Self-Powered Wireless Speed Sensor System

Western Carolina University
School of Engineering + Technology

Original Objectives

Create wireless connections for:
- Self-Powered Speed Sensor
- Display Monitor

Task to be Completed:
- Evaluate possible solutions (develop concepts)
- Research power harvesting techniques
- Research railway standards
- Determine appropriate data management solution (micro processing unit selection and display)
- Determine various network protocols
- Build/Prototype
- Verification/Field Testing
- Finalize design and deliverables

Requirements

Wireless Transmission	Data must be transmitted wirelessly at least 100ft	Not Met (Covid-19 prevented further testing)
HMI	Human Machine Interface-Display (User Friendly)	Not Met (Covid-19 prevented development)
Energy Harvesting	Self-Sustaining	Not Met (Covid-19 prevented further testing)
Temperature	-40°C to 100°C :Sensor 85°C Max: HMI	Met
Size	Flexible, compact as possible	Met (could have been smaller given more time)
Weight	Less then 10 pounds	Met
Refresh Rate	Every 2 mins or on demand if requested	Met

Concepts

Power Harvesting Concepts
- Variable Reluctance Speed
  - Capture energy generated by the magnetic flux
- Vibrational Energy
- DC Generator
  - Physical gear linkage

Transmission Concepts
- NRF24L01 Radio Transceivers
- High Power Bluetooth

Problem Statement

Sensors used in rail applications only connect through the use of wire/cable. Therefore, the cost of materials is very high. A proposed solution is to limit materials used in cabling by creating a wireless array. This collecting and sending of data wirelessly through some means of communication could then be displayed to the engineer. This also requires that each sensor have a self-sustaining power system. To prove the validity of this solution the scope will only involve creating a system incorporating a VR speed sensor and displaying the collected information wirelessly.

Final Design/Results *

Due to the breakout of covid-19, the intended final design criteria could not be met. However, the latest iteration of the final design involved the wrapping of two coils, seen in Fig.1 and Fig.2, in 34 gauge copper wire. The coil in Fig.2 produced the highest output of usable power. Within the coil is a pole-piece and a magnet. Based off testing, these two must have a 1:1 ratio to acquire the best results. This in turn produced the highest amount of flux generated at the air space between the pole piece and a rotating gear. A Flux Bridge as seen in Fig. 3 would have been the next step for testing. Fig 4. would have our interpretation. If that idea failed, then we would implement a dual coil design with a flux bridge between them to attain our required current output of 16 mA. Ideally a closed magnetic field could increase efficiency of the coil.

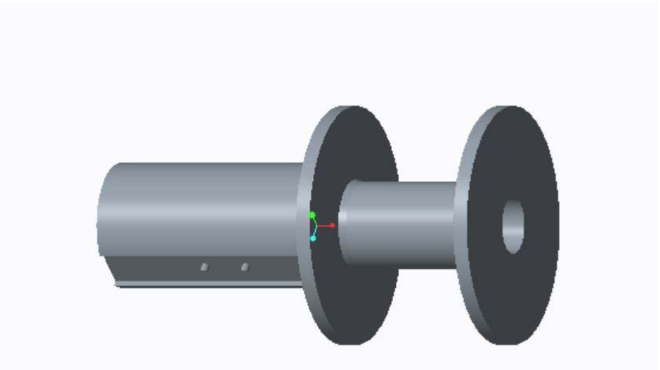

Fig. 1

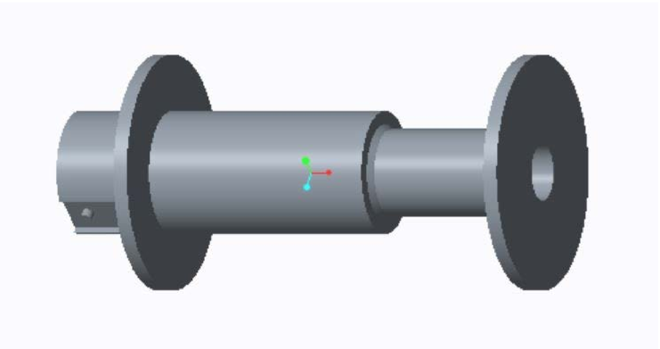

Fig. 2

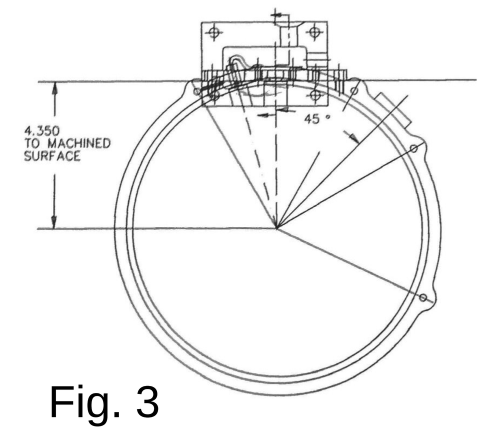

Fig. 3

Fig.4

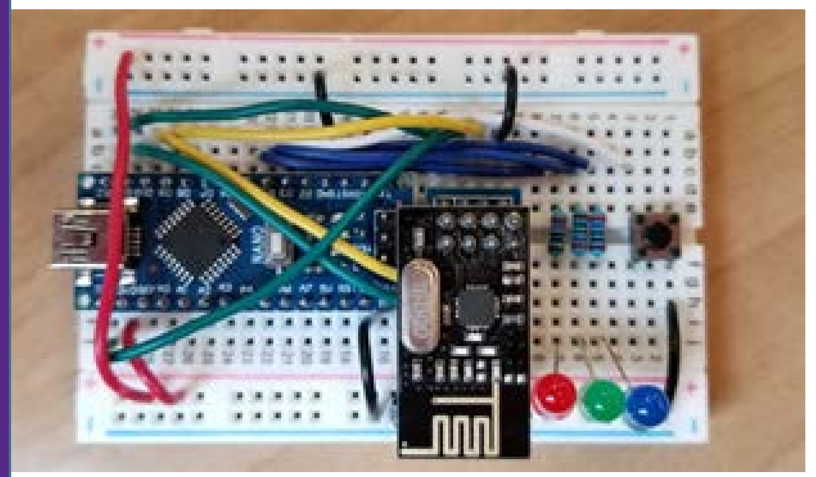

Fig. 5 Breadboard circuit for the central receiver, LEDs would be replaced by HMI in final design

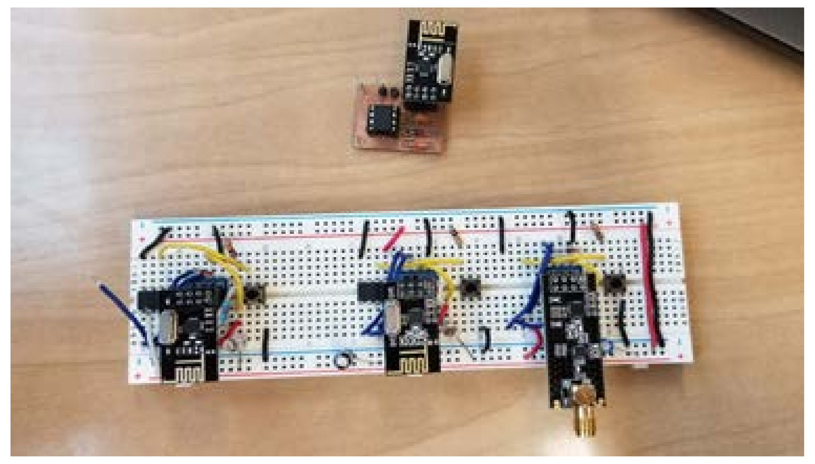

Fig. 6 Breadboard circuits for transmitters. High power transmitter on bottom right. Sensor would be connected in place of button

Fig. 7 Various printed bobbins. Far left: original bobbin. Top Centered; printed versions of Figs. 1+2.

* On March 16, 2020 classes and labs were closed to students due to the COVID-19 Pandemic. Without access to fabrication and testing equipment, Objectives and Deliverables were modified accordingly.

Modified Objectives*

- Modified items due to COVID-19
  - Test Plan
  - Final Design
  - Max Wireless Distance
  - HMI
  - Energy Harvesting
  - Size
- Team operate in new environment
  - Team members adapted to the fully online work environment. However, timing of feedback was delayed.
- Impact on the overall project
  - Without access to lab equipment, all further testing and development was cut off. Thus, the impact to the project as a whole was decreased.

Summary

A foundation for a wireless closed self-powered system of sensors used for the management of locomotive operations.

Team & Acknowledgements

- Oliver Adcox - BSEE
- Drew Hamlet - BSET
- Daniel Smith - BSECET
- Alex Sapp - BSEE

Mentor
- Dr. Bill Yang

Smith Systems INC
- John Arnold
- Sinjon Stringfellow
- Isaias Acevedo