# Hardware Setup Information

The system diagram of the Autonomous Water Rover is as follows :

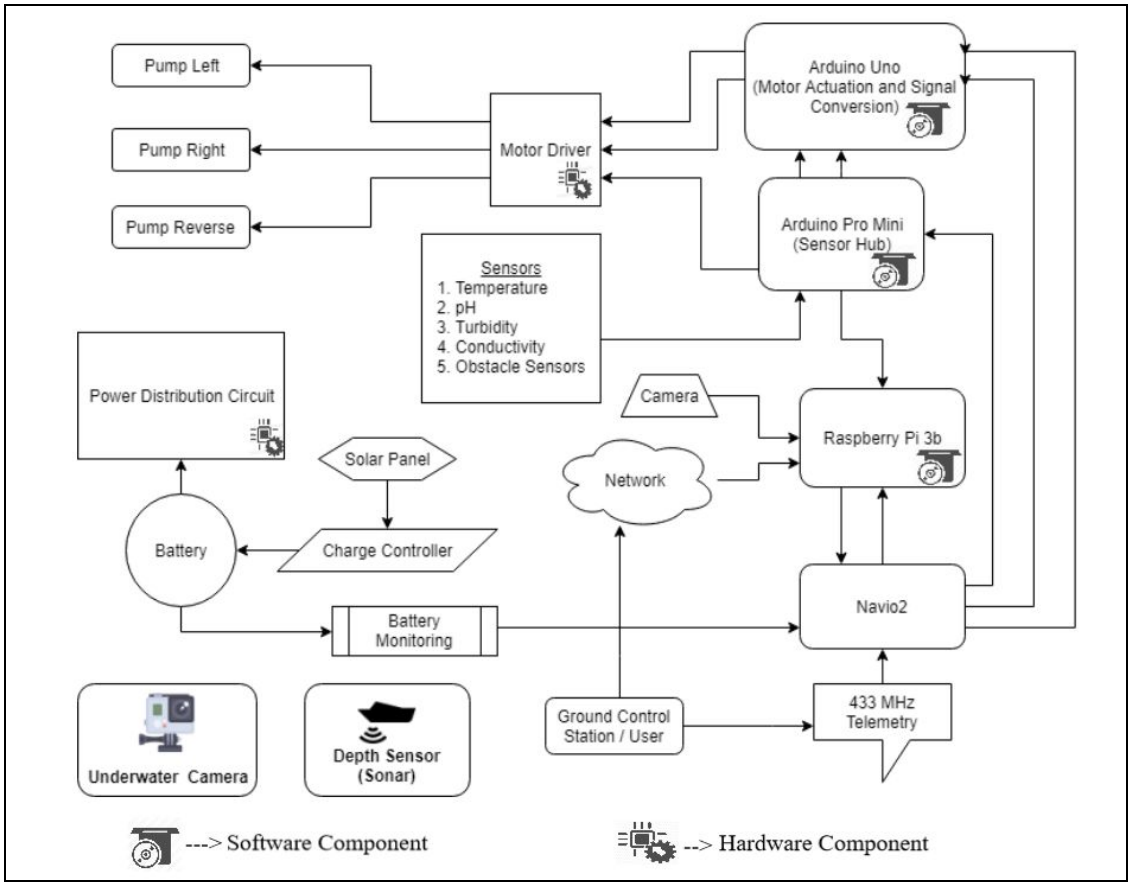



Figure 1 System Diagram

The various components in the above figure are as follows :-

- **Power System**: The power generation, storage and distribution includes the following main components :
    - Battery : LiPo will be used to ensure operation of rover for over an hour on one charging
    - Solar Panel : A 50W Solar Panel is used to charge the 12 volt battery and also increase the operation period

    - Charge Controller : A 20A 12V waterproof solar panel charge controller will be used
    - Voltage regulation : Voltage regulators will be used to always keep the supply voltage for the pumps constant i.e. 12V to obtain similar performance even at different battery levels. Also 5V and 3.3V voltage regulators will be used for obtaining required supply voltage for the Rpi controller board, Navio2, telemetry and all installed sensors on the rover

- **Raspberry Pi 3b** : It is a single board computer which will be used for complex path planning through ardupilot, hosting the web interface, providing live video streaming and communicating with sensor nodes
- **Navio2** : It is an autopilot Hat for Raspberry Pi 3b which simplifies autonomous navigation by bringing multiple sensors on a single board and by seamless integration with Raspberry Pi. It also has analog to digital converters along with pulse generators to produce pulses which can control servo motors. The following sensors will be used by the Autonomous Water Surveillance Rover :
    - GNSS Receiver : Tracks GPS, GLONASS, Beidou, Galileo and SBAS satellites for accurate positioning
    - Dual IMU : Accelerometers, gyroscope and magnetometer readings will be used for orientation and motion sensing
    - High resolution barometer : Senses altitude with 10 cm resolution and can be used to relay accurate location information along with GPS
    - Communication Ports : UART interface will be used to relay information through telemetry radio
- **Ground Control Station** : It could be any windows based personal computer having Mission Planner installed
- **Local Area Network** : A LAN is created to access the website hosted on the raspberry pi. It is not needed for operation in autonomous mode

- **Telemetry Radio** : The mRo SiK Telemetry Radio V2 operates at 433Mhz and provides 300m range by default. This radio will be the link to relay localization details and program missions for the rover remotely
- **Underwater Camera** : A GoPro hero is used to gather images of the underwater bed upto three meters. As penetration of light at this depth is sufficient, an illuminating light source will not be necessary. The light source can be fitted to the base of the rover for illumination if surveillance is to be done in the absence of sunlight
- **Camera** : A raspberry pi camera version 2 is used to provide live first person view of the rover to operator
- **Sensor Node** : Data acquisition from the environment will carried out and the information will be relayed to the Rpi. An arduino pro mini is used because of its small form factor for interfacing the sensors and communicating with raspberry pi
- **Distance Sensors** : Two waterproof ultrasound (40 KHz) distance sensors i.e. JSN-SR04T are used to detect obstacles on the surface of the water and in the forward path of the rover
- **Water Quality Monitoring Sensors** : To measure the quality of water following parameters are being measured :-
    - ***pH*** : DFRobot Gravity : analog pH sensor is being used to measure the pH of water. The pH measurements have a resolution of ± 0.1pH at 25 ℃
    - ***Temperature*** : DS18B20 waterproof temperature sensor probe is used to get ±0.5°C accuracy in the range -10°C to +85°C. It uses 1-Wire interface i.e. requires only one digital pin for communication
    - ***Conductivity*** : A generic rain sensitive sensor module is used in analog mode to get the conductivity readings. The accuracy of this module for measuring isn't high but can be used for thresholding purposes
    - ***Turbidity*** : DFRobot Gravity : analog turbidity sensor is used to obtain the turbidity readings which is later converted to NTU units.

- **Fish Finder** : ZEEPIN Fish Finder is a wireless & rechargeable sonar sensor along with a smart portable LCD display which is used to get depth data, temperature data along with the add on of identifying fishing areas

- **Signal Converter** : The output signal from the Navio 2 is in the form of RC pulses of the duration 1ms to 2ms. The external interrupt pins of an arduino uno is used to measure the pulse widths of these pulses and accordingly generate a PWM signal which drives the motor driver circuit
- **Motor Driver Circuit** : The arduino uno will send control signals to the motor driver which in turn will control the actuator i.e. pumps. The pumps will be operated at variable speed according to navigation control using PWM to allow more precise control over the rover

## Hardware Design

Hardware design has three main components. They involve the power distribution circuit, the motor driver circuit and other peripheral device connections. A circuit as shown below was designed to reduce wire connections and also to simplify sensor interfacing. It includes the power distribution system, the motor driver circuits and sensor input slots for the Arduino Pro Mini.

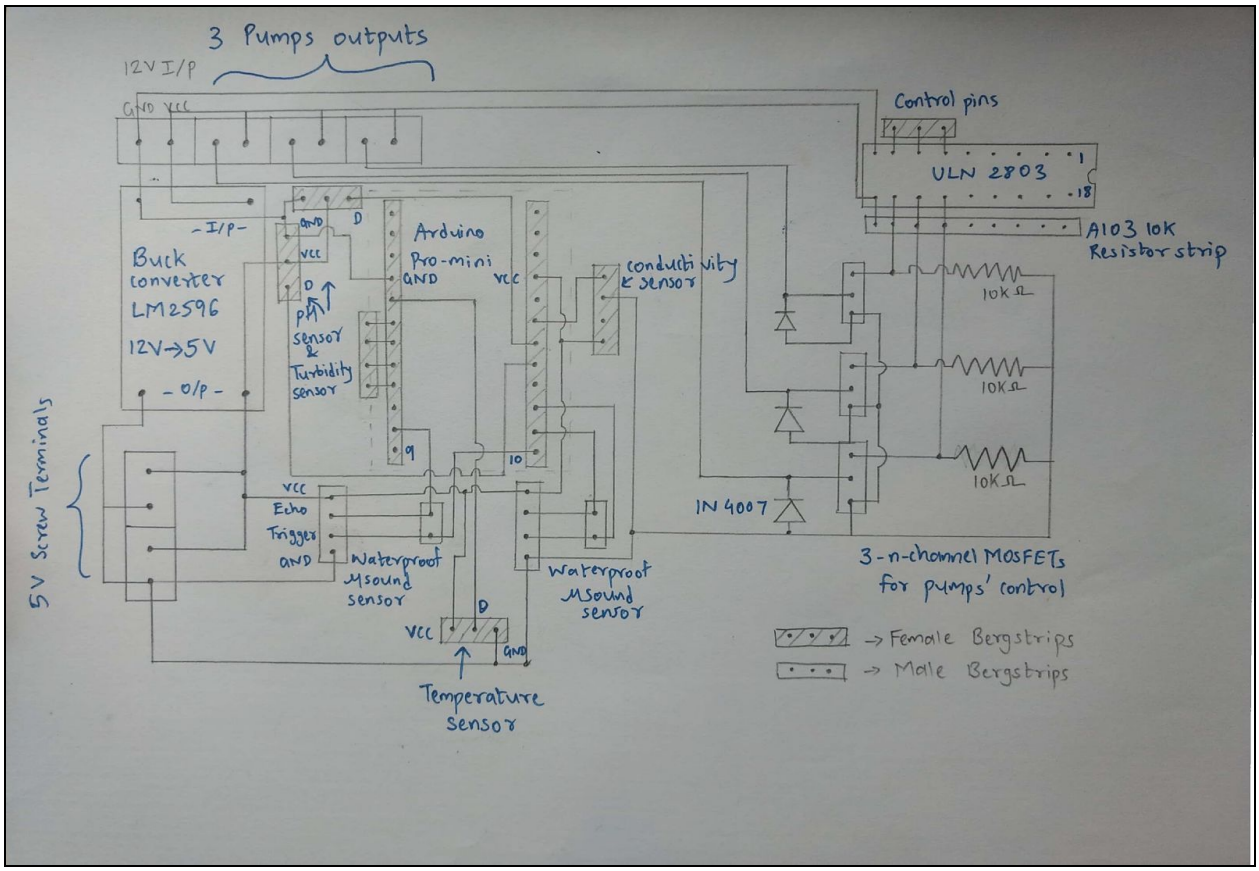



Figure 2 Circuit Diagram

**Step 1**

- The foremost thing to figure out is the motor control on the right hand side of the diagram. Since we are using bilge pumps, only unidirectional control is required eliminating the need for a H-bridge configuration.

- The ULN 2803 has Darlington pair transistors which are being used to provide the Gate of the n-channel Mosfets with the corresponding voltages. A point to remember is that the ULN 2803 will complement the output, thus a 0v i/p is to be given for a high output and vice versa.
- The Gate terminal is to be grounded with a high value resistor (10k ohms) since the Mosfet is a voltage controlled device.

- The Resistor strip A103 helps to keep the output of the ULN 2803 at a stable output. Thus, by giving complementary i/ps to the ULN 2803, we can control the pump motors.

**Motor Driver Circuit**

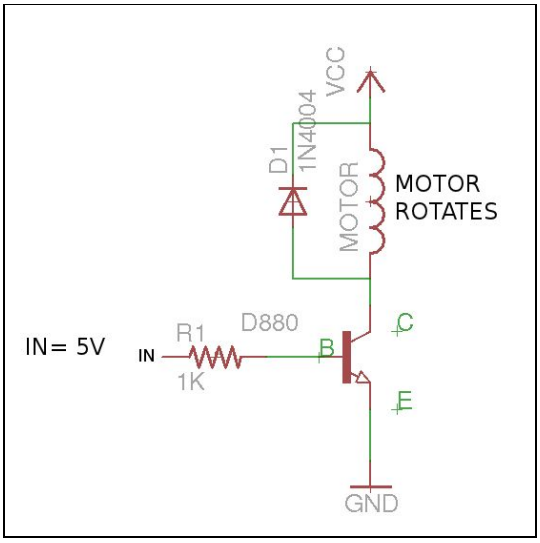



Fig 3 MOSFET schematic

Fig 3 shows the basic controlling of a motor using a MOSFET.

The total cost for the board is Rs. 561/8.25$

**Step 2**

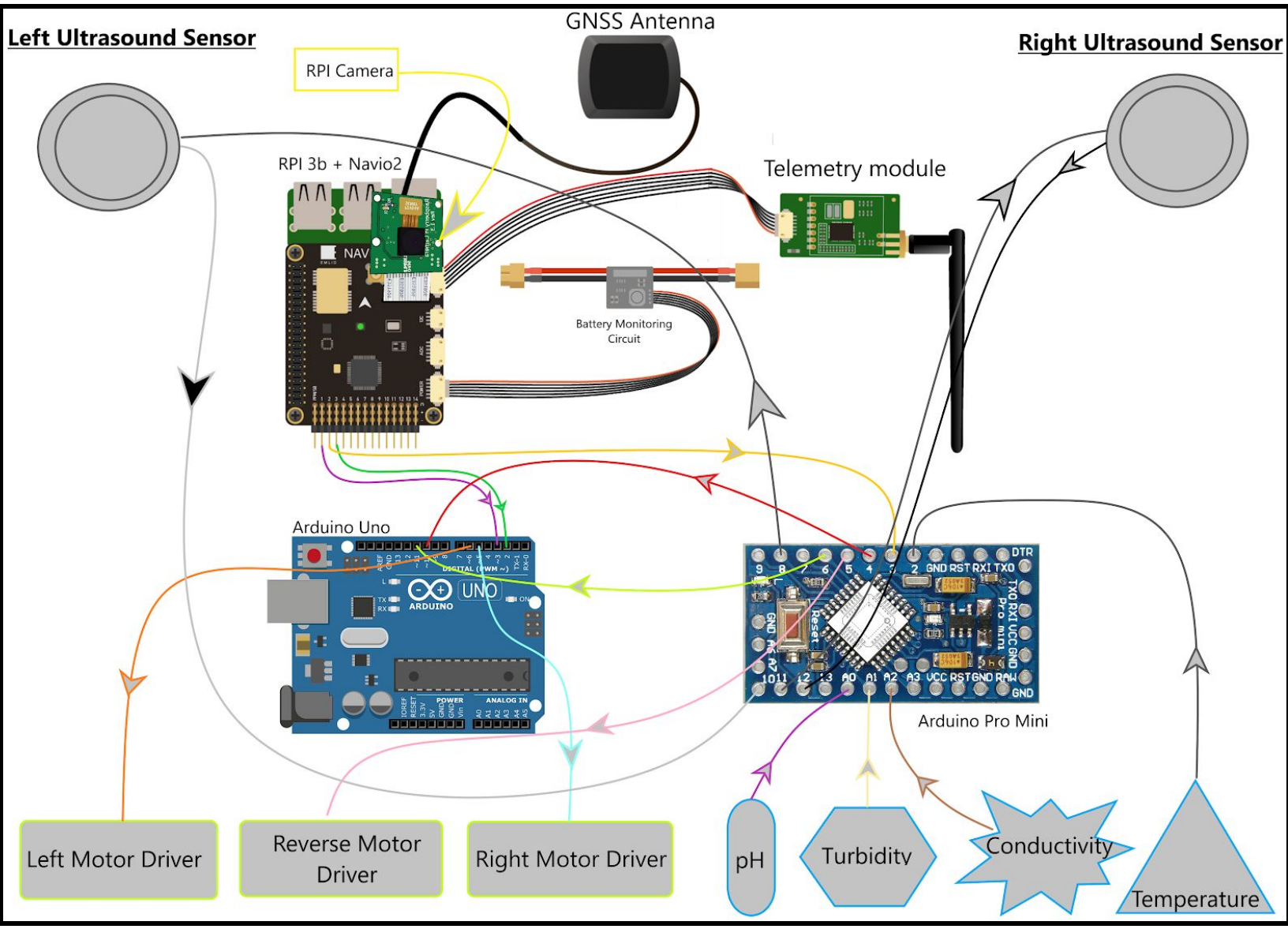
**Power Distribution Circuit**

The 12V Lipo battery is connected to a General Purpose Board on which different circuits of the system are soldered. The voltage is stepped down for powering the sensors and the

microcontroller board, using a LM2596 buck converter which step downs the voltage from 12V to 5V. The circuit is soldered on a General Purpose Board as shown in figure 2

**Step 3**

- The peripheral devices include the RPI 3b, Navio 2, Arduino Pro Mini, Arduino Uno and sensors. After Navio2 is mounted on RPI we have to proceed and attach other peripherals and wires for communication and sensors. The connection diagram is as follows :-



- Arduino Pro-mini shield in figure 2 is made using female bergstrips and the data pins of all the 4 sensors are connected to the corresponding pins as shown in above figure.

- The ultrasound sensors are also connected with their echo and trigger pins. All the sensors and the Pro-mini are powered by the LM 2596 buck converter which gives a 3A/5V output.