Hydropower Turbine

Armando Torres, Cory Cathrea, Daniel Cardoso, & Stephanie Villanueva

Overall Summary of The Project

Design, build, and test a portable hydropower turbine system capable of generating power from the variable flow of water within a river or stream. The system must have the ability to supply power to low wattage appliances while having minimal impact on environment. These properties will encourage the user to abandon the use of heavy and harmful fossil fuel generators while in the wild.

Project Description

- The purpose of the project was to prototype a hydropower turbine system capable of generating power from the flow of water in a river. The flow of water will allow the impeller to spin, causing the motor to create power.
- The turbine must be portable so the user does not have to leave equipment behind before going into the wild.
- Minimal impact on the environment while supplying power that can power a variety of low wattage appliances that users can bring into the wild.
- The system must be able to power low voltage appliances.

Project Justification

- Provides clean and sustainable energy source that a user can carry through the environment without a motor vehicle
- Could potentially reduce carbon emissions when replacing a common fossil fuel generator
- Higher operating power than most portable hydropower turbine products on the market

Functional Requirements

Electrical System Requirements

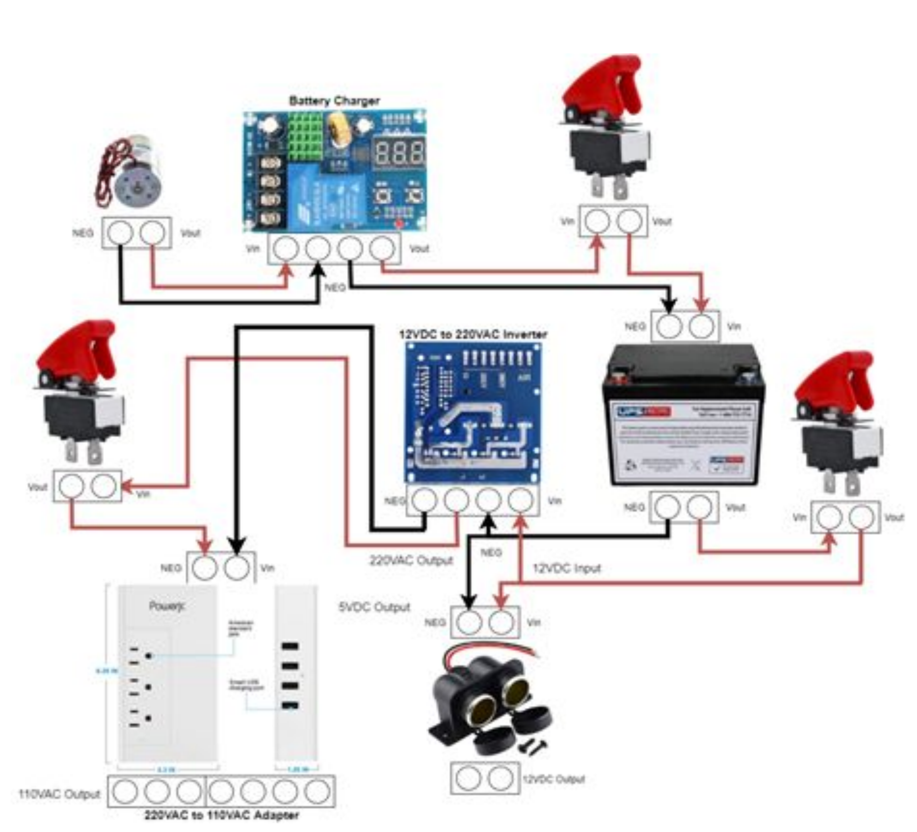
- Charge 12V deep cycle batteries using a charging circuit
- Should power 12V appliances
- Utilize a power inverter to change 12DC to 120/110VAC @ 60Hz for use in the United States
- Should allow camper to power low wattage (<=500W) AC & DC Appliances supplied by user
- Supply reliable power for a minimum of 2.5 hours if battery is charged fully by the product

Structural System Requirements

- Product can not weigh in excess of thirty-pounds
- Should be collapsible from 2.8 ft to 1.0ft
- Expandable from 2.8ft to 4.0ft
- Fully operate in depths from 2.0ft to 4.0ft

Engineering Organization Standards

- IEEE 1020-2011 - Electrical control and monitoring for equipment and systems that correlate with small hydroelectric power plants. Measured with oscilloscope and multimeter to give one the capability to view the voltage, amperage, and frequency
- IEEE 1147-2005 - Evaluations of hydroelectric installations. Applies with the temporary installation of the turbine in many environments. Measured by following all safety procedures when installing.
- e-CFR 1926.605 - Describes the correct material handling procedures when constructing the system. Applies with the regulation for the material handling operations that take place underwater. Ensures that the materials that make up the structure of the system do not pose any threat to the environment
- IEEE 142-2007 - How to properly ground systems. Applies when grounding the electrical systems circuitry. Implemented by ensuring electrical enclosure is watertight.



Electrical System Design Ideology

The electrical system of the hydropower turbine aims to be versatile enough to handle a variety of power needs, but simple and compact to not hinder the user. The current design of the turbine allows the user to charge 12V deep-cycle batteries with the help of a DC brushless motor and battery charger printed circuit board (PCB). This is an integral part of the product as without proper charging the user could be left without power. Once the system is charged it can be disconnected via a simple toggle switch. After the charging circuit is disconnected the user can choose from three power levels: 12VDC, 5V USB, and 120VAC at 60hz. The 120VAC and 12VDC have the capabilities to power devices up to 500-W. This is dependent upon the battery having a fully charge to 42 Ah.

Electrical System Data Collection

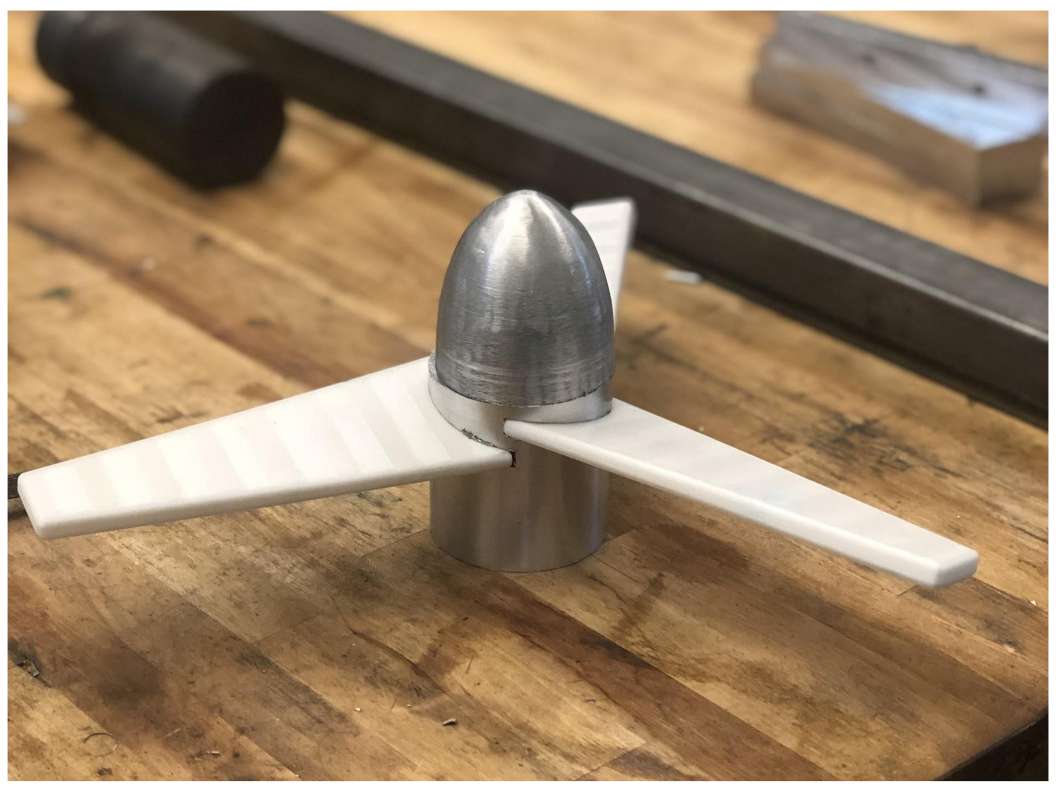
To validate the electrical system of the hydropower turbine it is important to test all three power levels as well as the power generation circuit. For power generation it was expected that the turbine operating in at least two meters-per-second water would charge the 12V 42Ah deep-cycle batteries and shutdown without losing any components. The power system was then expected to supply power via the 12V car-lighter outlet adapter to charge a phone or similar device. Either device must be fully operational or fully charged by the system to be validated. That adapter is then disconnected from the circuit for the 120VAC and USB outlets to be tested. A cell phone charging USB cord will be used to test that section of the circuit and will need to fully charge the device to be validated. Finally the 120VAC outlet will be tested using a simple hair dryer. A hair dryer can pull a large current in a compact size and would stress the system. If the hair dryer runs for an hour at least without fail the system will be validated.

Mechanical System Design Ideology

The design for the structure mimicked the venturi funnel principle. This is where the center of a pipe is restricted and the largest velocity in the system takes place. At the center of the funnel was where the impeller was placed. This allowed the system to generate the most energy possible in the flow of water it is placed in. The funnel itself would be composed of aluminum to ensure that the structure remained lightweight. The ends of the funnel would have had collapsible duct tubing attached at both ends to ensure that the structure would remain portable. The duct tubing would then be staked down by U-shaped aluminum rods to ensure that the duct tubing is stable. The structure as a whole would then be placed on top of wheel chocks to avoid sand entering the system as well as have a net attached at both ends of the duct tubing to avoid fish and other materials from reaching the impeller. A rope will then be wrapped around the funnel of the structure and staked down to ensure that the assembly remains rigid under all flow conditions.

Mechanical System Data Collection

The structural testing of the turbine was not completed. The overall testing procedures for the structure of the system consisted of assembling all the components together and staking it on the ground on campus. This would have helped ensure that the structure was rigid in ground conditions before it was placed underwater. Once this was completed, the team would have placed the assembly in both slow and harsh water flow conditions in a river up north and recorded the stability in different types of water flow.



Logos retrieved from ieee.org and ecfr.gov