THE ENGINEERING PORTFOLIO OF

ROGERIO BONATTI

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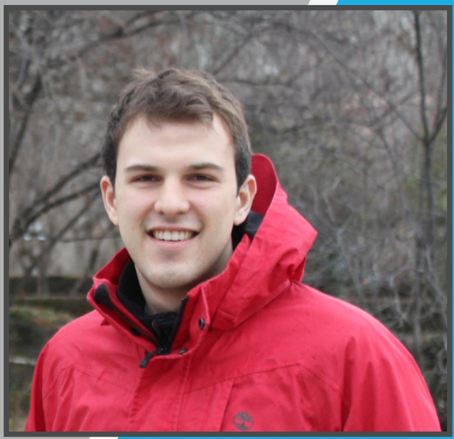
PROFILE



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I am Rogerio, a Mechatronics Engineering student at University of São Paulo, Brazil.

This portfolio supplements my resume by showing in detail selected Robotics and Mechanical Engineering projects created during my undergraduate course and research internships.

These projects were developed at my home school and at Cornell University, where I spent one year studying Mechanical Engineering in a study abroad program with a full scholarship from Brazil's Ministry of Education.

CNC MILLING MACHINE

Goal

Design and construction of a CNC Milling Machine with 0.5m x 0.3m x 0.2m working volume and 0.1mm precision capable of machining plastic, wood and soft metals, controlled by an ARM processor, and capable of linear interpolation for its movement.

My Contributions

Team leader:

- Managed a 10-people team to complete the project
- Organized sub-teams, and created project's schedule and deliverables
- Integrated results from mechanical , electrical and software subareas

Electronics :

- Designed and manufactured power stage and logic control circuitry PCBs
- Studied and implemented stepper motor connections and torque vs. speed curves
- Designed and built circuitry housing and general electrical connections

Mechanics:

- Proposed and calculated initial models to infer the natural frequency of solutions

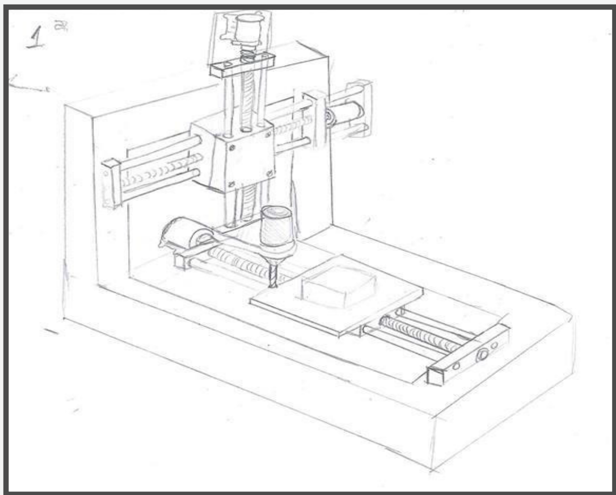
Results & Assessment

Date duration: Aug 2015 - Nov 2015

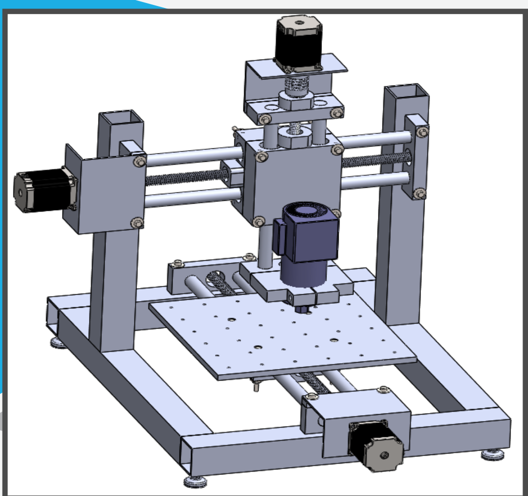
Budget: $500, with structural components and micro processor supplied by the school

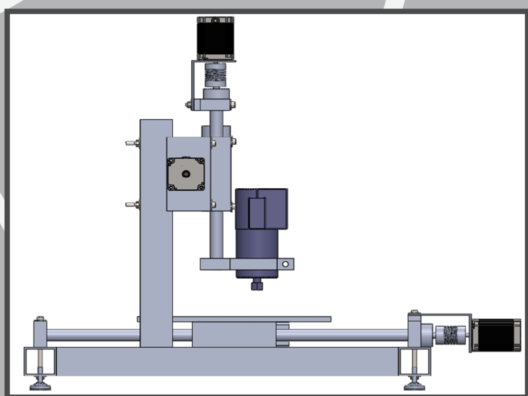
Results:

- Machine successfully machined plastic, wood and soft metals
- Precision of 0.05mm achieved with success
- Minimum natural frequency of 50Hz, above minimum requirements



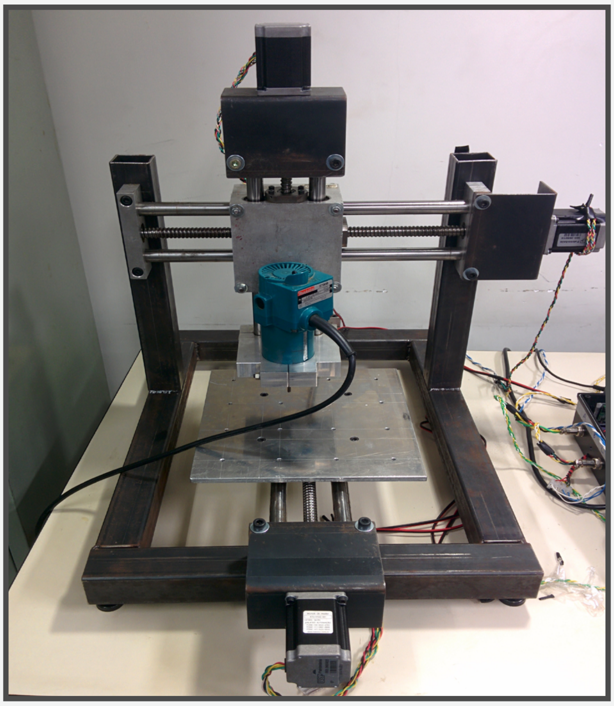
Initial drafts



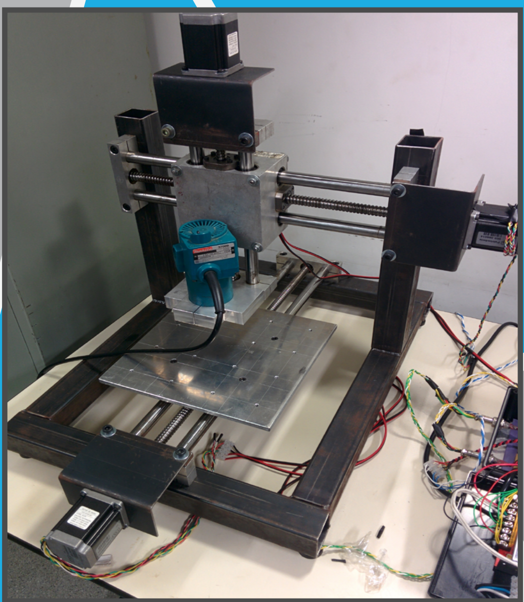


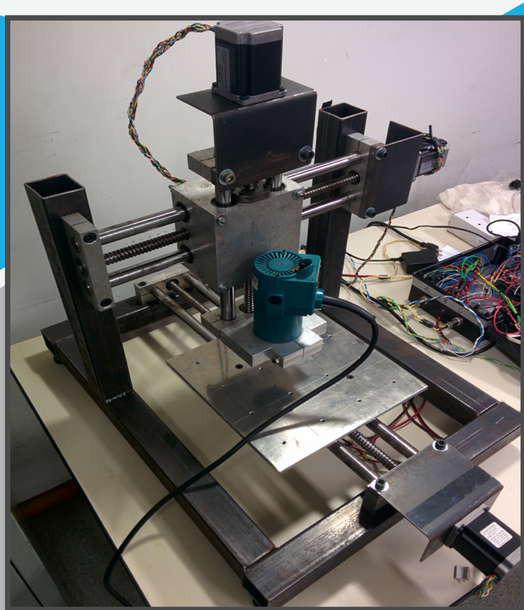
Structure's CAD

CNC MILLING MACHINE



Pictures of final machine





ROBOTIC MANIPULATOR

Goal

Design and construction of a closed kinematic chain manipulator with DC motors as actuators, and control software implemented in a micro controller. The mechanism must fit inside a 30cm cube, and have a trajectory precision of 1mm.

My Contributions

Team leader:

- Managed a 9-people team to complete the project
- Organized sub-teams, and created project's schedule and deliverables
- Integrated results from mechanical, electrical and software sub-areas

Control:

- Tested DC motors with and without arm's structure to empirically determine system's transfer functions
- Designed and implemented discrete time PID control system for linear trajectory interpolation with a micro controller
- Created the G code generator for square and circular trajectories

Electronics:

- Designed and manufactured power stage and logic control circuitry PCBs

Mechanism:

- Manufactured mechanism's parts with 3D printing and water jet cutting

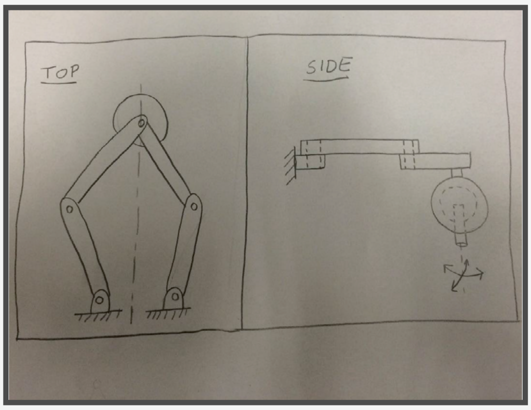
Results & Assessment

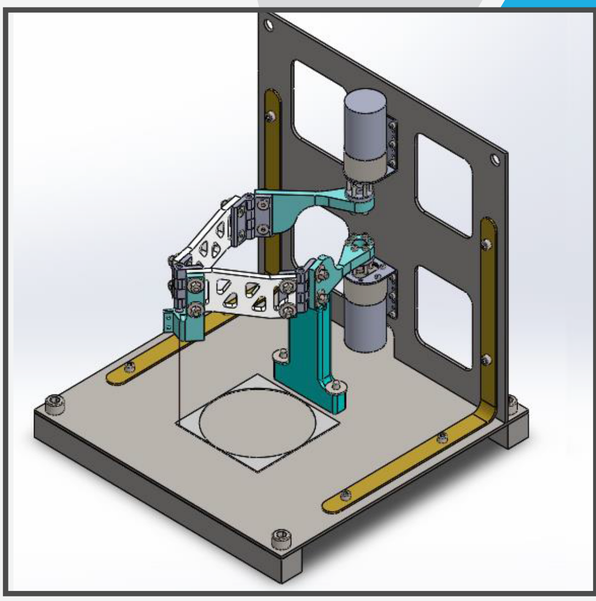
Date duration: Feb 2015 - Jun 2015

Budget: $200, with micro processor supplied by the school

Results:

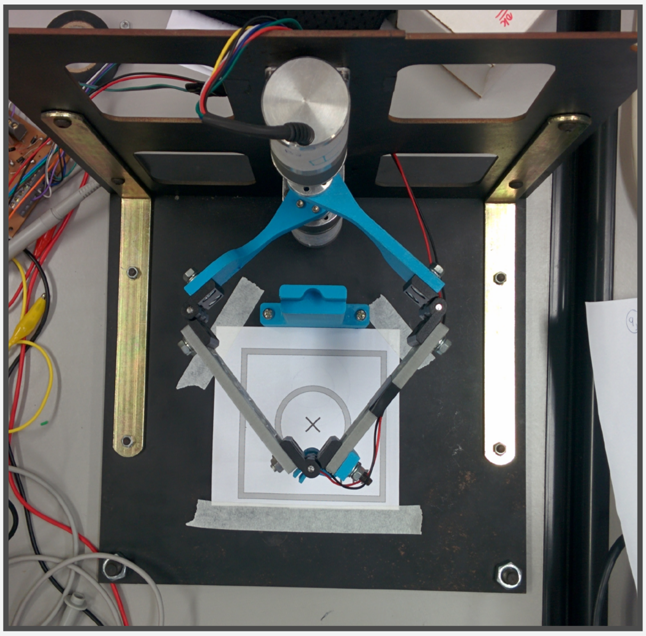
- Mechanism based on 5 precision rotational joints coupled in a closed kinematic chain
- Arm successfully performed square and circular trajectory in a plane
- Trajectory precision of 1mm achieved with success
- Settling time and maximum overshoot between points within restrictions of 0.5s and 5%

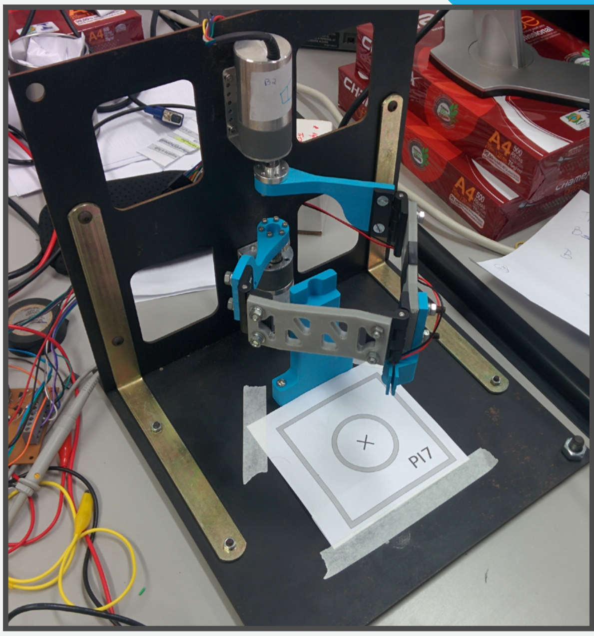




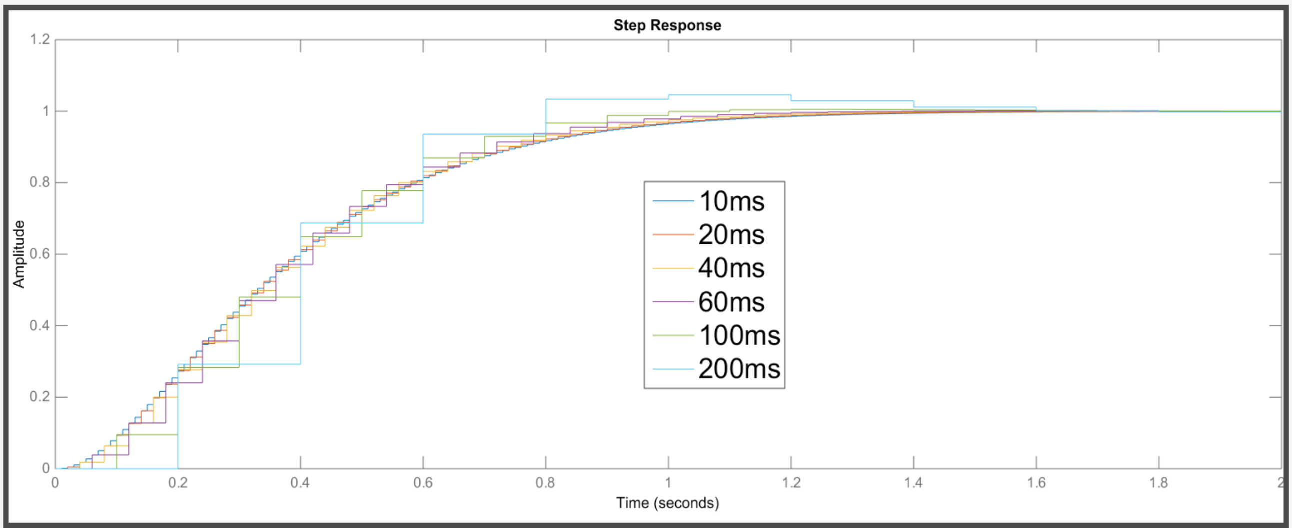
Initial drafts and CAD

ROBOTIC MANIPULATOR





Final machine's pictures



Step response considering different sample times

URBAN ENVIRONMENT SIMULATION IN WIND TUNNEL

Goal

Optimize wind energy harvesting in urban environments with the use of micro turbines in optimal locations on top of buildings with different shapes. To assess it, we did wind tunnel experiments.

My Contributions

Theory and analysis:

- Helped with literature review and modelling on the topic of urban wind energy harvesting and wind tunnel atmospheric boundary layer simulation

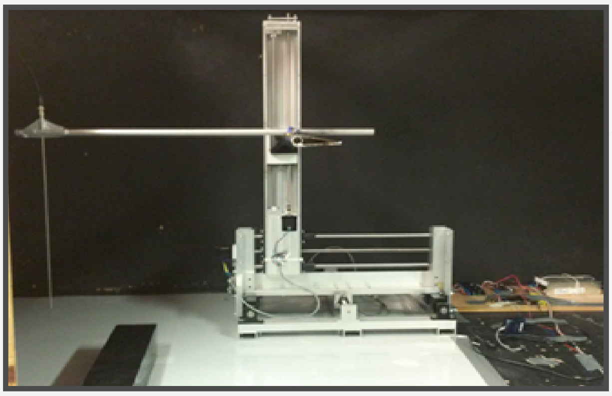
Design and Machining:

- Adapted a cartesian robotic platform for the attachment of a hot wire anemometer

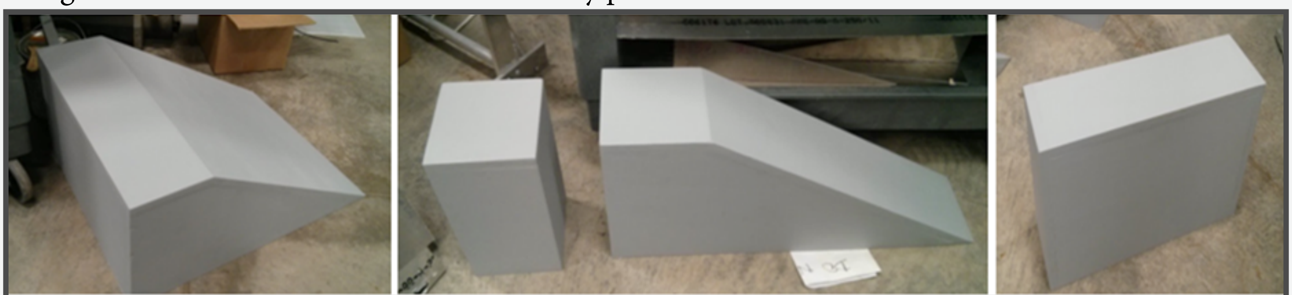
Experiments:

- Studied wind velocity instrumentation techniques and implemented hot wire anemometry to measure wind speed in a 3-dimensional grid around the model's profile
- Conducted wind tunned experiments to characterize incoming velocity profiles

Wind tunnel



Roughness elements to emulate urban velocity profile in wind tunnel



URBAN ENVIRONMENT SIMULATION IN WIND TUNNEL

Results and Assessment

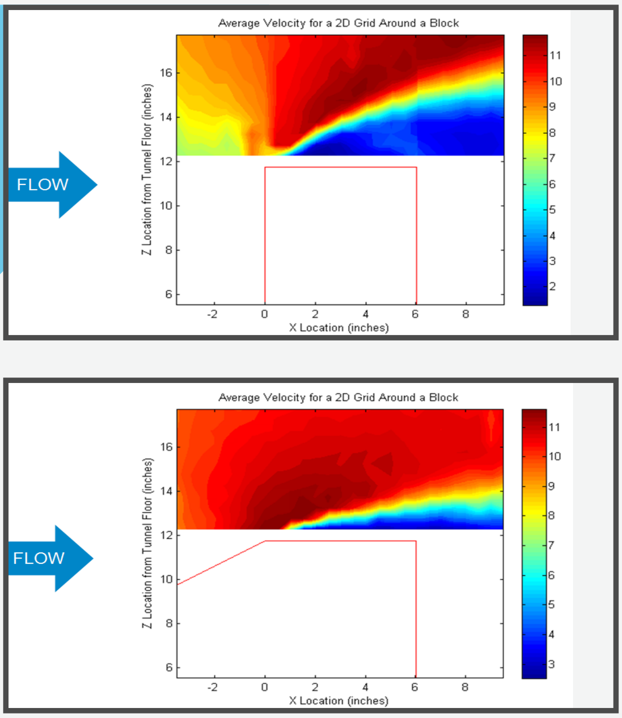
Date duration: February 2013 - December 2013

Results:

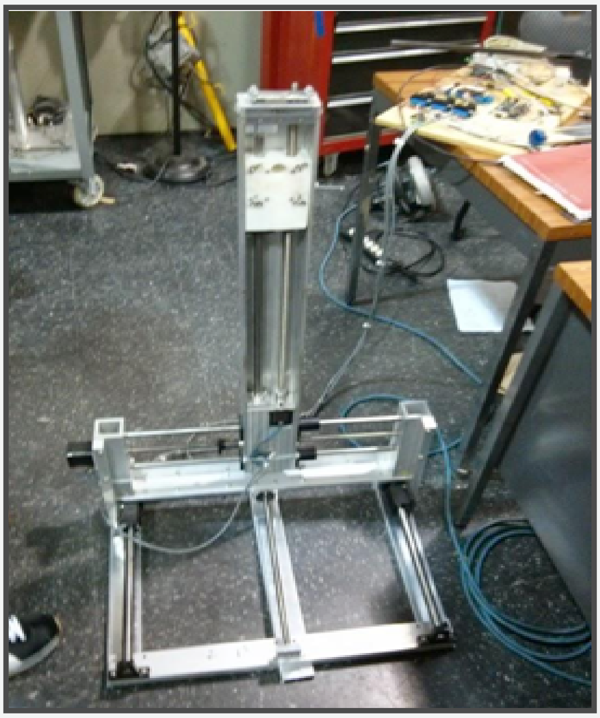
- Wind tunnel testing was done in a simulated boundary layer with both a basic rectangular model and a 30 degree sloped model and data was gathered along the center-line of each model
- There was a velocity increase between 16% and 35% at the sloped model's rooftop leading edge resulting in an increase in power production between 56% and 150%. Turbulence intensity was negligibly affected by the sloped model
- The region of interest corresponds to an area no more than one and a half inches of height above the model, equating to twenty-five feet in real-world height using our scale factor of 1:200

Conclusion:

- Altering the geometry of buildings in this manner can be extremely beneficial to energy production using small wind turbines at the leading edge of structures



Wind velocity profile with different models


Cartesian Robot used for wind velocity measurements

SMALL ANIMAL VENTILATOR

Goal

Optimize mechanical ventilation for medical patients who cannot sustain natural breathing. To do this, I developed a precision mechanical ventilator for small animals such as mice to be used in experiments that study the behavior of the respiratory system under varied flow conditions or under the influence of drugs.

My Contributions

Theory and analysis:

- Studied and modeled various artificial ventilation techniques in terms of ease of implementation, precision control and biological impact on animals

Design and Machining:

- Designed and built the first Brazilian small animal ventilator

Software and instrumentation:

- Integrated differential pressure sensors to equipment to evaluate animal airway impedance during ventilation
- Developed control software on LabVIEW to input the animal's air needs based on its weight, allow the user to record ventilation data and test different flow characteristics (such frequency and changing the inhalation / exhalation rate)

Experiments:

- Evaluated the machine's performance on animal lung's models

Results & Assessment

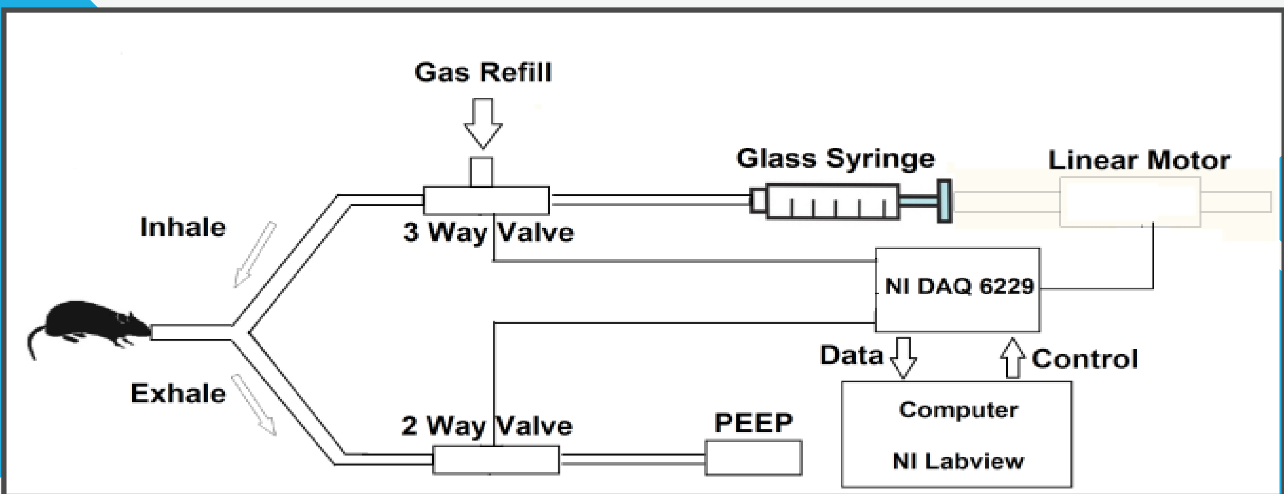
Date duration: Jan 2012 - Dec 2012

Budget: approximately $1,000

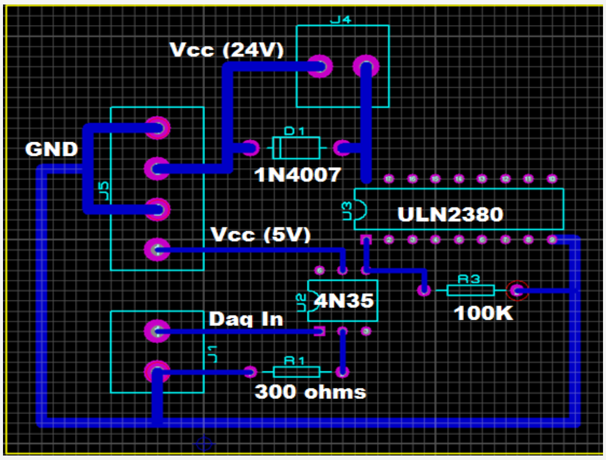
Results:

- Successful creation of a small animal mechanical ventilator capable of oxigenating animals in the range of 10 to 150 grams, and maximum inhalation frequency of 180 breaths per minute
- Airflow generated by the displacement of a precision linear motor with position encoder attached to a precision glass syringe
- Modular machine, capable of coupling with syringes from 3ml up to 20ml for different animal sizes
- Integration of machine with pressure sensors to estimate the animal's lung model in real time
- Ventilation pattern can mimic real-life conditions using variable inhalation / exhalation ration and variable input volume per inhalation according to a probabilistic distribution

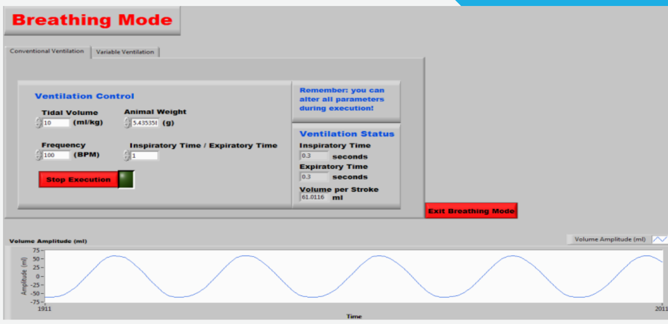
Block diagram of machine's role in animal ventilation



SMALL ANIMAL VENTILATOR

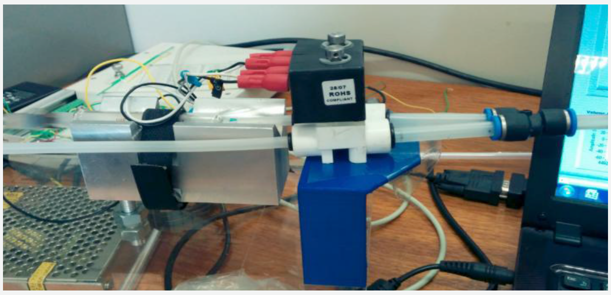


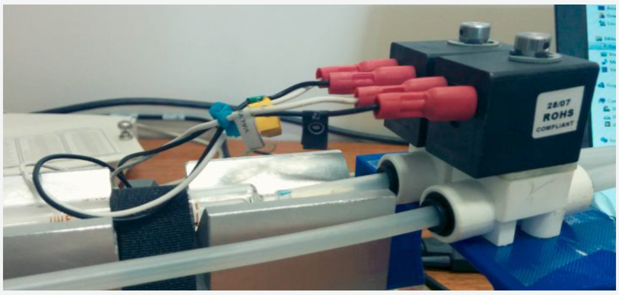
Circuitry PCB design



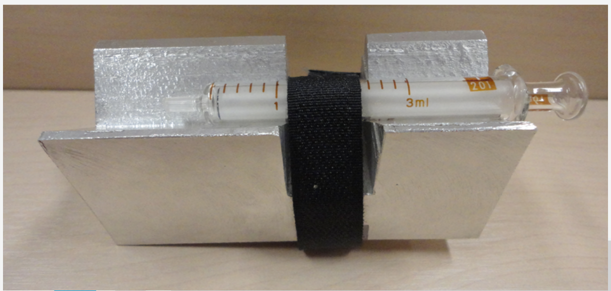
User interface and parameter selection

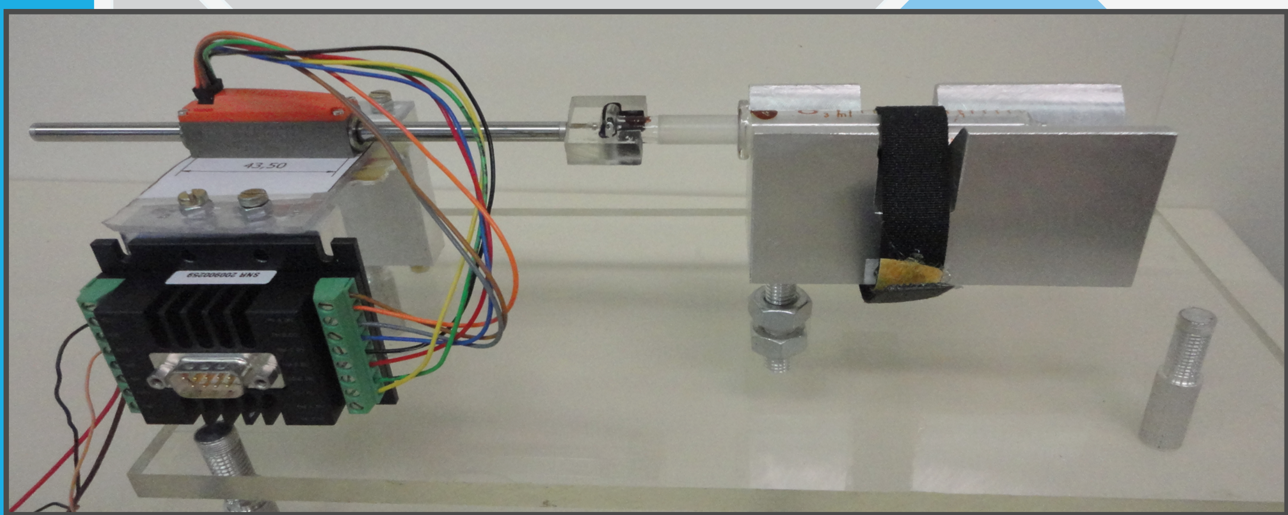
Solenoid valves to control air flow attached to tubing





Different syringe sizes attached to the same metal block





Final structure with linear motor attachment to precision glass syringe

SEARCH & RESCUE ROBOT

Goal

Design and build a remotely-operated ground vehicle prototype capable of detecting a metallic tube without physical contact, collecting it without touching adjacent plastic objects and transporting it out of the operator's visual field, in a dark chamber.

The vehicle must be able to surpass physical obstacles such as ramps and trenches filled with water in its trajectory towards the target object.

My Contributions

Team leader:

- Managed a 6-people team to complete the project
- Organized sub-teams, and created project's schedule and deliverables
- Integrated results from mechanical , electrical and software sub-areas

Pneumatics:

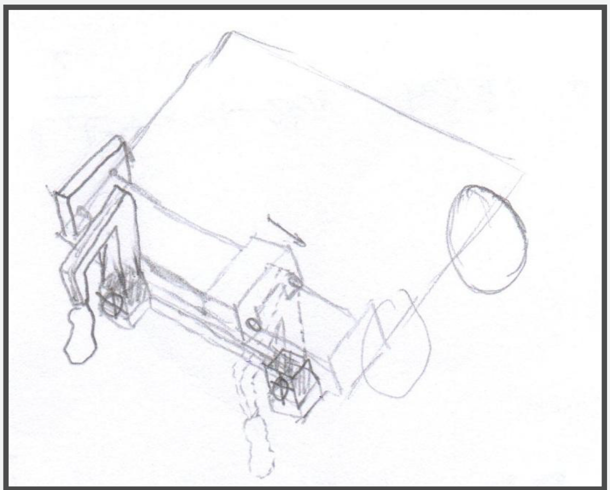
- Designed and implemented a pneumatic circuit with control logic using mini air pumps and mini solenoid valves. The air filled a balloon that captured the object

Electronics:

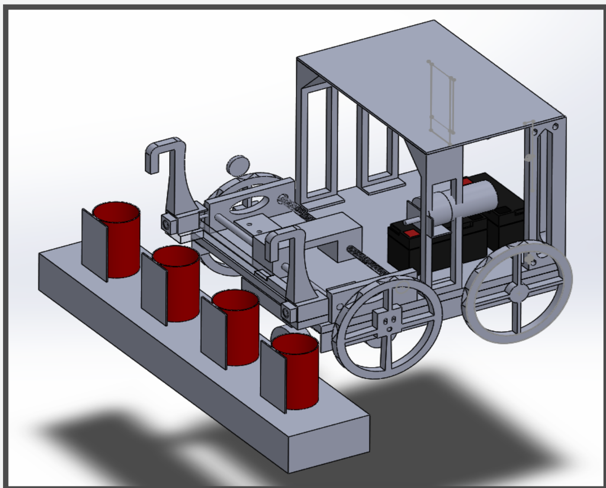
- Integrated inductive sensors in Arduino to detect metallic objects
- Designed and manufactured power stage and logic control circuitry PCBs

Mechanism:

- Manufactured mechanism's parts with 3D printing



Initial draft and CAD



Solenoid valves tested to control the miniature air pump's airflow

SEARCH & RESCUE ROBOT

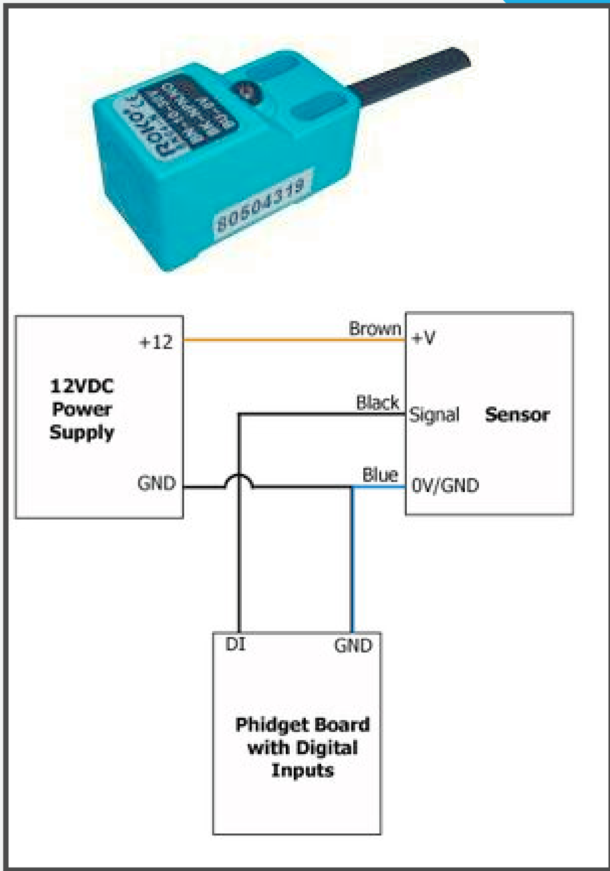
Results & Assessment

Date duration: Aug 2014 - Nov 2014

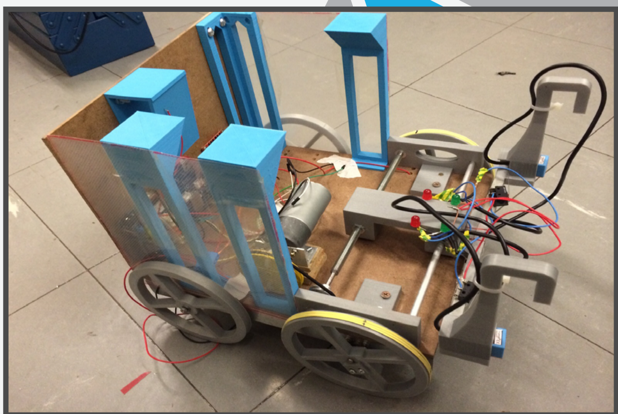
Budget: approximately $200

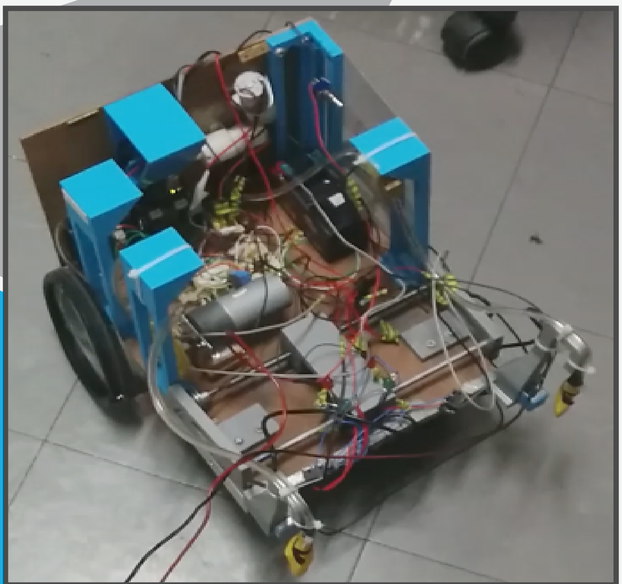
Results:

- Robot successfully integrated inductive sensors, remote operation by Bluetooth communication, video streaming, pneumatic circuits and mechanical movements to detect and capture the aluminum cylinder
- Aluminum cylinder is contactless detected by inductive sensor coupled to a moving platform with a threaded insert
- Baloon is inserted in cylinder and inflated by the pneumatic circuit; it is left inflated to maintain grip of the object
- Remote operation: vision given by cellular phone streaming via IP, and controls transferred to an Arduino board via Bluetooth with an Xbox controller
- 8th place out of 40 teams in competition



Magnetic sensor circuit





Final vehicle

AUTONOMOUS SUMO-FIGHTING ROBOT

Goal

Design and build an autonomous robot to actively engage the opponents' robot and push it out of a 3ft diameter arena in 3 minutes or less. Maximum dimensions of an 8in cube, and maximum mass of 3lb.

My Contributions

Software and electronics leader

Electronics:
- Integrated sensors to Arduino board to detect opponents (sonars) and to detect the arena's edges (infra-red sensors)
- Designed and manufactured power stage and logic control circuitry PCBs

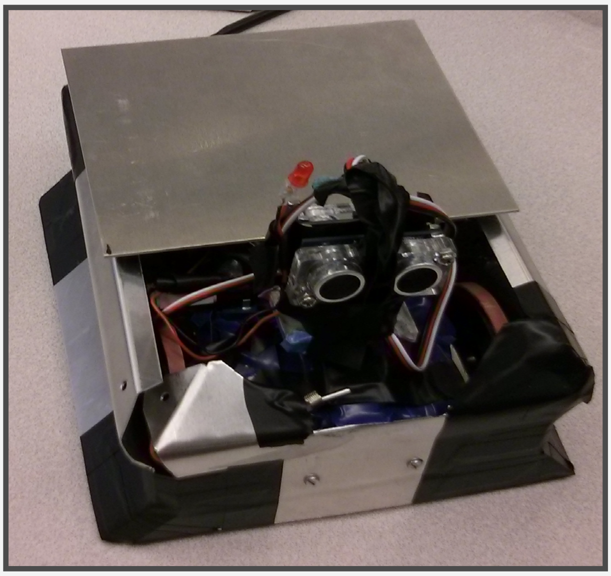
Software:
- Programmed attack and defense sequences based on robot's position in the arena and enemy sensing
- Programmed enemy detection based on the rotation of two back-to-back sonars on top of a servo motor

Results & Assessment

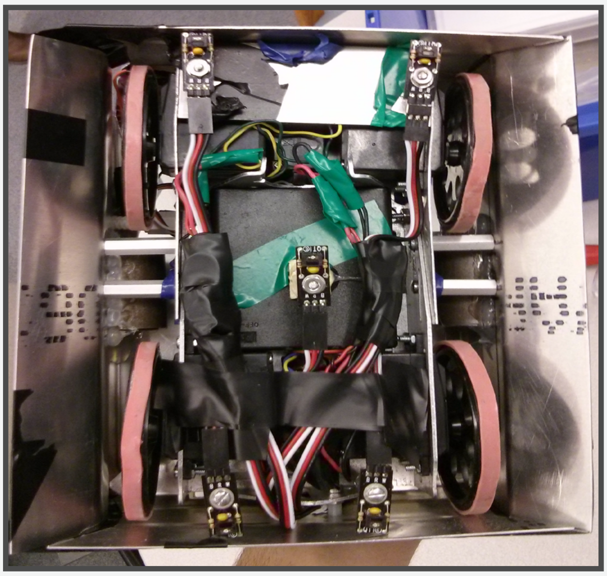
Date duration: Aug 2013 - Nov 2013

Budget: $40, with several components and materials provided by the class

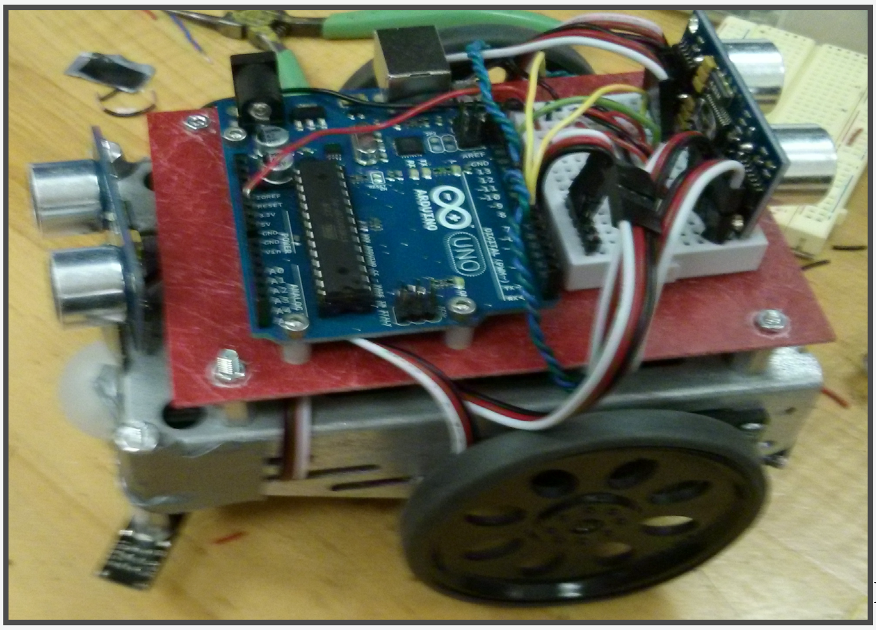
Results:
- Robot successfully integrated micro controller, sensors, electronic circuitry and electrical motors into an autonomous sumo-fighting robot
- Opponent detection was done by scanning arena with two back-to-back sonars rotating over a servo motor
- 5th out of 57 robots in sumo competition in the class



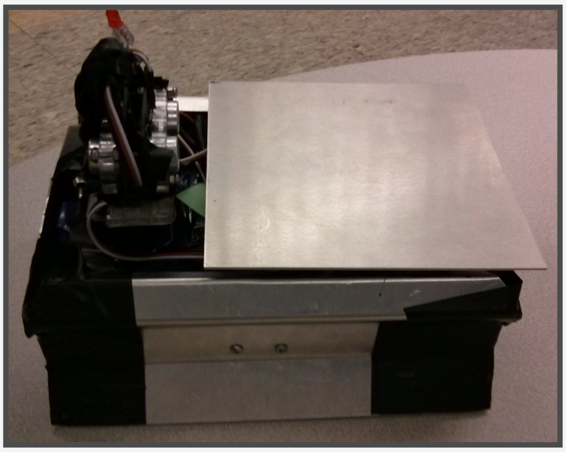
Final robot assembly



AUTONOMOUS SUMO-FIGHTING ROBOT



Initial assembly for testing



WIND-POWERED WATER PUMP

Goal

Develop a small-scale prototype of a water pump with the water input from a reservoir at the height of the shaft to an elevation of at least 1.5m height above the shaft at a rate of at least 1 liter per minute. The pump is powered by a wind turbine with radius of 0.75m and wind speed of 7m/s.

My Contributions

Fluid dynamics leader

Fluid analysis:
- Estimated expected flow rate and power based on fluid dynamics theory
- Calculated fluid friction losses in piping

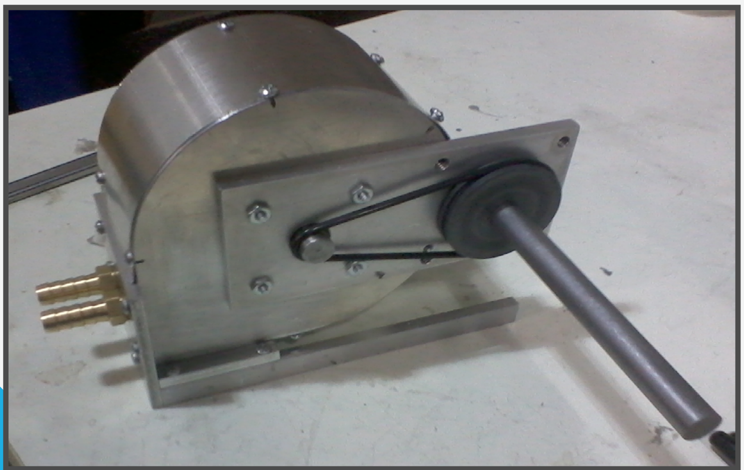
Design and Machining:
- Co-designed impeller and casing according to centrifugal pump theory
- Machined impeller blades and casing

Results & Assessment

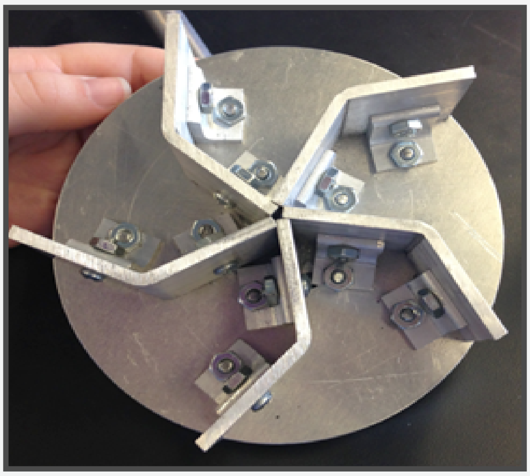
Date duration: April 2013 - May 2013

Budget: final cost of $285 per pump, including materials and labour cost

Results:
- Water pump built according to initial mechanical project
- Tests failed to demonstrate expected flow rate due to leakages in the pump's casing which caused pressure loss

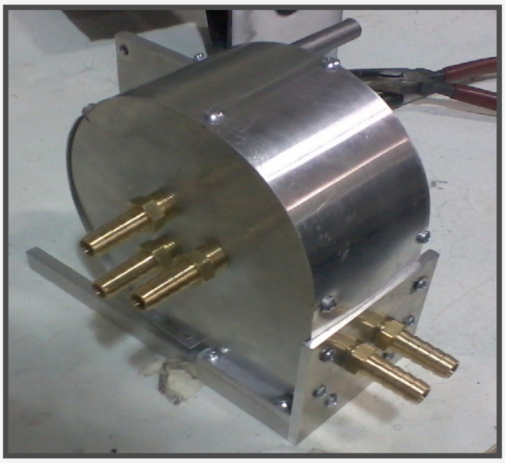


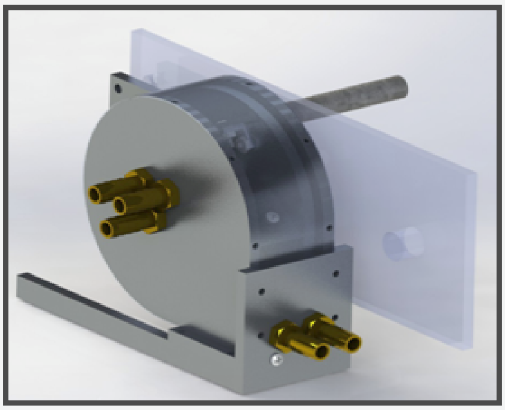
Pump's casing

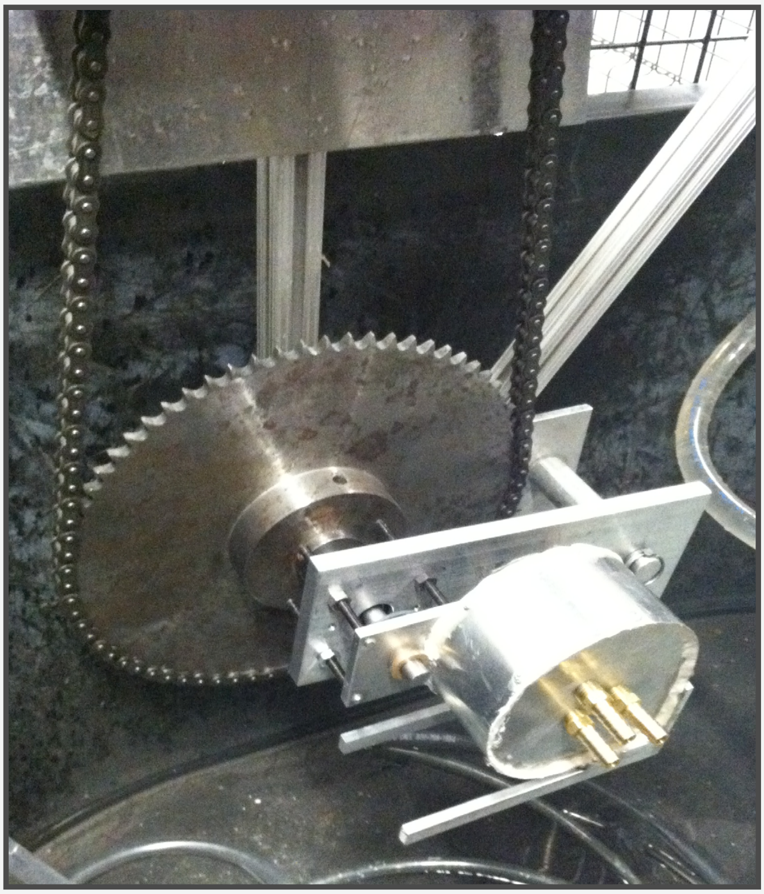


Pump's impeller

WIND-POWERED WATER PUMP







Final testing

Get in touch

Feel free to email me any questions or inquires

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