

Senior Project – Electrical Engineering– 2016

Energy Harvesting – Heated Hockey Skate Blades

William Donahue
Advisor – Prof. Dosiek

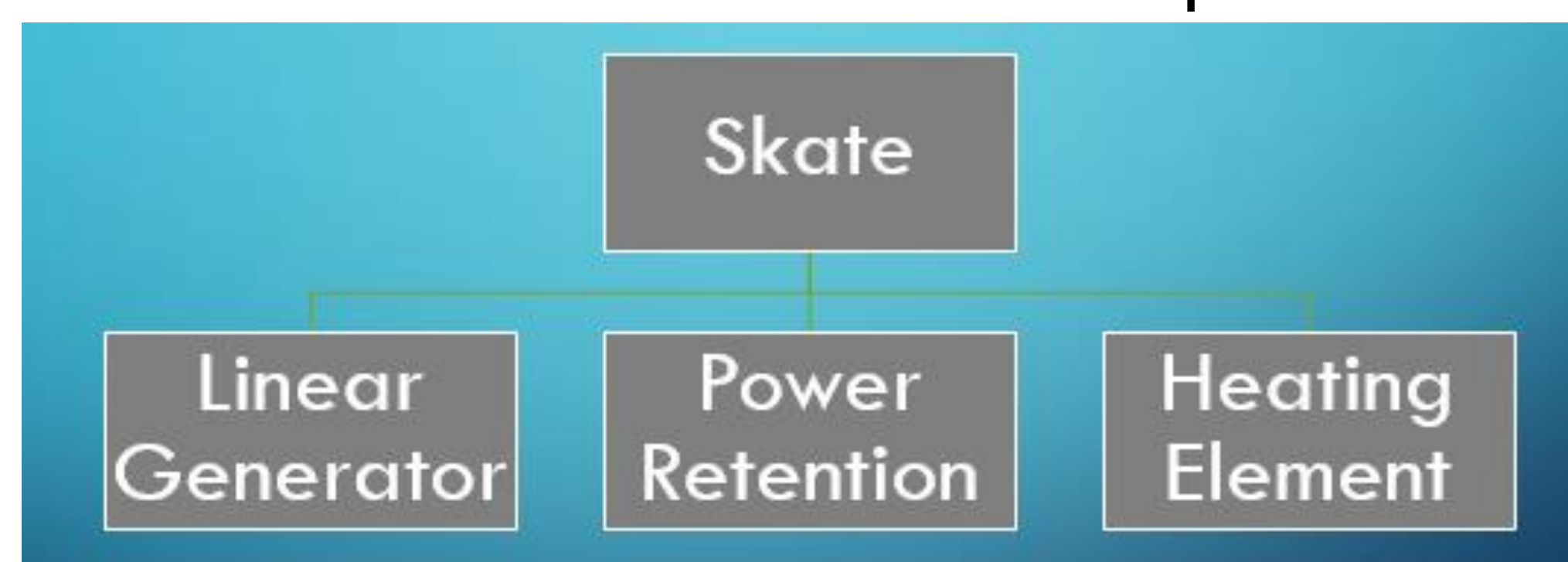
Abstract

Hockey players are able to glide on the ice due to a thin layer of water lying between the blade of the skate and the ice itself. When players skate, that thin water layer becomes a 'snow'. As the players continue to skate, the layer of 'snow' becomes thicker and thicker, making the ice harder to skate on due to the increased friction between the skate blade and the ice. The theory of this report is to show how the company Thermablade's design and concept of the heated hockey skate can be altered to improve the product. Using Faraday's Law of induction in a basic circuit could implement this theory. The use of Faraday's Law of induction removes the rechargeable battery from the system, which eliminates the need to recharge the skates, and instead harvests energy from the motion of the skate itself.

Design



The system uses the motion of the player's skates to harness energy through Faraday's Law of induction. Once the energy is harvested it is used to transfer heat from the circuitry to the blade. When the blade reaches the desired temperature of 41°F the performance of the player is improved by standards that meet Thermablade's product.



The three subsystems involved in the system are shown in the block diagram above. The linear generator harvests the energy needed, which is then stored in the power retention system and put into the heating element to raise the temperature of the blade. These subsystems are placed within the TUUK of the skate and are connected through circuitry. The heating element will sit on the blade to ensure for reliable heat transfer.

Future Work

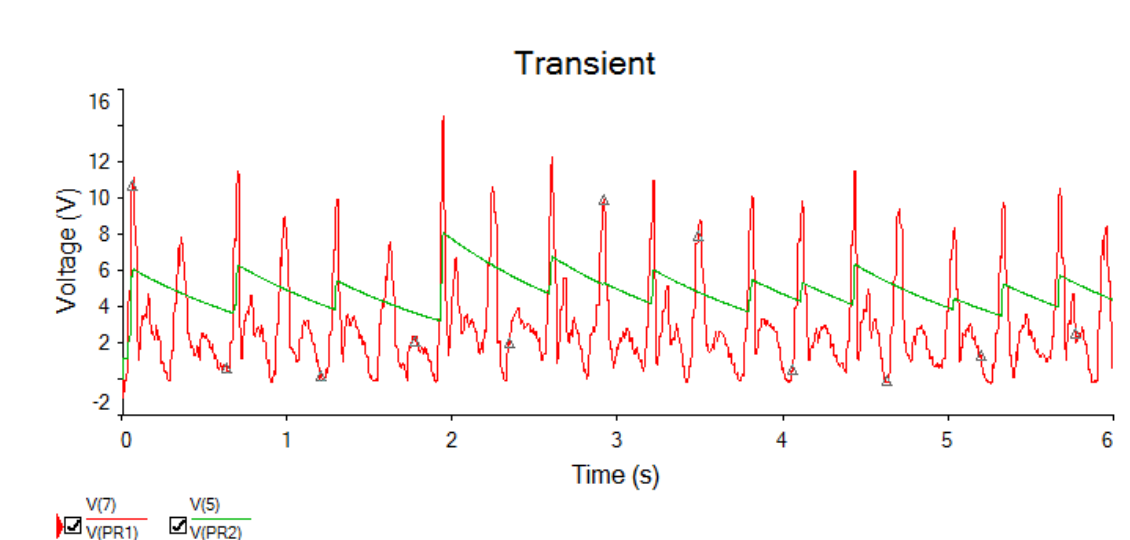
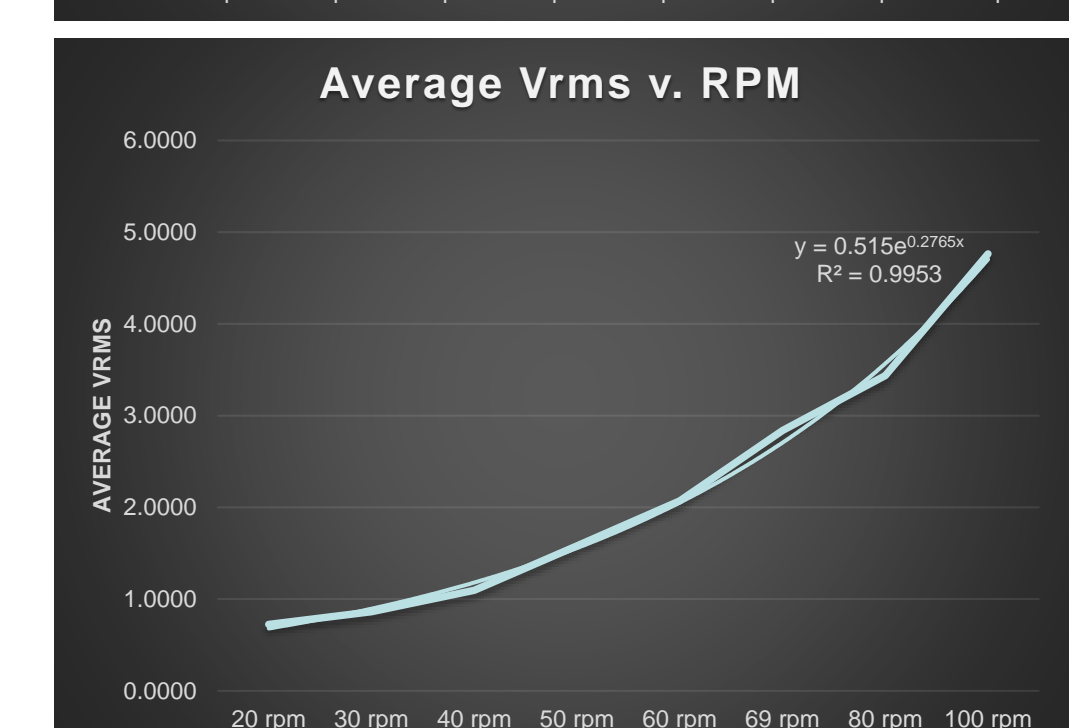
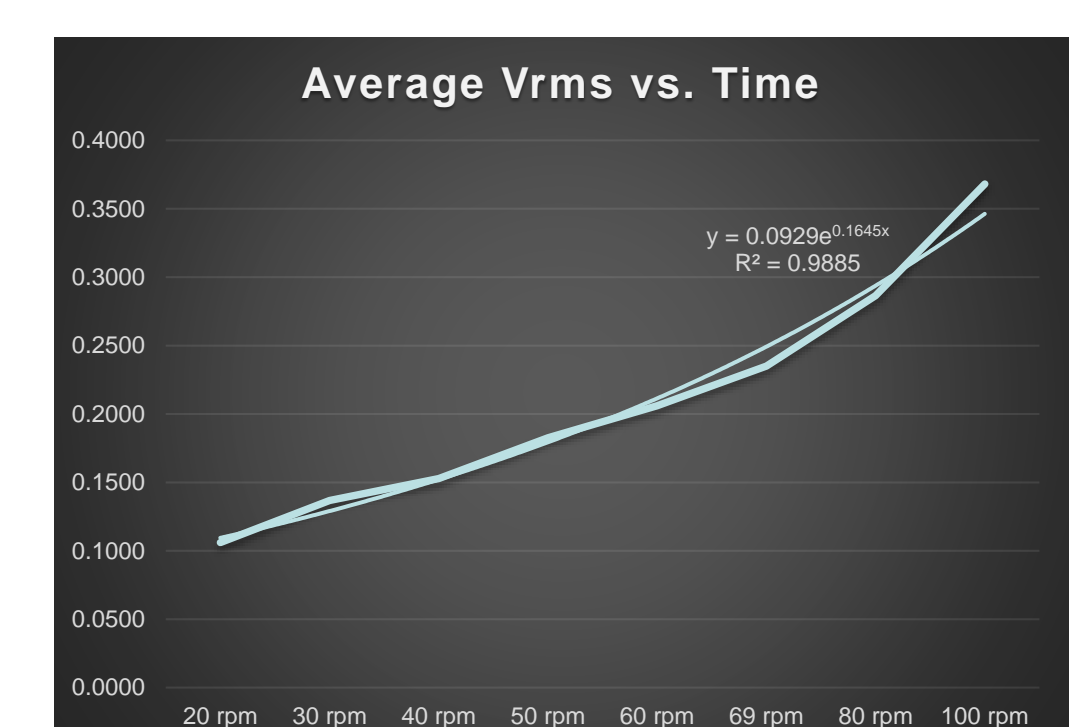
To ensure the system works correctly there must be analysis of heat transfer between the resistive wire and the steel blade. This can be done using heat transfer equations paired with the MultiSim simulations that were done. This further analysis of circuit components to research if the system functions the most efficient way possible. The components included in the research would be the number of turns and the strength and size of the magnets used, as well the resistance values in the circuit.

Goals

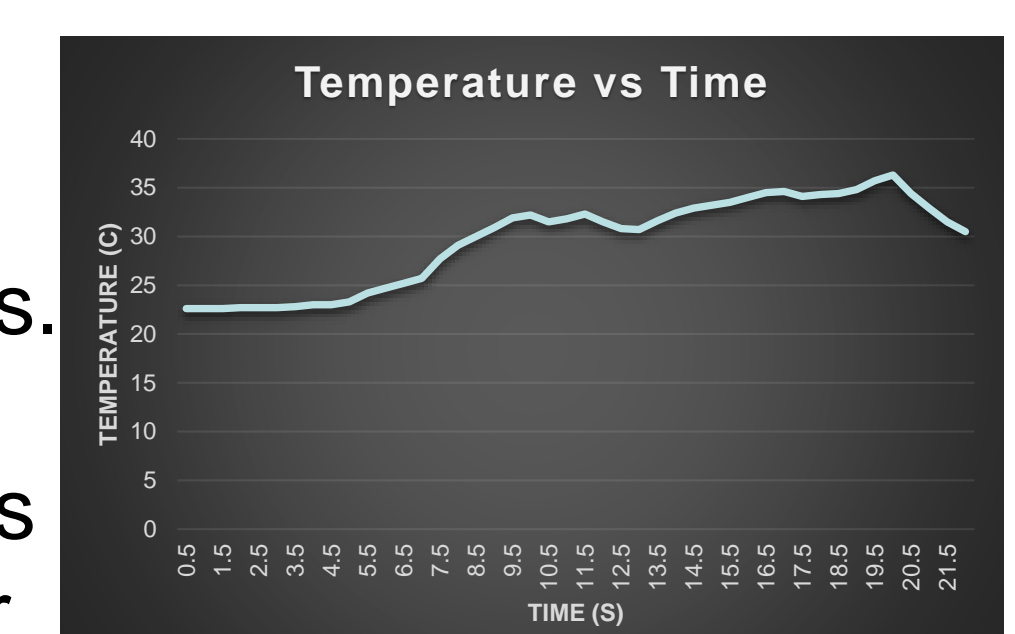
- Statistically compete with Thermablade's product
- Implement system, while keeping physical presence unknown
- Keep cost of product under \$150
- Extremely high reliability due to inaccessible circuitry within TUUK of the skate.

Results

Using a machine that mimicked the motion of skating, the linear generators were rotated back and forth at a rate between 20 to 100 RPM. The trials were then used to get the RMS voltage at different rates. This test was done on the constructed linear generator and the linear generator from the shake flashlight. The results varied due to variations in the number of turns and the strength of the magnets within the two systems.



The circuit that the shakelight contained was simulated using a wave that was recorded in MATLAB from the previous tests. The input voltage was smoothed by the super capacitor and rectified when it passed through the full wave rectifier.



The choice to use resistive wire was made due to the cost of resistive strips. The linear generator was attached to the resistive strip. An Arduino Uno was used in combination with a thermistor that was attached to the resistive wire to record the temperature. The temperature increased ten degrees, which was the ideal value needed.