# Team 5 – Ard We Know

# (APA + FI + RS)


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# Brief description about your project idea and approach

## Idea:

An automated car which can perform parallel parking using ultrasonic sensors to detect distance between itself and obstacles; there are two ultrasonic sensors placed at the front and back of the car. The car has a safety system consisting of automated windshield wiper action in case rain is detected in the outside environment. Rain detection occurs through the use of a raindrop sensor and when rain is detected windshield wiper movement is simulated using a servo motor that will start moving for 180 degrees and back. Moreover, there is a fuel level detection mechanism which is composed of a water level sensor that detects three levels (0, 1, 2) where 2 represents the full tank state and 0 represents the empty tank state. Finally, we added an entertainment feature in the form a radio system that is controlled using a touch screen where the user can choose a station to listen to.

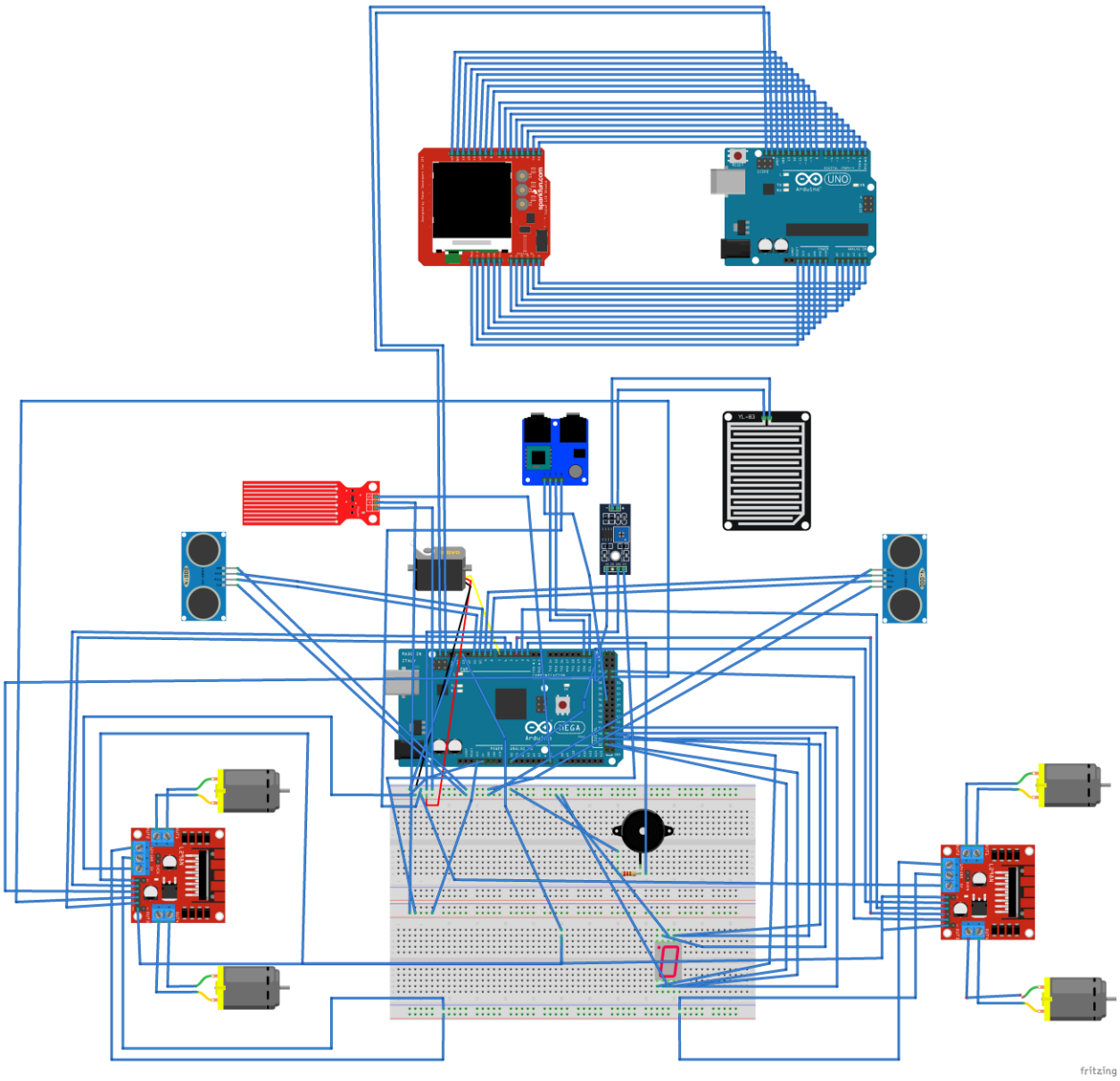
## Approach:

An Arduino Mega board was used to connect the parallel parking system components, the radio module, the fuel detection system components, and the rain detection system components. An Arduino Uno board was used to wire the LCD touch screen and both boards were connected using the SCL and SDA pins present on each pin; the I2C library wire was used to make this connection. Through this connection data in the form of user input on the LCD touch screen was able to move from the Arduino Uno board to the Arduino Mega board so that it could be used to switch channels on the radio module.

# The components and their functionalities

| Component | Functionality |
|---|---|
| 1. Arduino Mega | For connecting all components together |
| 2. Arduino Uno | For the LCD TFT Touchscreen |
| 3. Jumpers | Wiring and connecting pins |
| 4. Breadboards | For moving extra connections that do not fit on either Arduino boards. |
| 5. 2 H-bridges | Middelware for controlling the DC motor using the Arduino. |
| 6. 4 DC Motors | For controlling the momevent of the car. |
| 7. LCD TFT Touchscreen | For controlling the radio's input, and displaying the frequency. |
| 8. Seven Segment Display | Showing the Fuel Level as either 0, 1, 7 (2 is not working). |
| 9. 2 Ultrasonic Sensors | For detecting the car's movement. |
| 10. Radio Module | For connecting to various radio channels. |
| 11. Water level sensor | For detecting the fuel level (simulated by water level) of the car. |
| 12. Raindrop Sensor | For detecting when it rains. |
| 13. Resistor | For connecting the buzzer (used along with ultrasonic sensors) to GND. |
| 14. 6 AA batteries | To power the DC motors through the h-bridges connected to them. |
| 15. Car chasset | To hold the various components while the car is moving. |

# The Full Circuit Using Fritzing



# The names of the libraries used and their functions

| Library | Functionality and Description |
|---|---|
| Servo / #include <Servo.h> | • Description: Allows Arduino/Genuino boards to control a variety of servo motors. This library can control a great number of servos. It makes careful use of timers: the library can control 12 servos using only 1 timer. On the Arduino Due you can control up to 60 servos.<br>• Api Usage: We used the .write() function with the angle parameter to make it rotate 170 degrees back and forth. |
| Wire / #include <Wire.h> | • Description: This library allows you to communicate with I2C / TWI devices. On the Arduino boards with the R3 layout (1.0 pinout), the SDA (data line) and SCL (clock line) are on the pin headers close to the AREF pin. The Arduino Due has two I2C / TWI interfaces SDA1 and SCL1 are near to the AREF pin and the additional one is on pins 20 and 21.<br>• Api Usage: We used |

| | |
|---|---|
| | Wire.begin() to initialiaze the connection. Wire.requestFrom(), Wire.isAvailable(), Wire.read() to change frequency. This frequency is constrained between 88.0 and 108.0. |
| TEA5767/ #include <TEA5767Radio.h> | • Description: A simple to use library for the TEA5767 I2C FM receiver IC. It supports multiple devices and just wraps the I2C command to set the frequency.<br>• Api Usage: We used .setFrequency() on an instance of the library to contact the frequency. |
| LiquidCrystal / #include <LiquidCrystal.h> | • Description: This library allows an Arduino board to control LiquidCrystal displa ys (LCDs) based on the Hitachi HD44780 (or a compatible) chipset, which is found on most text-based LCDs. The library works with in either 4- or 8-bit mode (i.e. using 4 or 8 data lines in addition to the rs, enable, and, optionally, the rw control lines).<br>• Api Usage: We used .setCursor() to specify coordinates of text |

| | |
|---|---|
| | to be written as well as .print() to print text. |
| Adafruit GFX / #include <Adafruit_GFX.h> | • Description: This is the core graphics library for all our displays, providing a common set of graphics primitives (points, lines, circles, etc.). It needs to be paired with a hardware-specific library for each display device we carry (to handle the lower-level functions). |
| Adafruit TFTLCD / #include <Adafruit_TFTLCD h> | • Description**:** Adafruit library for 8-bit TFT LCDs such as ILI9325, ILI9328, etc. This is a library for our Adafruit 16-channel PWM & Servo driver, shield or FeatherWing. |
| Adafruit TouchScreen / #include <Adafruit | • Description**:** This is the 4-wire resistive touch screen firmware for Arduino. |
| freeRTOS / #include <Arduino_FreeRTOS.h> | • Description: This is the library used for scheduling the various tasks of the system.<br>• Api Usage: xTaskCreate() to create tasks for the separate systems making up the project. |

# How we take and handle inputs

| Input | Type | Pin | Action |
|---|---|---|---|
| LCD | Analog, Digital, PWM | Arduino Uno pins (in addition to I2C connection between Uno & Mega boards) | Take user input to change the radio channel or turn the radio off/on |
| Ultrasonic Sensors | PWM | 8,9,10,11 | Detect whether the car is too close to an obstacle |
| Raindrop Sensor | Analog | A0 | Detect whether there is rain or not to decide when to activate the servo motor |
| Water Level Sensor | Analog | A7 | Detect the fuel level to display either 0, 1, 2 on the 7 segment display to represent the tank state |

# How we configure and handle the outputs

| Output | Type | Pins | Action |
|---|---|---|---|
| H-Bridge | Analog | 1. Enable: 12<br>2. PWM: 3..6<br>3. Normal: 26..29 | Control the motors as well as their speed. |
| 7 Segment Display | Digital | 47, 48, 49, 50, 51, 52, 53 | Display 0, 1, 2 which indicate whether the water level is low, medium, high respectively. |
| Servo Motor | PWM | 7 | Rotate 180 degrees and back |
| Buzzer | PWM | 2 | Generate buzzing sound when the car is near to an obstacle |
| Radio Module | I2C | SDA, SCL | For outputting the radio channel sound specified |

# How the features were prioritized and divided into tasks

The system was divided into 4 main tasks, all of which have the same priority (1).

1. Parallel parking & obstacle detection
2. Fuel level detection & 7 segment display
3. Rain detection & windshield wiper movement (servo motor)
4. Radio & LCD shield

# The problems or limitations faced during implementation

- The DC motor could not run on low speeds and kept buzzing; we kept the speed at maximum.
- The components were too heavy for the car body and sometimes it would lag before starting to move. Keeping the speed at maximum as well as using 6 AA helped reduce this problem.
- There is a lag period between obstacle detection and car changing direction. The effect of this problem was reduced by using a larger distance to detect that there is an obstacle.
- When a lot of testing was done (parallel parking) the DC motors stopped moving, but after the batteries were disconnected for a while and then reconnected the car was powered normally and moved as specified in the code.

# Work Division

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|---|---|
| Donia Ali | (RS) LCD touch screen handling and Radio System Module |
| Arwa Tawfik | (FI) Rain Detection and Windshields / Fuel Level / Seven Segment / Servo motor |
| Maria Maged | (APA) Parallel Parking – Motors, H-bridge with PWM and ultrasonic sensor |
| Reem Alansary | (APA) Parallel Parking – Motors, H-bridge with PWM and ultrasonic sensor |
| Maryam Khaled | (RS) LCD touch screen handling and Radio System Module |