UNIVERSITY OF BALAMAND

ISSAM FARES FACULTY OF TECHNOLOGY

Graduation Project Design Report

A Portable Electricity Generator Based On a Water Turbine

Submitted by

Raed Hammoud & Omar Abdelkader

Guided by:

Dr. Claudia Mattar

Year: 2020-2021

Acknowledgment

First, we want to thank Issam Fares Faculty of Technology and our dean Dr. Elie Karam. Then, we want to thank our Chairmans, including Dr. Rabih Nachar and Dr. Rodrigue Imad for their patience, responsibility and for helping us to reach what we are on today. In addition, a big appreciation to our supervisor Dr. Claudia Mattar who helped us the most to get this work done.

This thesis could not be done without the encouragement and devotion of family and friends.

ABSTRACT

Electricity is essential in our daily life. It provides us with the power needed to power domestic machines and for light. Our project consists in producing electricity using a water turbine. A turbine is a rotational mechanical device which transfers the energy from the fluid entering it into work, which can be utilized for producing electrical power when joined with a generator. Moving fluid follows up on the blades with the goal that they move and give rotational energy to the rotor and thus we generate electric power. The project aims to produce electricity with a small portable turbine that can be installed on water flow paths that exist beside homes or rural areas. The objective is to make it portable and replace diesel generators which are very pollutant.

Table of Contents

List of Figures

List of Tables

Chapter 1 Introduction

1.1 Overview

There has been an immense progression and improvement everywhere throughout the world due the science and innovation. Innovation is an art that utilizes sciences to solve the man's various problems. One of them is to generate electricity with the lowest cost and easiest way. Electricity industries are the main reason of the pollution in Lebanon. Lebanon have millions of water resources; water turbine is a device that changes over dynamic energy and potential energy of water into mechanical work that allows us to generate electricity.

Figure 1: Water Resources in Lebanon

1.2 Problem Statement

Lebanon is facing a lack in electricity production. At the same time, Lebanon is suffering from a high pollution level. Moreover, electricity generation is one major cause of pollution. However, Lebanon is rich in water sources, and these sources can be used to generate electricity. For example, for remote areas, for camping, and for 2 occasional use in agricultural areas, electricity remains a need and in general is provided for such purposes using diesel electricity generators. This is polluting and costly. In order to provide electricity and reduce pollution, the need for a portable electricity generator based on a water turbine is raised.

1.3 Objective

Electricity is a necessity in our daily life which we can't live without it. In order to produce electricity and at the same time reduce pollutions, we consider the following steps:

- Using portable water turbines, we will consider a village in Lebanon where water assets are accessible anywhere and anytime and could be put in the car's trunk.
- An examination will be led to register the measure of electric power created in such village utilizing the water potential energy.
- We will design this generator and illustrate it in a small prototype or drawing.

Chapter 2 Solidworks Prototype

2.1 Water Turbine Sketch

The water turbine is used to convert the potential energy of the water into a mechanical energy, and it is mounted as shown in Figure 2 and Figure 3 below.

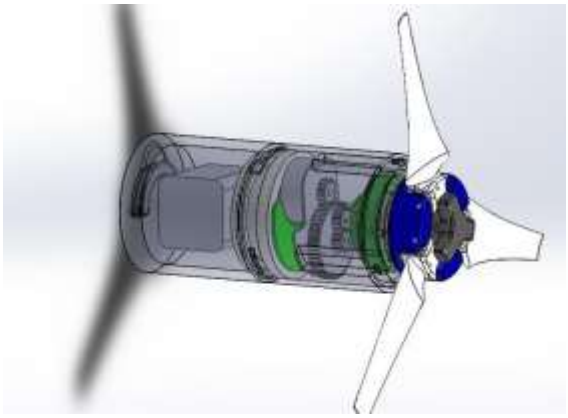

Figure 2: Water Turbine Sketch

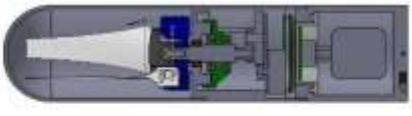

Figure 3: Water Turbine Sketch

2.2 Blades and Rotor

The turbine blades are moved by flowing water from the river, causing them to rotate. The rotor is a moving segment of an electromagnetic framework in the electric engine, electric generator, or alternator. Its rotation is due to the cooperation between the windings and attractive fields which delivers a torque around the rotor's axis as shown in figure 4.2.

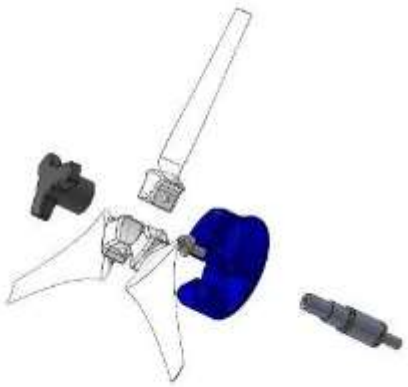

Figure 4: Rotor and Blades

2.3 Generator

An electric generator is a device that changes over mechanical energy got from an outer source into electrical energy as the yield. It utilizes the mechanical energy provided to it to constrain the development of electric charges present in the wire of its windings through an outside electric circuit. This progression of electric charges establishes the yield electric flow provided by the generator as shown in figure 4.

A gear (otherwise called a turning gear) is a device put on the principle shaft of a motor or the rotor of a turbine, it rotates the shaft or the rotor as shown in figure 5.

Figure 5: Generators and Gears

2.4 Battery

The generator's electric energy charges the battery to be used for many functions like charging phone or turning on a torch as shown in figure 4.5.

Figure 6: Battery

2.5 Wireless Battery Voltage Monitor Using Arduino and Bluetooth

2.5.1 The components and tools used

0-25v Voltage Sensor:

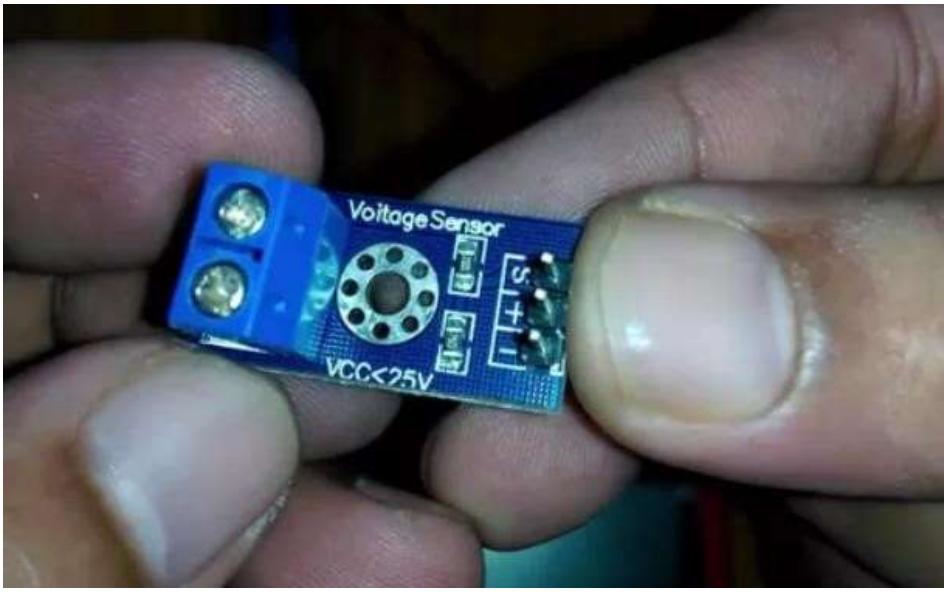

Figure 7: Voltage Sensor

This is the Voltage Sensor Module that we will be using for monitoring the battery voltage, This Module is capable of measuring the voltages ranging from 0.02445v to 25volts dc.

Bluetooth Module:

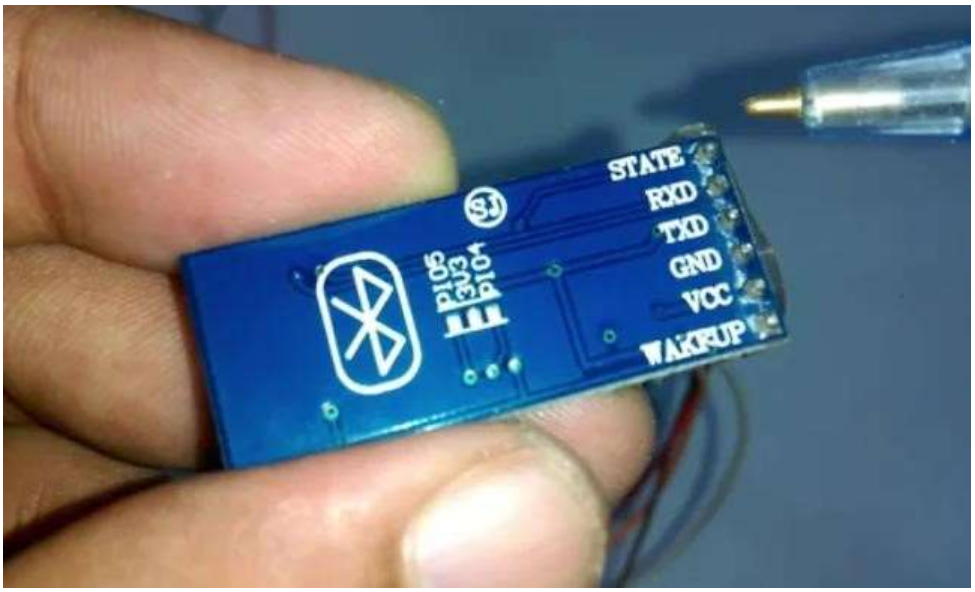

Figure 8: Bluetooth Module

This is the Hc-05 Bluetooth module; we will be using only 4 Pins. RXD…. TXD…. GND… And VCC.

2.5.2 Circuit Diagram of the wireless battery monitoring system:

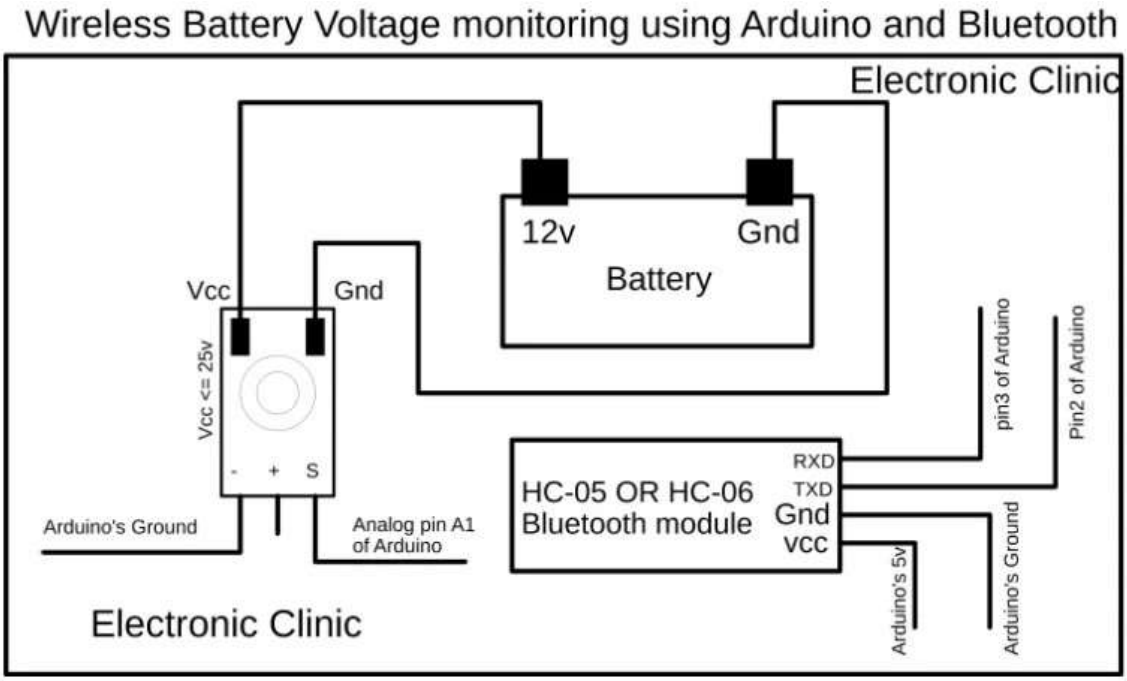

Figure 9: Circuit Diagram of the Wireless Battery Monitoring System

This is the complete connection diagram of the wireless battery voltage monitoring system using the Arduino and Bluetooth module. As you can see on the left side, the voltage sensor VCC is connected with the Battery 12v input and the ground of the voltage sensor is connected with the ground of battery. The s Pin of the voltage sensor is connected with the analog Pin A1 of the Arduino and the "– "Pin is connected with the Arduino's ground. While the + Pin is not connected.

Bluetooth module VCC Pin is connected with Arduino's 5 volts; the Ground Pin of the Bluetooth module is connected with the ground of the Arduino. The Txd Pin of the module is connected with Pin2 of the Arduino and rxd Pin of the Bluetooth module is connected with Pin3 of the Arduino.

Chapter 3 Project Implementation Design

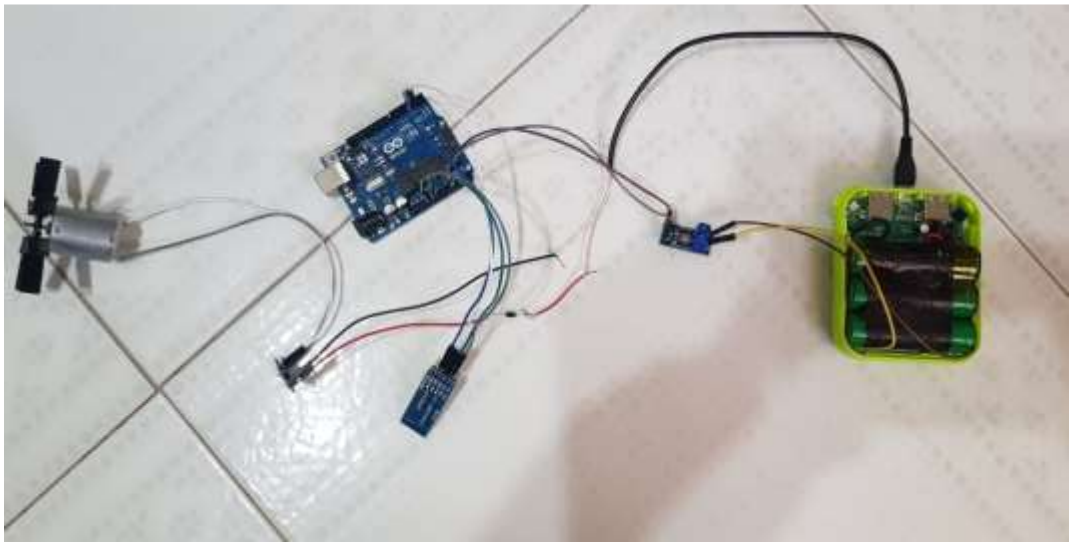

Figure 10: Graduation Project Overview

Here's our project implementation, it took about 1 month to buy all the items and building the circuit.

Figure 11: Materials Bought

It worked well, but there were some items that should be bought to this circuit to be completed and we had some problems about buying them, we will talk about this later.

3.1 Main Project Materials Used

Blades:

Figure 12: Blades

Generator:

Figure 13: Generator

Regulator:

Figure 14: Regulator

This part will regulate the voltage coming from the generator to 5v (the same voltage of the battery).

We used AMS1117 5v Power Supply Module.

Diode:

Figure 15: Diode

The diode will cut off the electricity from the battery when its full.

We used Diode – 1N4007 in this project.

Battery:

Figure 16: Battery

It will be the storage of the energy coming from the generator (we are using a powerbank 5 volts).

This Power Bank has a Capacity of 9000mAh

Input DC 5v – 1000mAh

Output DC 5V – 1000mAh

Output DC 5V – 2000mAh (Fast Charging)

3.2 Wireless Battery Voltage Materials Used

Voltage Sensor:

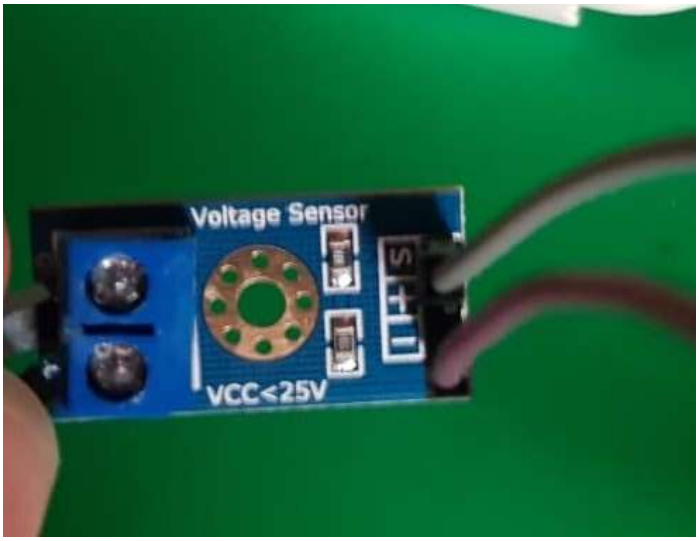

Figure 17: Voltage Sensor

It is the same module that we talked about in page 6, when we said in our design part that we need a voltage sensor which will be very important to the voltage monitoring system.

But this voltage sensor can’t handle a voltage greater than 25V.

There are many voltage sensors that can handle voltages greater than 25V but we don’t need them in our project and this sensor is the best choice in our case.

Bluetooth Module:

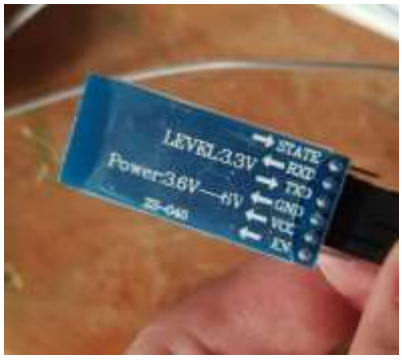

Figure 18: Bluetooth Module

Also, we talked about this module before. This module will allow the connection between the Arduino and the cellphone to monitor wirelessly the battery voltage.

Arduino:

Figure 19: Arduino Uno

This item will be the brain of the system, we already talked about it also. We should configure the Arduino in order to work as we want.

3.3 Problems occurred

- **The Generator:**

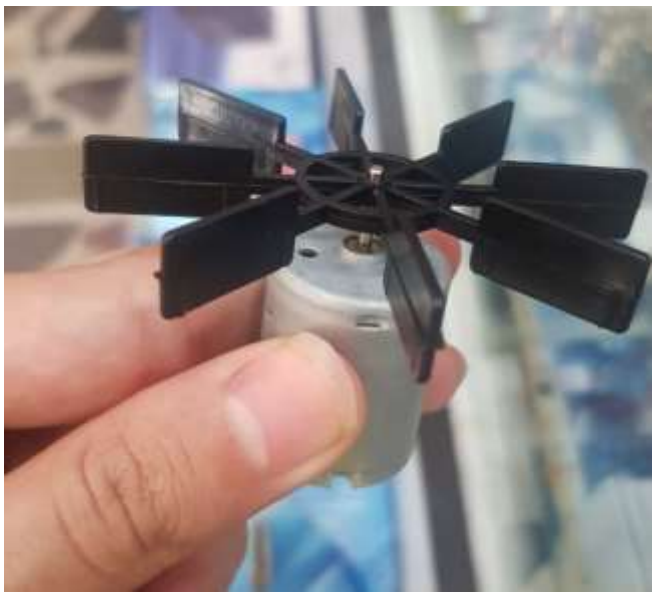

Figure 10: Generator with blade

This Generator do not generate much power as needed, because it generates about 0.8v with 20 spins/second, while the battery needs at least 5v to charge well.

That's why we need a bigger generator, which is a bit difficult to find and expensive (we already crossed the permitted budget line)

One more thing, in our circuit the regulator won't change anything, because it can handle 6v to 12v, so it doesn't matter if the generator release more than 5 volts.

- **Arduino**

Figure 11: Arduino Uno input voltage

Our project should be portable, so the Arduino must be turned on from the battery we are charging, but the recommended voltage to turn the Arduino Uno on is from 9v to 12v , while our battery is only 5v.

Figure 12: 9V Step-Up Regulator

For that purpose, we needed a 9v step-up regulator that would help us to turn on the Arduino without any problems, but we didn't find this piece anywhere in Lebanon so we were obliged to use an external power source to turn it on.

Figure 13: DC Cable

For sure we need a DC cable to connect the battery with the Arduino.

In addition, the project must be covered and organized well to be waterproof and useful.

3.4 Main project Circuit

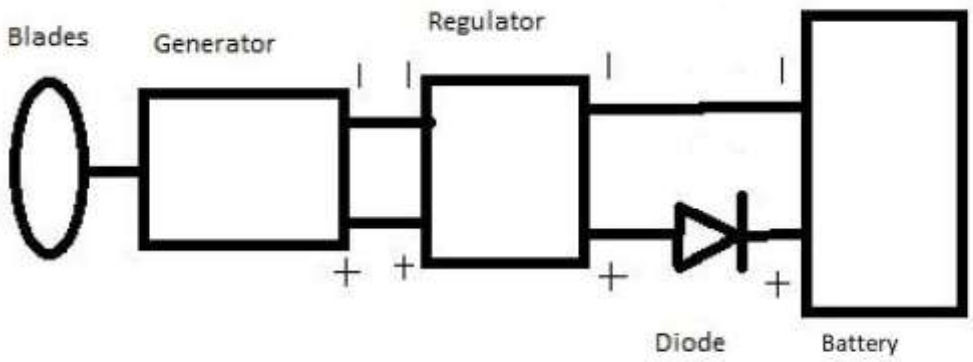

Figure 14: Main Project Circuit

Figure 15: Working Progress

First of all, we have to stick the blades in the part that rotates in the generator and make sure that it does not move.
Then, we connect the positive part of the generator to the Vin in the regulator and the ground to the ground, to regulate the overflowing voltage that come out from the generator.
The Vout of the regulator will be connected to a diode then to the positive side of the battery, while the negative part of the regulator is directly connected to the negative side of the battery.
You have to ensure that the blades rotate easily to be able to rotate as fast as possible.

All the items in this circuit are principles and this project cannot be done without any item of them so this circuit will charge the battery without any problems. Any other item added will be an extra to the project. So we have decided to add a feature to this project and it was to monitor the battery voltage without removing the battery from the water.

Figure 16: Testing the battery voltage monitoring system

3.4 Wireless Battery Voltage Monitoring Circuit

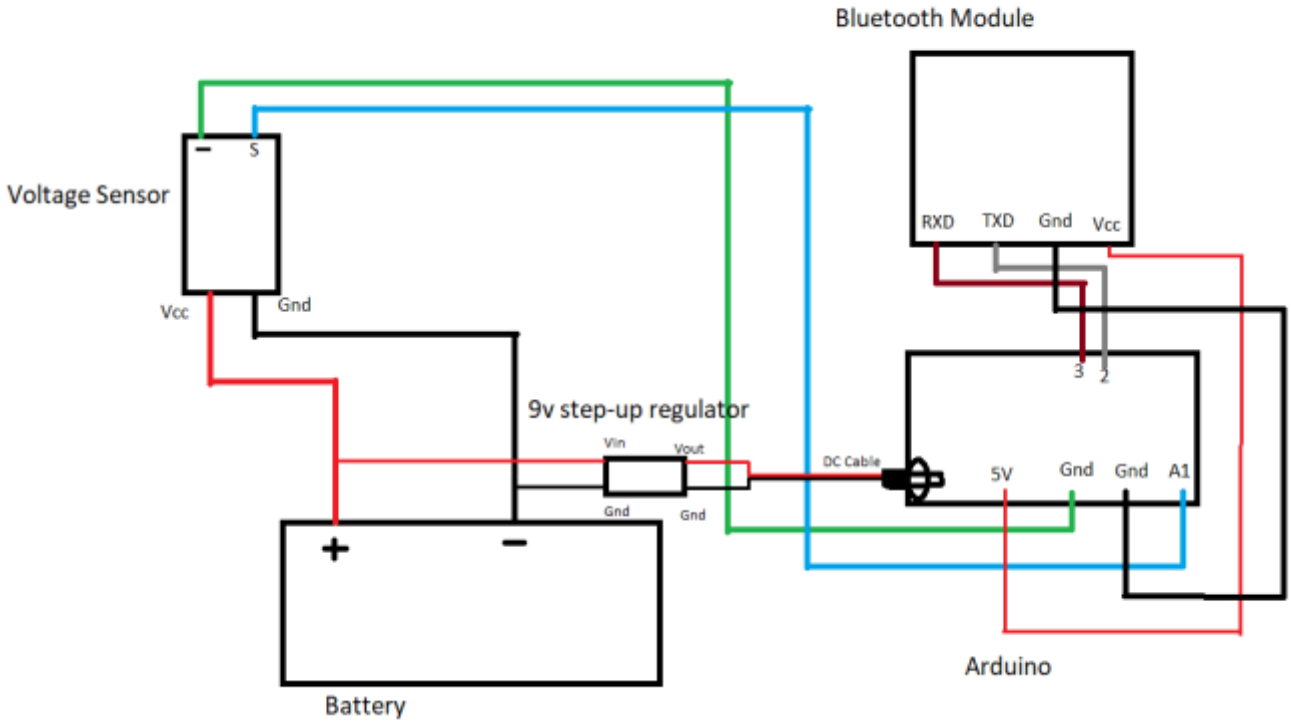

Figure 17: Wireless Battery Voltage System Circuit

This is the full circuit that should be uploaded in the project to be able to turn on the Arduino without any external power source.

We already talked about how to connect this circuit in the page 8, but here we have to add the 9V step-up regulator and connect the positive side of the battery to the Vin side of the regulator and the negative one to the ground. Then, bring a DC Cable and plug it in to the Arduino and connect it from the other side to the Vout and the ground of the regulator.

Figure 18: Working in progress

The application used to connect the Bluetooth module to the cellphone is called ***BlueSerial Beta***, it can be downloaded from Playstore.

Figure 19:BlueSerial Beta App Logo

When you launch the app you will find a device named HC-05, this will be the name of the Bluetooth module that we are working on.

Figure 20: BlueSerial Beta Main Page

After connecting to this device, the application will run as the Arduino is programmed to do, so it will show you the voltage of the battery every second (you will find the full code of the Arduino below in the appendix).

Figure 31: BlueSerial Beta monitoring the battery voltage

3.5 Project Specification

In this part we will review the equations expected to achieve our project. We will contemplate the movement and the velocity of fluid and the power produced by this turbine.

3.5.1 fluid velocity and mass flow rate

In this section we will analyze the movement of fluid that will enter from the inlet of the turbine. After making some studies in Ibrahim River, we figured out that the average velocity of the fluid is approximately between 1.7 (m/sec) and 2.2 (m/sec) [10].

The cross-section area of the turbine is: A= $\pi \times \frac{D^2}{4}$. We can deduce the mass flow rate for each case

Table 1: Table of Parameters

D (m)	$\rho(\frac{kg}{m^3})$	V(m/sec)	A(m^2)	$\dot{m}$(kg/sec)
0.3	1000	1.7	0.0706	120.02
0.35	1000	1.8	0.096	172.8
0.4	1000	1.9	0.125	237.5
0.45	1000	2.2	0.16	352

3.5.2 power produced by the turbine

In this section we will calculate the power produced by the turbine to generate electrical energy.

Since our system is adiabatic so no heat transfers with the surroundings, no gravity potential, no enthalpy change, one dimensional flow and steady state.

$$0 = \dot{Q}_{cv} - \dot{W}_{cv} + \dot{m}[(h1 - h2) + \frac{{V_1}^2 - {V_2}^2}{2} + g(Z_1 - Z_2)] \quad (3.2)$$

$$W_{cv} = \dot{m}(\frac{{V_1}^2 - {V_2}^2}{2}) \quad (3.3)$$

We will assume that $V_2 = 0.2V_1$. (3.4)

We can deduce power produced by the turbine for each case

Table 2: computing the power delivered by the turbine

$\dot{W}$	$\dot{m}$	V_1	V_2	$(\frac{{V_1}^2 - {V_2}^2}{2})$
165.41 W	120.02	1.7	0.34	1.3872
268.73 W	172.8	1.8	0.36	1.55
411.54 W	237.5	1.9	0.38	1.7328
817.76 W	352	2.2	0.44	2.32

Conclusion

The water turbine is made to contribute in solving the problem of electricity in Lebanon, since it's portable and can be put in any car's trunk, at the same time using a renewable energy, the water. Hence, anywhere water exists we will have electricity just from the water potential energy. In the light of testing and calculations, the water turbine can produce enough power so at least in case of camping we can turn on a light and charge our phones.

Appendix

The code used in the Arduino to monitor the battery voltage:

```
#include <SoftwareSerial.h>
SoftwareSerial blue(2,3); // Bluetooth module connected here

 float correctionfactor = 0;
int analogInput = A1;
float vout = 0.0;
float vin = 0.0;

 // two resistors 30K and 7.5k ohm
float R1 = 30000;  //
float R2 = 7500; //
int value = 0;

void setup() {
  pinMode(analogInput, INPUT);
   Serial.begin(9600);
   blue.begin(9600);

}

void loop() {
  // read the value at analog input
   value = analogRead(analogInput);
   vout = (value * 5.0) / 1023.0; // see text
   vin = vout / (R2/(R1+R2));

    vin = vin - correctionfactor;
Serial.print("INPUT V= ");
Serial.println(vin,4);
blue.print("Battery Voltage: ");
blue.println(vin,4);

delay(1000);

}
```