PURDUE UNIVERSITY | Agricultural and Biological Engineering

CAPSTONE/SENIOR DESIGN EXPERIENCE 2020

Title: Remote Data Monitoring and Tracking System for AgRover Utility Vehicles

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1.) Project Context

- Purdue Utility Project provides access to sustainable power and transportion to developing communities
- AgRover vehicle is the primary product of the Purdue Utility Project
- Problem/Impact: There is a need to monitor status of AgRover to improve product and increase customer satisfaction by facilitating maintenance and development of the vehicle
- Solution: Develop a data logging system for the AgRover to measure and upload to the Cloud key development and maintenance parameters of the vehicle

2.) Design Considerations

Consideration	Type of Consideration	Design Criterion
Diverse user base	Social/cultural	Easy to use
Different environmental conditions	Environmental	Durable
Will be used on many vehicles	Economic	Reproducible
Wealth of country may vary	Economic	Limit cost of system

3.) Constraints/Criteria

Design constraints for system were given by the PUP team:

- Budget of $500
- Must measure: engine temperature and speed, vehicle location, vehicle speed, and time of operation
- Independently powered
- Water and vibration proof
- Store data and remotely upload it to Cloud

Additional criteria were given as:

- Ability to measure slope, ambient temperature, payload

4.) Decision Making

Four potential data logging systems were considered. Systems were based on:

- Arduino Uno
- Raspberry Pi
- Pre-built King Pigeon S261
- Customized Android Smartphone

Although inflexible, the King Pigeon won due to its pricing, reproducibility, and ability to satisfy many constraints by default

5.) Data Logger Design Matrix

Criteria	Cost	Power	Flexibility	Ease of Production	Extra Inputs	Durability	Ease of Use	Total
Weight	8	8	6	7	7	5	5	
Arduino	9	7	9	4	10	6	7	345
Raspberry Pi	8	8	9	4	9	6	7	338
King Pigeon	6	7	7	9	8	10	8	**355**
Customized Smartphone	7	5	6	7	4	6	7	274

6.) Chosen Solution

- Data logging system based on King Pigeon S261, which can measure GPS (location & vehicle speed), store & upload data to server, and is waterproof, all by default
- Only need to include engine temperature and speed sensors and independent power source, as well as vibration-proof the system to meet all constraints

7.) Chosen Components

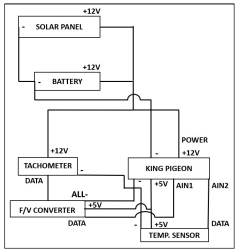
- TMP36 temp. sensor
- 10mm proximity sensor with frequency to voltage converter
- 10W/12V solar panel with 2Ah 5V battery pack and USB voltage converters
- Decisions guided by affordability, ease of implementation, and ability to work with King Pigeon S261

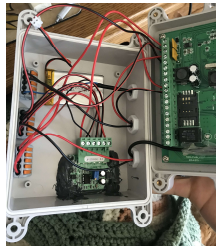
8.) Summary

- Electronic system completely designed and built
- Successfully measured sensor data with data logger, but will require future validation
- Successfully communicated with data logger but could not export data to server due to lack of access to SIM card
- Designed mounting plans for future workers to finish the system once possible

Product and Implementation Plans

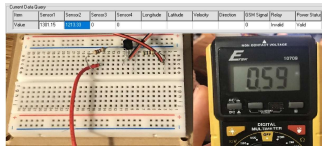
Completed Circuit



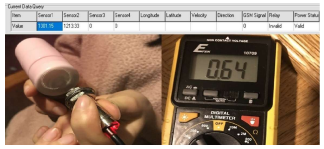


Successful Communication

Successful Data Acquisition



Data logger thought TMP36 sensor was a current sensor; used resistors to fix signal. Bit output of 1213 implies VAIN = 0.61V; meter read 0.59V at sensor, so sensor was being read correctly. But this is ~10°C, a low value, so need to calibrate in future



Glued two magnets to small fan to test tachometer. Bit output of 1301 implies VAIN = 0.65V; meter read 0.64V at F/V converter, so values were read correctly. 0.65V→26 Hz→ fan runs at 13 Hz. Seems reasonable but need to validate in future

MOUNTING PLANS

- The King Pigeon should be placed under the passenger side of the AgRover
- Mount solar panel onto vehicle frame using L-bracket; should extend over driver's seat (as in bottom-left picture but extending over seat instead of bed)
- To mount the temperature sensor, use a 3/4 inch x 3 inch coarse threaded bolt drilled out and waterproofed with epoxy to replace the oil stick (pictured below-center)
- Mount the tachometer using a piece of 1/8 inch steel, drilling two holes matching the top bolt pattern (pictured bottom-right)

9.) Conclusions and Lessons Learned

Conclusions

- Designed a data acquisition system based on the King Pigeon S261 and various other components
- The system was found to be a successful solution to data acquisition for the AgRover
- Made great progress and completed as much of the system as possible
- Made plans for finishing the system in the future after social distancing is over

Lessons Learned

- No solution is the best at every design criterion; while the King Pigeon was affordable and would be easy to reproduce, it was inflexible and very difficult to debug
- Sensor choice is very important for a data acquisition system. While data can be recorded by many sensors, mounting can be difficult for certain sensors, such as those we picked. Another sensor combination, such as a thermocouple and an optical sensor, may have been a better choice for this reason.

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References:

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