Rebuild an RC CAR with ESP32 & Arduino Code

The present document provides all the information needed to rebuild an RC CAR from scratch using ESP32-based *microcontroller units (MCUs)*, programmed in Arduino environment. The current project applies to the 1:16 *Xinlehong (XLH)* 9136 model, but can be easily adapted to any RC Car model that incorporates:

a) **DC motor** for the *forward/backward (FW/BW)* movement of the car,

b) **3-wire Servo Motor** (operating at 5V) for the control of the steering wheel,

c) **2S LiPo battery** (of 7.4 nominal voltage or perhaps of higher voltage if taking into consideration the specifications and limitations of the boards held by the proposed system).

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In This Document

Overview of the 1:16 RC car

Figure 1–1 presents the chassis of the RC Car used by the current project. The car incorporates:

a) 2S battery,
b) *electronic speed controller (ESC)* with an encompassed RF receiver, which receives commands from the Remote-Control device and drives the DC motor of the car (i.e., FW/BW movement) as well as the Servo motor (i.e., the control of the steering wheel),
c) 390 DC motor (of JST XH type of female connector),
d) 5-wire Servo motor.

The 5-wire servo (depicted in **Figure 1–2**) is currently replaced with a compatible 3-wire servo, which is a more common choice for that kind of RC cars. Despite the servo replacement, the battery's connector has been swapped to the more common XT-60 type of female connector.

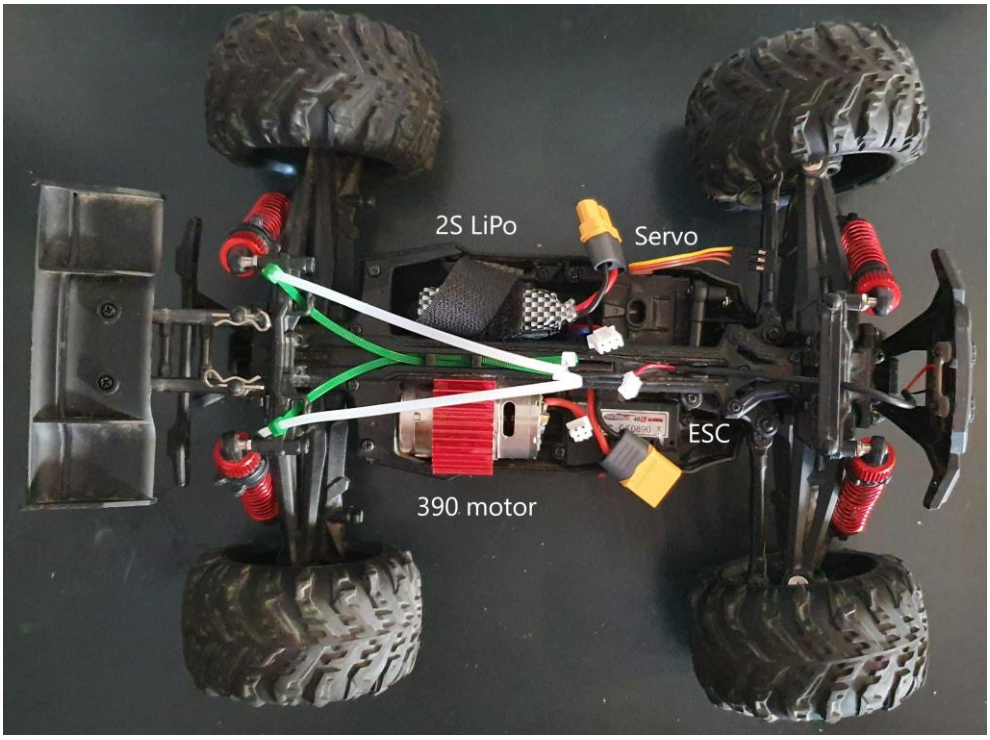

Figure 1–1 Chassis of the 1:16 RC Car.

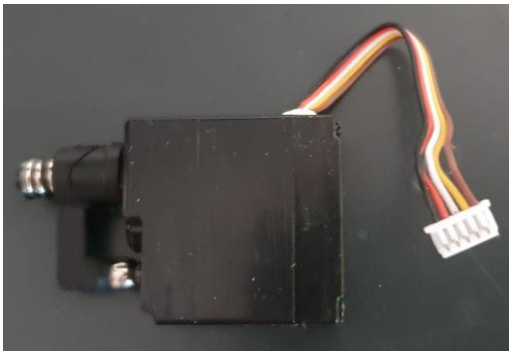

Figure 1—2 The originally 5-wire Servo incorporated by the 9136 RC Car.

Figure 1–3 illustrates the connections of the DC motor as well as the 5-wire Servo on the original ESC of the RC car system. It should be noted that the original ESC employs also a 2-pin JST PH type of female connector which is used for driving the RC car's lights; a function that will be not used in the recreated version of the system presented herein.

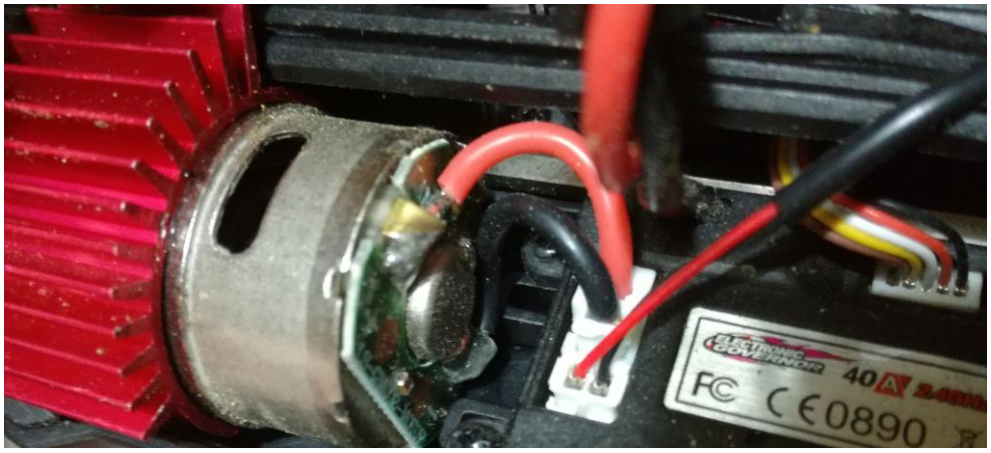

Figure 1—3 DC motor and 5-wire Servo connected to the ESC originally found on the RC Car.

Figure 1–4 depicts the original inner electronics of the Remote Control, which sends commands to the RC car. The device obtains power from 3 x AA batteries and encompasses two fundamental (5K) potentiometers which are used to control the FW/BW movement of the car as well as the steering wheel. Two more potentiometers on the top of the printed-circuit board (PCB) of the device are used to a) diminish the maximum speed of the car, and b) adjust the servo's quiescent point so as the front wheels of the car are aligned to move in straight line.

In **Figure 1–4** we have removed all but the two fundamental potentiometers that drive the car FW/BW and turn it *left/right (L/R)*. Each one of these two potentiometers

employs a 3-pin JST PH type of female connector.

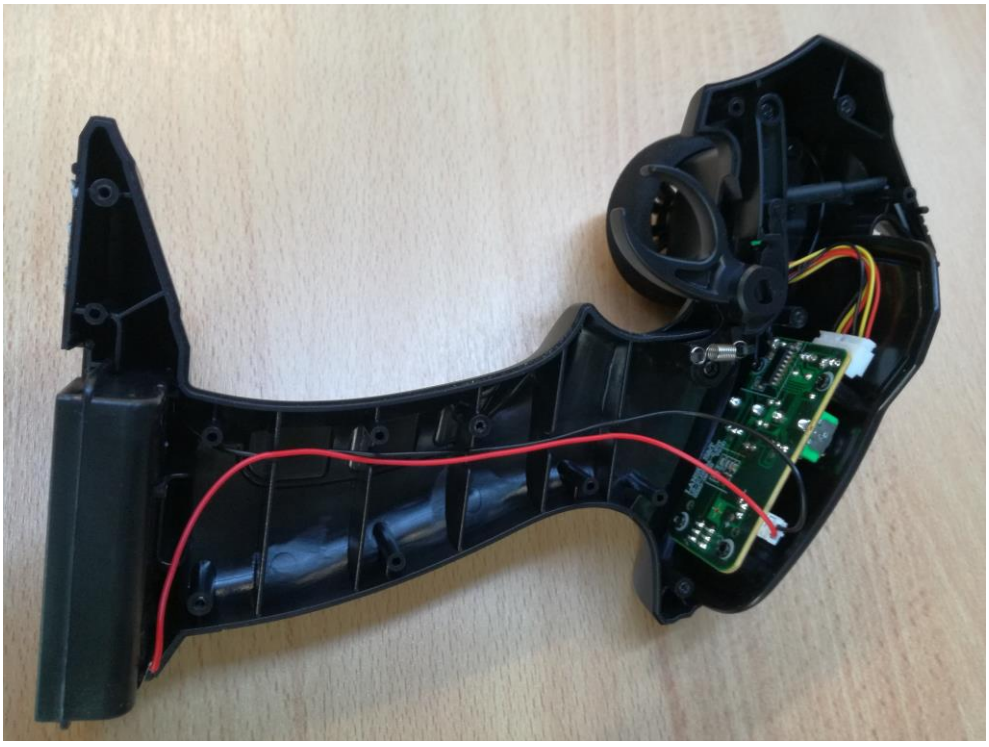

Figure 1—4 Remote control and original inner electronics of the device.

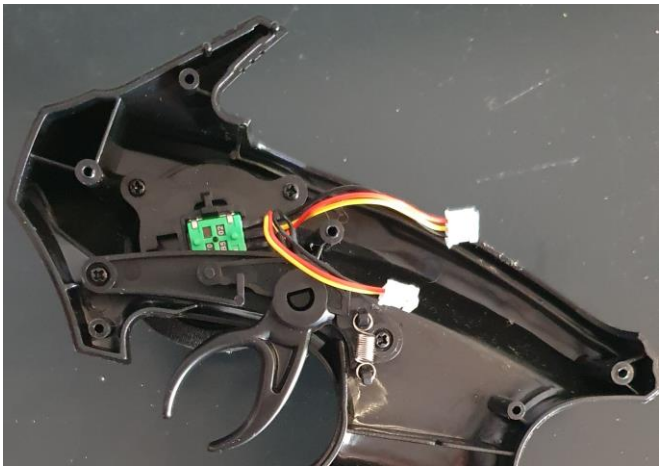

Figure 1—5 Remove the original electronics from the Remote-Control device.

Rebuilding electronics of the RC car

Figure 1–6 presents the re-designed electronics of the RC Car. An on/off switch is used to power on/off the RC car, which three connectors are used for connecting the DC motor, battery and servo to the boards of the system.

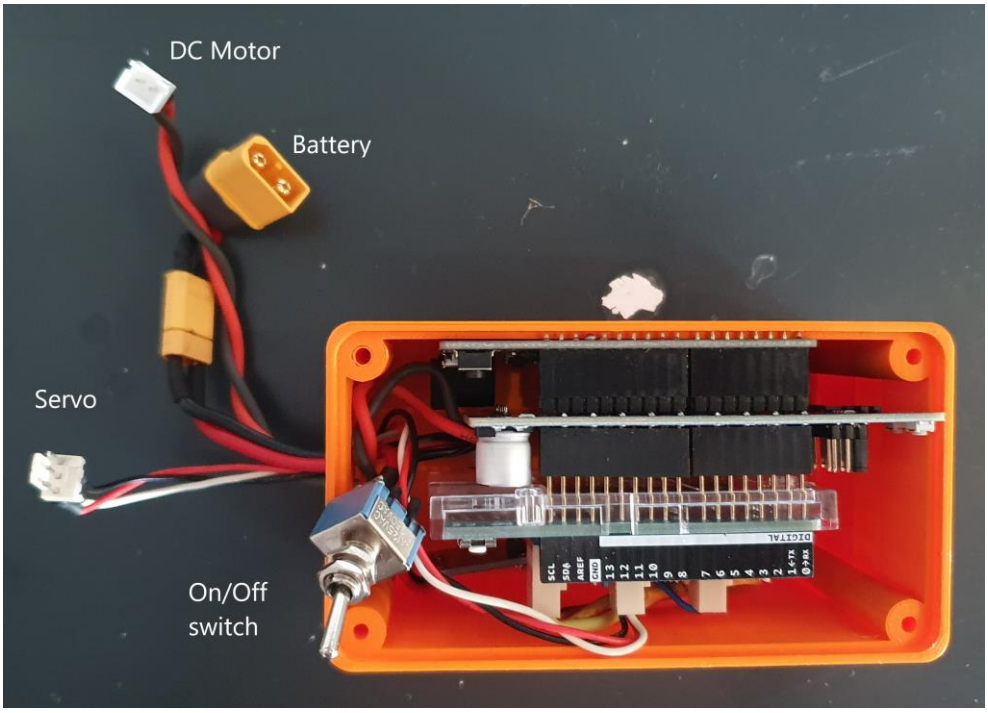

Figure 1—6 3D printed enclosure and user-defined electronics of the RC Car.

The separated electronics of the RC Car system are illustrated in **Figure 1–7**. The brain of the system constitutes an ESP32-based microcontroller (that is, WeMos D1 R32 board) which is also able to provide an RF interface with an equivalent microcontroller at the Remote-Control device. A DC Motor driver board system (that is, the SHIELD-MDD10 by Cytron Technologies) obtains power from the 2S LiPo battery and (through an H-bridge motor driver) controls the speed and direction (FW/BW) of the DC Motor. The third board of the RC Car system, that is, the Motion shield, employs BNO055 orientation sensor. While this board is used for future upgrades of the system (e.g., applying a drift functionality to the RC Car), it employs connectors which are used for the interconnection of various electronics of the system to the microcontroller board. One additional breakout board (that is, the INA219 current measuring module) provides information on the current consumed by the RC Car electronics.

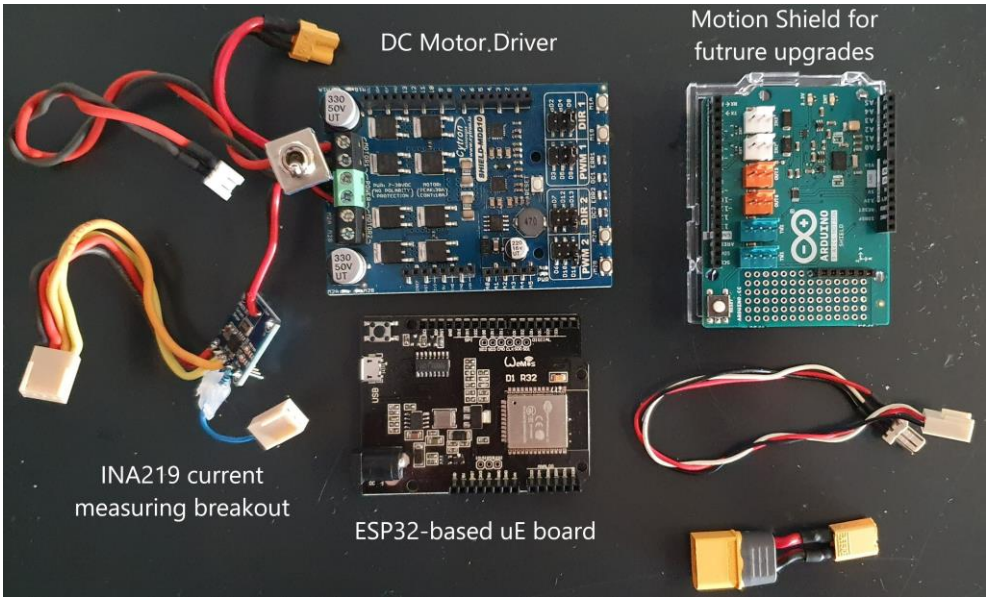

Figure 1—7 Separated electronics of the RC Car system.

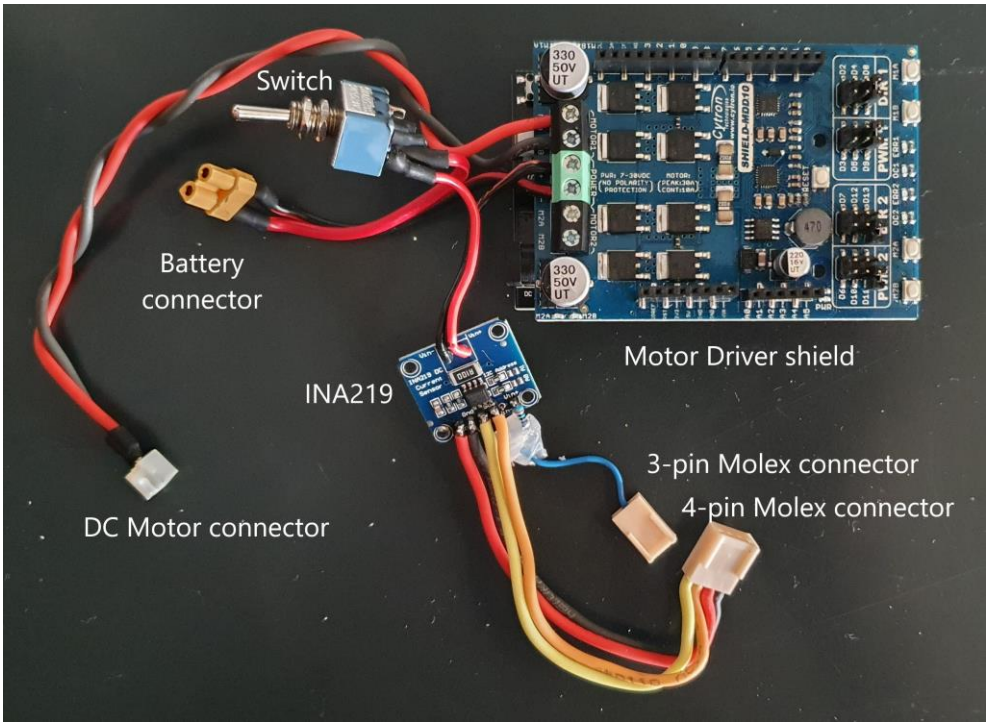

Figure 1—8 Interconnections of the RC Car system electronics.

Figure 1–8 presents the interconnections of the RC Car system electronics. In detail, the positive pole of the battery is connected to one of the two edges of the on/off switch. The other edge of the switch is connected to the positive input pin of INA219 module. The other (i.e., negative) input pin of INA219 is connected to the positive input of the power clamp of the Motor Driver shield (i.e., the green one), while the negative input of the same clamp is returned back to the negative pole of the battery.

Moreover, the I2C control of the INA219 module is achieved through 4-pin (2.54mm) Molex connector, which is directed to the corresponding pins of the microcontroller board (via the Motion shield connectors). Finally, the battery's two poles are connected (via the INA219 module) to a voltage divider of 2 x 10K resistors, and the divided-by-two (7.4V) nominal voltage of the battery is directed to an Analog Pin of the microcontroller (i.e., the blue wire) through the 3-pin Molex connector.

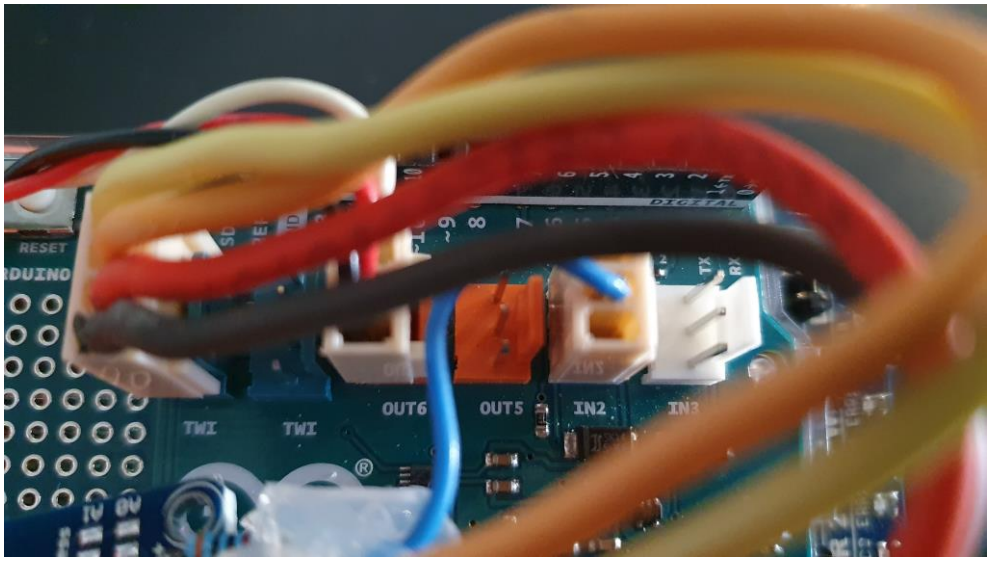

Figure 1—9 Connections through the Motion shield.

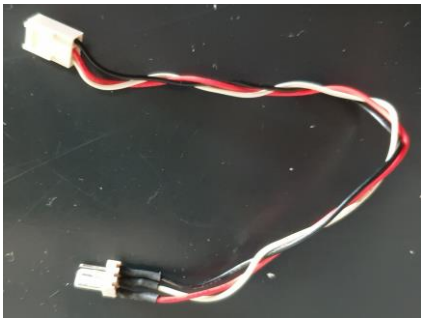

Figure 1—10 Connections through the Motion shield.

Figure 1–9 presents aforementioned connections of INA219 module to the ESP32 microcontroller board, through the connectors found on the Motion shield (connectors referred to as TWI and IN2). The additional OUT6 connector holds the cable for driving the Servo motor (through a PWM pin). This cable is depicted in **Figure 1–10**.

Rebuilding electronics of the Remote Control

The separated electronics of the Remote-Control system are illustrated in **Figure 1–11**. The brain of the system constitutes an ESP32-based microcontroller (that is, the C3 mini V1.0.0) which is also able to provide an RF interface to the equivalent microcontroller of the RC Car system.

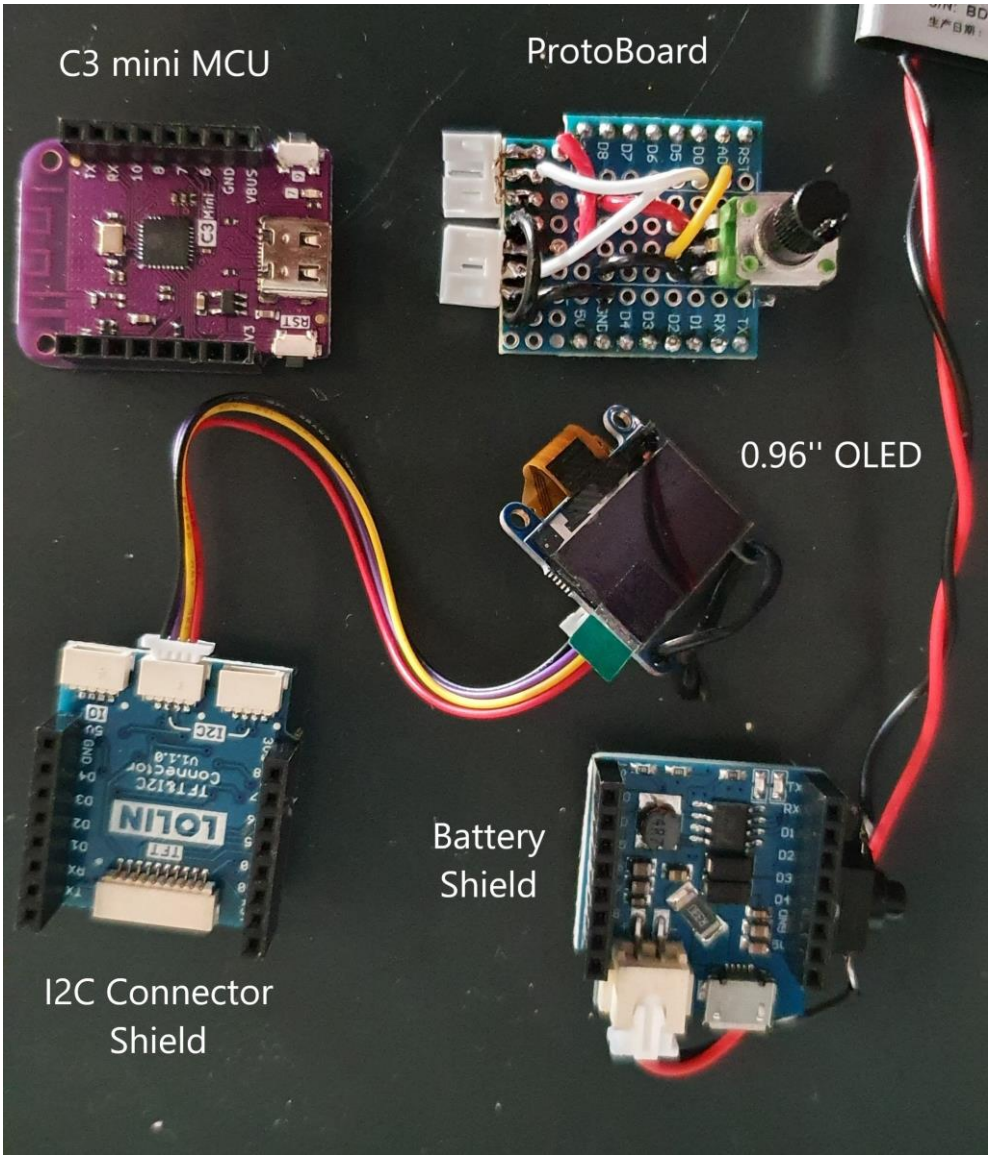

Figure 1—11 Separated electronics of the Remote Control.

A Battery Shield along with a 3.7V battery and an on/off switch provides power to the Remote-Control system. Information acquired by the RC Car (i.e., the percentage of the remaining battery, the battery's voltage and current consumed by the RC Car system) are depicted by an 0.96'' OLED, which is connected to the I2C pins of the MCU board through the corresponding I2C Connector Shield. Those reading are primarily needed because the LiPo battery should not drop below 6.2V so as to avoid a permanent damage. Finally, a ProtoBoard shield is used to accept the two potentiometers of the Remote Control that control FW/BW and L/R movements (see **Figure 1–5**), as well as to employ an additional 5K potentiometer for the alignment of the steering wheel (through the adjustment of the Servo's quiescent point).

The connections of the protoboard are quite simple. In detail, the inner pin of each potentiometer is driven to an Analog Pin of the MCU, while the other two potentiometer pins are connected to the power and ground pins respectively.

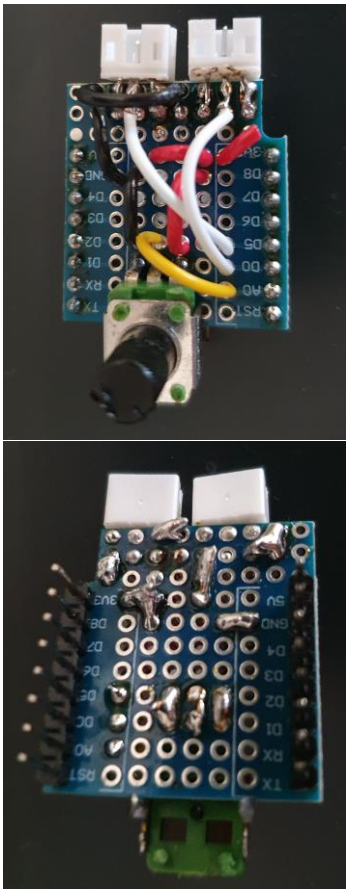

Figure 1—12 ProtoBoard Shield of the Remote Control.

Bills of Materials

Remote Control:

1. (2x) JST PH Connector Male 3-Pin 2.0mm ➔ Steer and Wheels control
2. (1x) Potentiometer Linear 5Kohm/6mm , Vertical ➔ Servo adjustment
3. (1x) ProtoBoard Shield ➔ to connect the three aforementioned potentiometers
    a. (2x) Pin Header 1x8 Male 2.54 mm
4. (1x) C3 Mini V1.0.0 Microcontroller Compatible with LOLIN D1 mini shields
    a. (2x) long 10.5mm / 8pin female header ➔ Stackable headers for the μE
5. (1x) LOLIN lithium (LiPo) Battery shield ➔ Provide power to the remote control
    a. (2x) Long 10.5mm / 8pin female header ➔ Stackable headers for the Bat. Shield
6. (1x) 3.7 V 1S LiPo battery ➔ Battery for the remote control
7. (1x) Push Button - Latching Black (12x8x8.2mm) ➔ On/Off switch
8. (1x) TFT I2C Connector Shield ➔ to attach I2C OLED 0.96 Shield
    a. (2x) Long 10.5mm / 8pin female header ➔ Stackable headers for the I2C Connector Shield
9. (1x) I2C OLED 0.96 Shield V1.0.0 (128x64 pixels) ➔ Display
    a. I2C Cable 100mm 10cm for LOLIN (WEMOS) SH1.0 4P double head cable

RC Car:

1. (1x) XT60 Male connector ➔ Battery connection
    a. (1x) XT30 Male/Female connector ➔ attach/detach the Battery connector
2. (1x) 3-pin Mole Male connector (2.54mm) ➔ Servo connection
3. (1x) 2-pin JST XH Male connector ➔ DC Motor connection
4. (1x) On/Off switch
5. (1x) INA219 breakout board
    a. (2x) 10K resistors ➔ voltage divider for the LiPo battery
    b. (1x) 3-pin Molex Female connector
    c. (1x) 4-pin Molex Female connector
6. (1x) Motor Driver shield
7. (1x) WeMos D1 R32 ESP32-based Microcontroller board
8. (1x) SHIELD-MDD10 Motor Driver by Cytron Technologies
9. (1x) 3-pin Molex Male/Female connector ➔ Servo connection cable
10. (1x) Motion Shield (future upgrades)