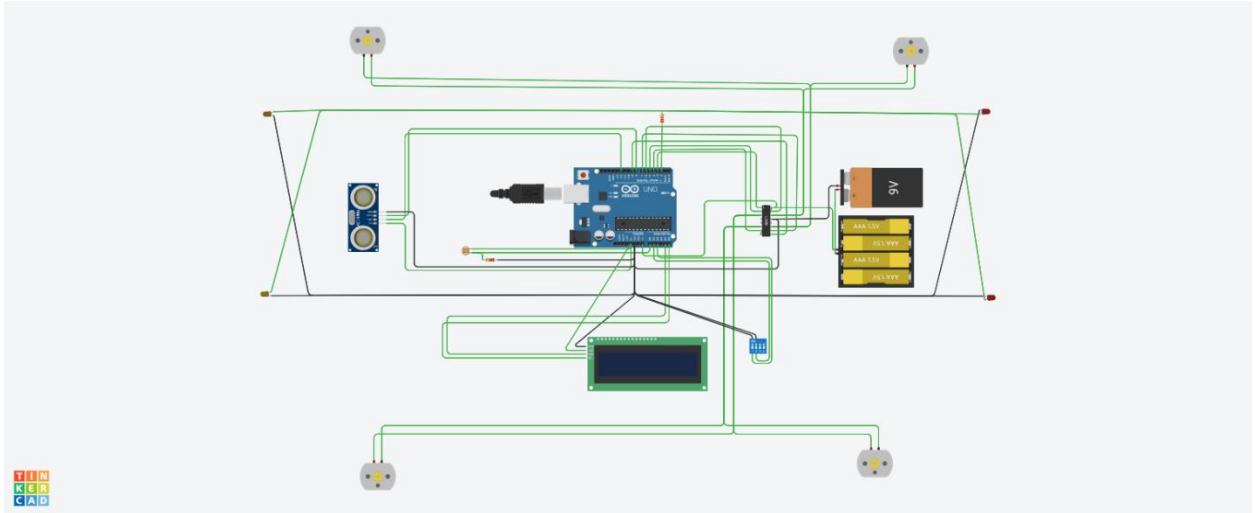
8. LCD Display Module

Displays:

- Speed
- Light status (ON/OFF)
- Safety state (SAFE / OBSTACLE)

9. Safety Buttons Sensors

- Check the seatbelt and door before moving
- The car can move if the door is closed and the seatbelt is fastened
- Otherwise, the car will not move.



<https://www.tinkercad.com/things/biWAMIYXoqi-phase-1-project?sharecode=WANjqpi-d3QQBnAoKnWevCtdt4a--Y42-4BOKmglXJU&authuser=0>