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Unattended Underground Energy Harvesting Sensor

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CAPSTONE DESIGN EXPO 2017

Unattended Underground Energy Harvesting Sensor

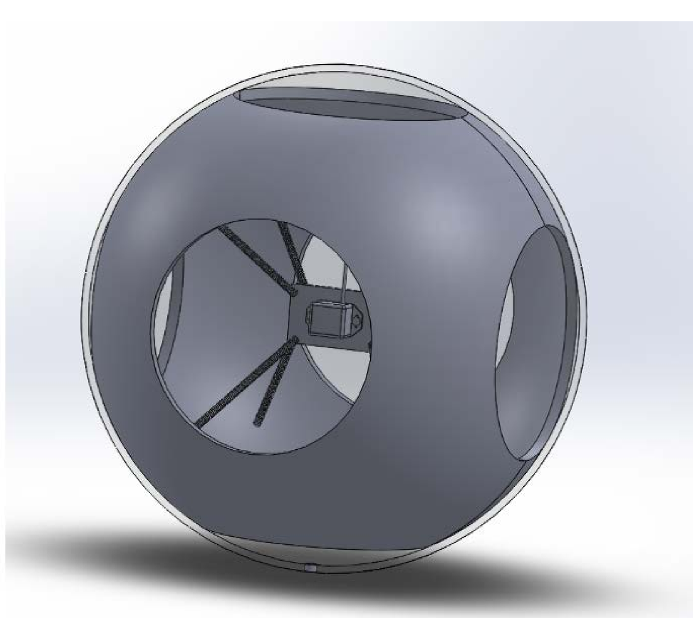
MNE513 | **Team members:** Buck, Jeffrey; Wade, Tzshay; Foxley, Jaeton; Ruffin, Brandon | **Faculty adviser:** Karla Mossi | **Sponsor:** Sentel | **Sponsor adviser:** David Young

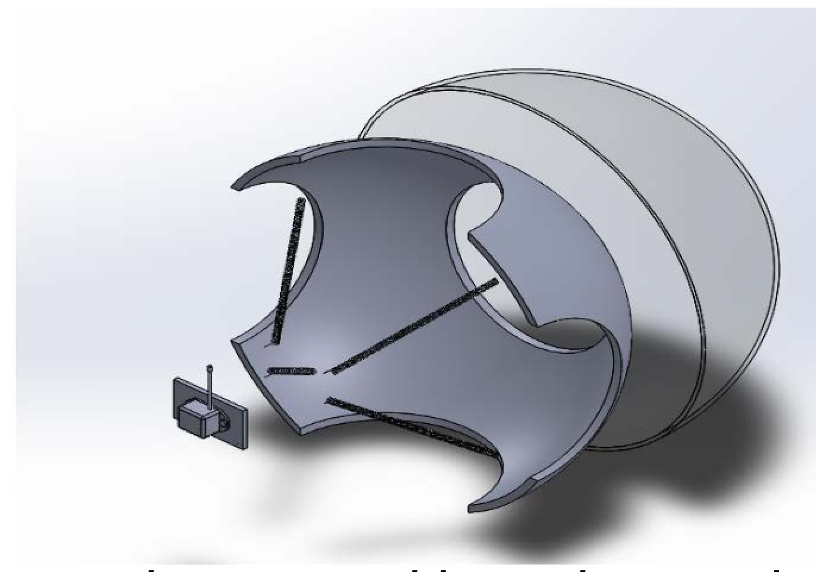
Overview

This project explores the possibility of creating an autonomous underground sensor which can detect vibrations and harvest energy from the environment

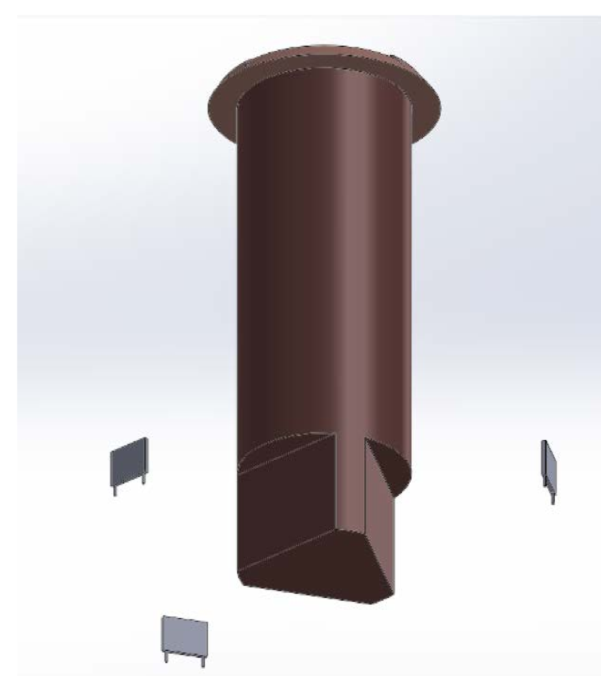
Design

The sensor features a plastic outer shell to protect from moisture and corrosion, in addition to an internal metal frame to shield against above ground pressure. Springs attach the sensor to the metal frame in order to amplify vibrations.

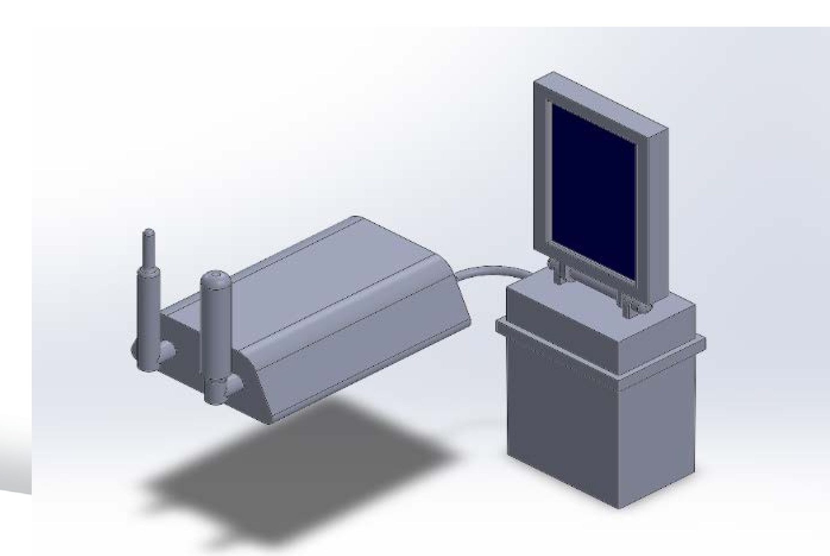




The sensor is powered by a thermoelectric cell which can harvest energy through a difference in temperature.



Once a vibration is detected the sensor transmits a wireless signal to a solar powered gateway above ground. The gateway then has the capability to transmit that signal to the user.

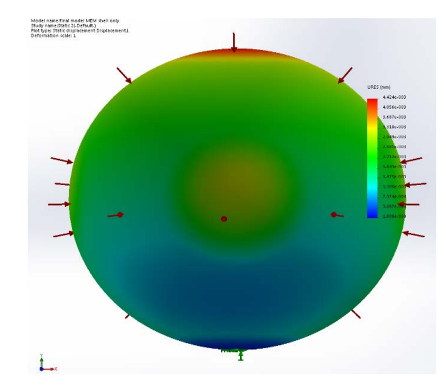


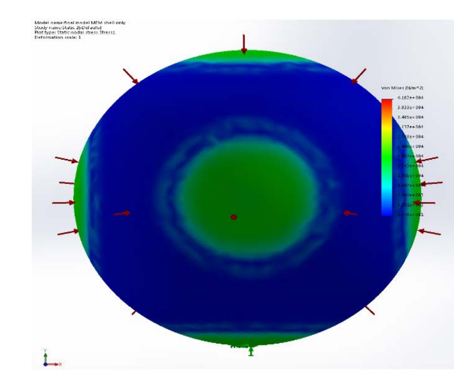
Purpose

The purpose of a device like this would mainly be for security reasons. This device could be set around the perimeter of a secure area and help to determine if the area is being breached.

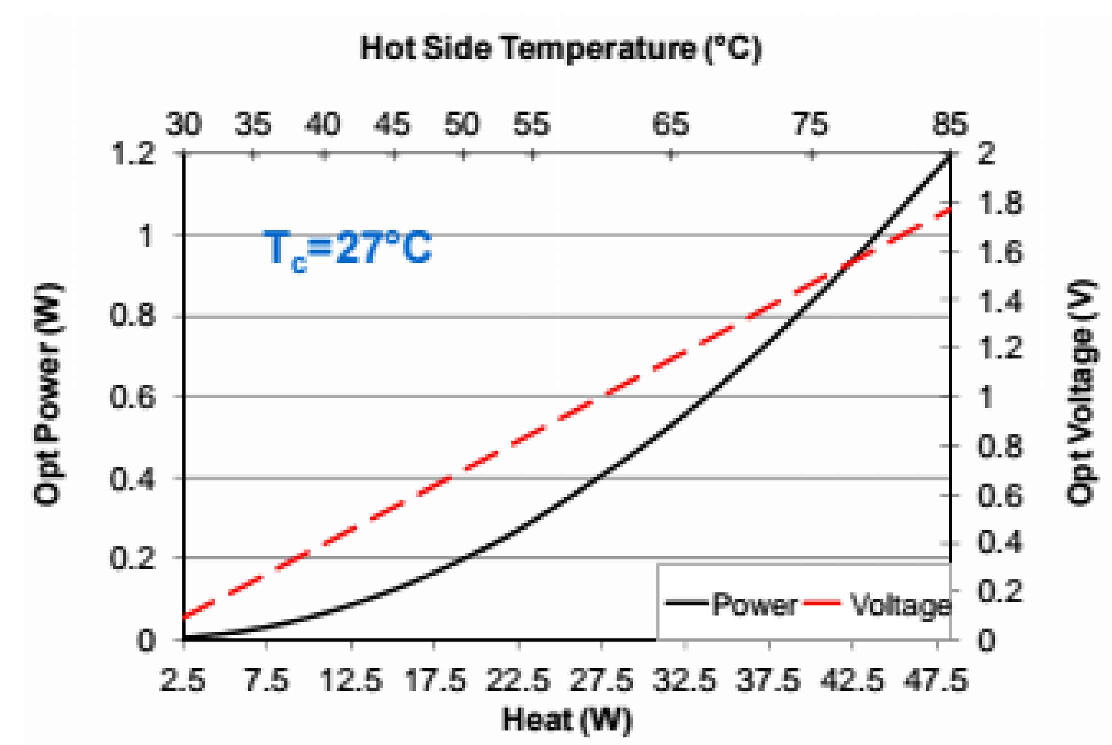
Analysis

The sensor was put under a pressure test of 1000 N/m^2. The strain and stress diagrams are shown below.





Furthermore, more than one thermoelectric device would be needed depending on the environment. The sensor needs at least 2V to operate. The thermoelectric output values can be seen below.



Performance

The activity sensor was able to measure both extremely small and large vibrations. The sensor has a sensitivity of 0.05 (g) and was easily able to detect normal human movement. Burying the sensor did have a negative effect on the normal wireless range of 250ft-300ft.

Conclusions

This device can take the pressure of a person standing on it, but would need stronger materials in order to withstand a vehicle. However, under the circumstance of a frame deformation the device should still work as the springs would keep the device centered. The energy harvesting aspect of this device is also feasible. Accounting for the temperature differences in the soil and ambient temperature, the multiple thermoelectric devices could power the sensor. Additionally, the solar panels generate a sufficient amount of power for the gateway to operate in normal weather conditions. In the event of energy harvesting failure, both the sensor and the gateway have a backup battery life of 5 years.

Future Recommendations

In the future there may be a possibility to combine the activity sensor and the gateway. This would consolidate the device to one battery and eliminate the need for two energy sources.