ANALYSIS OF IOT REMOTE WEATHER STATION FOR DAWSON ROAD MANAGEMENT

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PROBLEM DEFINITION

To gather and store road related weather data and information to help inform road material application decisions. The devices should be self-contained and scalable. They will also need to be able to withstand harsh winter conditions and be able to transmit data from rural areas with little to no maintenance.

ANALYSIS

For this problem we believe IoT powered devices set up in a point-to-point communication to a master. Outlined below are several options to solve it and the solutions we believe fit the best for the outlined problem

HARDWARE

The two most common IoT boards are Arduino and Raspberry Pi, to begin with the team will develop a solution surrounding the Raspberry Pi, but will also look at the possibility of using Raspberry Pi as the master and using Arduino powered weather station nodes to gather and transmit the data back to the master node.

The device has 2 main functions, collect road surface temperature and ambient temperature and to transmit that data back to the master station for it to be reviewed and analyzed. The ability to collect subsurface temperature is also desired and will be discussed further below

TEMPERATURE READING

For collecting temperature data, we looked at several common temperature sensors and looked into reading surface temperature, because of the importance of road surface temperature, we settled on looking into appropriate infrared temperature sensors, and found the model MLX90614 to be best suited for our needs, especially as it is calibrated to work as cold as -40*C for sensor temperature and -70*C for object temperatures with an accuracy of 0.5*C. It also contains a sleep function to help reduce power consumption which will help ensure each node needs as little maintenance as possible.

DEVICE COMMUNICATION AND DATA TRANSFER

IoT devices contain several different types of communication and data transfer, from Wi-Fi, Bluetooth, cellular and Radio Frequency. With the requirement of our devices being deployed onto remote roads, Wi-Fi is not a solution, as we cannot guarantee a stable internet connection. Bluetooth is also not an option, as it only functions in quite a short range, and due to the nature of needing to deploy the nodes quite a distance between each other to collect data, the short range would work against us. Cellular is an appealing option as it will allow each node the ability to connect to the internet and transmit their data directly to a single master node that can then upload the collected data to be analyzed and reviewed, however, we cannot guarantee every road the nodes will be deployed on will be in range of a cell tower. Finally, radio frequency, we believe radio frequency will be the best solution to our data transmission and collection. While RF does not have the same range as cellular, the ability to deploy the slave nodes in a point-to-point configuration with transceivers on each node, will allow us to have each slave node collect and transmit the data back to the master node. For the transceivers, we found the RFM9x LoRa transceiver to suit the requirements of having a long range transceiver. The RFM9x is rated up to a 20km line of sight in rural areas with few buildings. Testing will be done to check the optimal distance of none-line of sight range, but we believe based on readings it should still be several kilometers. Due to the nature of broadcasting across radio, there are a couple of concerns regarding transmitting the data, security and filtering. While we aren't transmitting critical or sensitive information, we believe it still be wise to use a lightweight one-time pad or symmetric key encryption to provide a small amount of security to the data, this will also allow us to more easily filter out potential unwanted data being transmitted on the same wavelength from someone else.

POWER

For powering the slave nodes, a lithium rechargeable battery with easy access to allow crews to swap batteries in the field. Exact battery and module are still being looked into, while keeping the cold and harsh weather being factored into the decision.