Integration of Blockchain and RFID system for Road Safety

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***Abstracts* - Black ice refers to an ice coating formation on the top surface of roads. The detection of this layer is not possible through naked eyes yet it's a vital information to avoid skidding of vehicles or accidents. Due to this reason we saw a need to use external sensors to detect black ice formation. Its formation causes huge losses and damages to the government properties, human life. Governments in different nations are taking various precautionary measures for treatment and prevention of black ice. This project is focused on anticipating the formation of black ice using Internet of Things, edge computing for better data transmission and a secure blockchain database along with sensors to detect black ice formation. Blockchain technology is also being implemented for further precautionary measures to prevent accidents by crowdsourcing the necessary data.**

Key words:* *Blockchain, RFID technology, Internet of Things, Black Ice, prevention measure, Roadways & Bridges

INTRODUCTION

The winter season has around 90% coverage in the states this leads to snowy weather conditions which in turn creates black ice formation. Black ice is a thin transparent film of ice on the top surface of roads and bridges which cannot be perceived through naked eyes thus this creates opportunity for us to use RFID technology for detecting ice layer formation

It usually forms over late night or early morning as the temperature continues to drop. Thus, we developed a road embedded RFID system.

A. Concrete Embedded RFID

We will be implementing RFID by embedding passive tags in concrete roads. We then describe the application of RFID to detect ice layer thickness. During experimentation the read ranges (MRRR) and RSSI value seem to decline exponentially due to embedding the RFID. Thus, the author in [1] proposer RFID tags which are based on electromagnetic & dielectric properties of concrete. This will help us understand at what signal level the icing starts to build and anticipate the road condition ahead of the time. The tags have a readable range over a meter while they are embedded, makes it the right fit for outdoor applications.

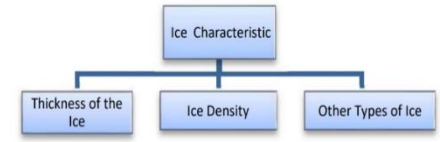

Figure 1. Ice characteristics
Shows three major ice states on the road surface

Even though the proposed sensor has all the in-built applications and alerting systems to curb black ice

prevention, we propose to implement blockchain technology to integrate the sensor and its internet-of-things along with RFID technology for precise data collections.[1]

Blockchain is a simple yet reliable platform to transfer data or information from point A to point B in a fully safe and automated environment. The Blockchain information is not stored in a single computer or a node, thereby not centralized database system. In fact, blockchain works on the principle of decentralized database system with millions of computers or nodes connected simultaneously, and this information is available to anyone on the internet. The main features of blockchain is its decentralized distributed ledger that means it is not owned by a single entity. The data or information is cryptographed or created in blocks of chains which makes it impossible to erase or tamper with it, thereby making blockchain robust, safe and trustworthy platform for all kinds of transactions. [2]

The primary purpose of conducting this research is the design, development and testing of a Block-chain application and coupling that block-chain technology with sensors and RFID technology. A novel embedded sensor system is being proposed for the detection of black ice as well as wet, dry and frozen surface conditions on roads, bridges, runaways etc. This sensor system is enabled with GPRS, which we plan to connect with Internet of Things using Blockchain for regulating warning signals to prevent accidents and other hazardous activities. This system is also useful on airplane runaways to avoid losses during flight take offs and landings. In recent years, many cars are already equipped with RFID technology. RFID can be used to vehicle tagging to understand traffic flow, vehicle speed detections, vehicle-to-vehicle supportive communication etc. [2]

BACKGROUND

According to recent study in the United States of America, over 70 percent of the US is considered as snowy region. During icing of pavements in cold weathers, the speed must be reduced drastically to avoid skidding and losing control over the wheels causing accidents [1]. Every year 1300 people are killed in road accidents during snowy or icy pavements [1]. Nearly, 900 people are killed, and 76000 people are injured in snowfall or sleet. Also, nearly 2.3 billion dollars' is invested annually on snow and ice control methods. [2]

The sensor proposed for this project is an intelligent road sensor manufactured by Lufft Corporation called "IRS 31pro-UMB" passive sensor. This sensor is successfully been implemented, and the purpose of selecting this sensor for our study are the added benefits of its already well set up database system which is connected to Internet of Things to get real-time data from the sensors installed on roadways. "ViewMondo" – Road and Runway Management Software" is a visualization tool that gives the real-time updates of the weather and road conditions on a map or a list. Simultaneously "SmartView3" is a collector tool used to poll measurements data from all the stations and store it in a MySQL database [2]

A. Internet of Things (IoT)

The author in [5] explains IoT as a integrated system which comprises of smart machines interacting with other devices such as RFID, sensors, infrastructure and environment to meet new challenges. It has wide range applications in road safety, health care, utilities, transportation, etc. The goal is collection of data or information without human aid. This technology not only help us gather information's, but also provides usage, transmission, analytics, application and communication of this services.[5]

Technologies such as cloud computing and big data has been leveraged by IoT to go beyond its traditional capabilities since its inception. The author uses this paper to describe the challenges faced into integrating blockchain with IoT and pavement sensors system.[5]

What is RSSI value?

When you receive a signal from RFID to the antenna, you actually receive it's signal strength

or power level. It is typically measured in decibels per milliwatt, or dBm. It is related to two physical properties on a logarithmic scale. For RFID we measure the change in power level to do this experiment, with reference to single milliwatt.[4]

How is RSSI Used?

In any sort of RFID reader, every reader is related with Received sign quality Indicator additionally called as RSSI esteem. They give us a thought of how well a tag is reacting in a read zone. This is a decent pointer how well a tag is working in regard to different condition. This labels likewise accompany a disadvantage, the RSSI worth doesn't give us the separation of the tag from the radio wire in a detached RFID framework. This is mostly because of different natural variables which influence the read capacities of the reader. This is because of the numerous RFID variables can influence a label's range in a latent framework; along these lines' reader, RSSI alone is anything but a dependable estimation to utilize when figuring label separation. Rather, other label information esteems, for example, the label's understood rate (for example the occasions a tag is reader every second) and reaction time (for example the measure of time it takes the tag to react just because) ought to be utilized notwithstanding RSSI when performing such computations.

Low Temperature and RFID

Low temperature effects affect various parts of RFID label usefulness. Likewise, the impact of conceivable amassing of day off ice on the label surface is discussed aspects of RFID tag functionality. Also, the effect of possible accumulation of snow and ice on the tag surface is discussed. Thus, we base our development of project on understanding on the fact that with layers of formation of snow over the embedded RFID, and we compare the RSSI value deviations in the current environment to detect black ice formation.

Concrete Embedded RFID

We will be implementing RFID by embedding passive tags in concrete roads. We then describe the application of RFID to detect ice layer thickness. During experimentation the read ranges (MRRR) and RSSI value seem to decline exponentially due to embedding the RFID. Thus, the author in [1] proposer RFID tags which are based on electromagnetic & dielectric properties of concrete. This will help us understand at what signal level the icing starts to build and anticipate the road condition ahead of the time. The tags have a readable range over a meter while they are embedded, makes it the right fit for outdoor applications.

Even though the proposed sensor has all the in-built applications and alerting systems to curb black ice prevention, we propose to implement blockchain technology to integrate the sensor and its internet-of-things along with RFID technology for precise data collections.[1]

RESEARCH QUESTION

- Integration of 31pro-UMB sensor into our blockchain using internet of things.
- Does black ice formation lead to considerable reduction in signal strength?

We want to figure out ways of how to integrate the data gained by IRS

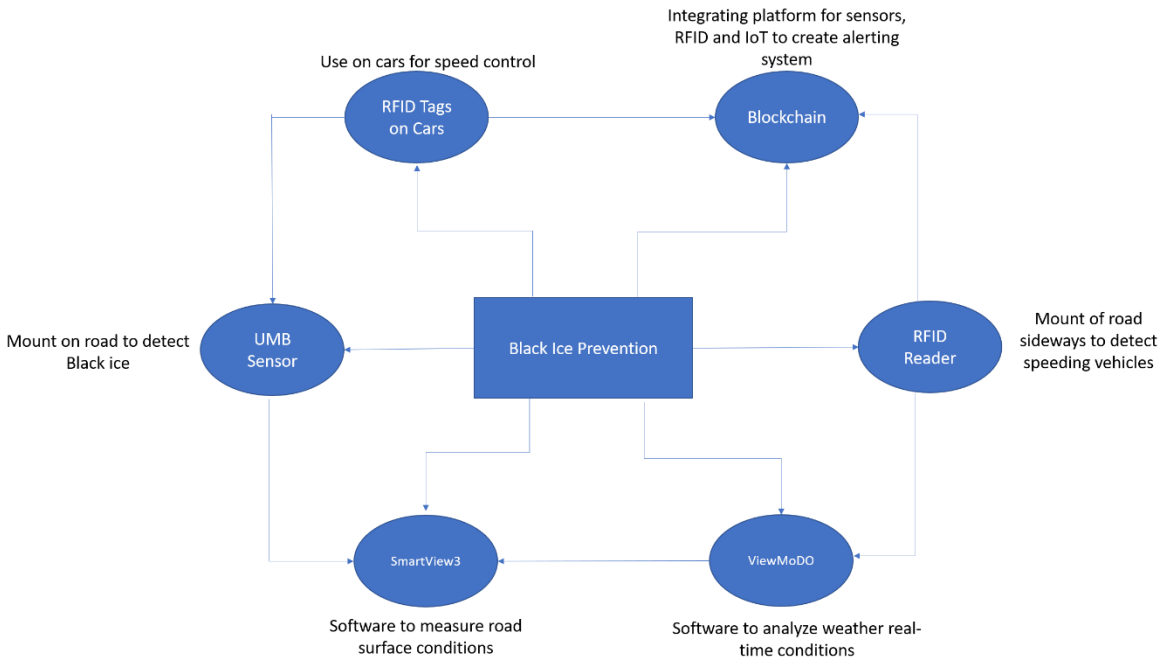

Figure 2. IoT Black Ice Schematic Diagram

This diagram shows the interconnection of various process taking place during prevention of black ice.

RESEARCH HYPOTHESIS

We hypothesize that RFID technology can be used collect data of everyday weather conditions which can be then integrated using IOT to a blockchain data base. This will help us understand road conditions over prolonged period and could also help us in forecasting the road condition in future for alerting the drivers.

METHODOLOGY

Using embedded RFID sensor on roads and parallel antenna placement we can experiment in a controlled environment. Formation of black ice would led to reduction in antenna signal strength which in-turn would be identified as a potential layer of black ice or similar layer on the top surface. This data can be collected over time through regular inputs into the blockchain data base which would be collected using IOT. We can exactly understand at what signal level the icing starts to build, this would help us to anticipate the road condition ahead of the time and help in prevention of road accidents

Even though the proposed sensor has all the in-built applications and alerting systems to curb black ice prevention, we propose to implement blockchain technology to integrate the sensor and its internet-of-things along with RFID technology for better prevention of black ice formation and also to curb road accidents happening on highways etc. Blockchain is a digital/distributed ledger used as a secured database system which cannot be tampered, and the registered data cannot be erased from its system forever [2]. Blockchain is an open source technology that can validate transactions; thus, transactions happening in blockchain is immutable and irrevocable [2]. Blockchain technology along with RFID and intelligent road sensor can help in maintaining a well-organized database, which can

be applied in analyzing for better forecasting techniques both for weather and road mishaps.

We plan to create blocks of SmarView3 database, ViewMondo database, UMB 31-pro sensor data along with RFID database into the blockchain technology. [2] Also, implementing blockchain to provide alert systems for various stations which have already been logged in through SmartView3 system. This can help the stations to initialize with the De-icing methods by adding salts on the highways beforehand.

Design for Six Sigma Research

Traditional research methods were fused with the industrial continuous improvement methodology (DFSS-R). This methodology is based on recognition by many companies as a means for reducing defects, increasing company productivity and improving company profitability. Six Sigma can be considered an extension of Total Quality Management. Management (TQM) initiatives. The advantage that this methodology has over quality initiatives is that it applies statistical techniques not only to product quality but

also to many aspects of business operations in order to improve the overall organizational efficiency. [5] The distinction ―Six Sigma‖ originates from statistical terminology. In statistics the sigma (σ) represents the standard deviation. Given a normal distribution curve the probability of falling within a plus or minus six sigma from the mean is approximately 0.9999966. It is more commonly expressed in production processes as a defective rate for processes that will be 3.4 defects per million units (Yang 2003).Accordingly, Six Sigma promotes a high degree of consistency by designing operations with extremely low variability. The objective for Six Sigma methodologies is to reduce the operational variation to achieve small process standard deviations. [5]

CALCULATIONS & OBSERVATIONS

The result of Gen1 and Gen2 measurements are presented in table 1 and 2. The table shows the maximum reliable read range (MRRR) values of five different tag types at three different temperature. Table 2 shows the threshold power, that is to say the minimum reader transmission power levels, which enabled the reading of the tag in the 860-870 MHz frequency span. Three different types of underlay were tested (transparency, paper and cardboard), each with and without the ice coverage.

	RFID TAG	Antennas	RFID Reader
Specifications	Passive UHF - Plus Micro Mini Windshield Sticker	ALIEN ALR-8698 RFID ANTENNA	RFMAX weatherproof RFID reader enclosure
Price	$ 5-10	$179	$499

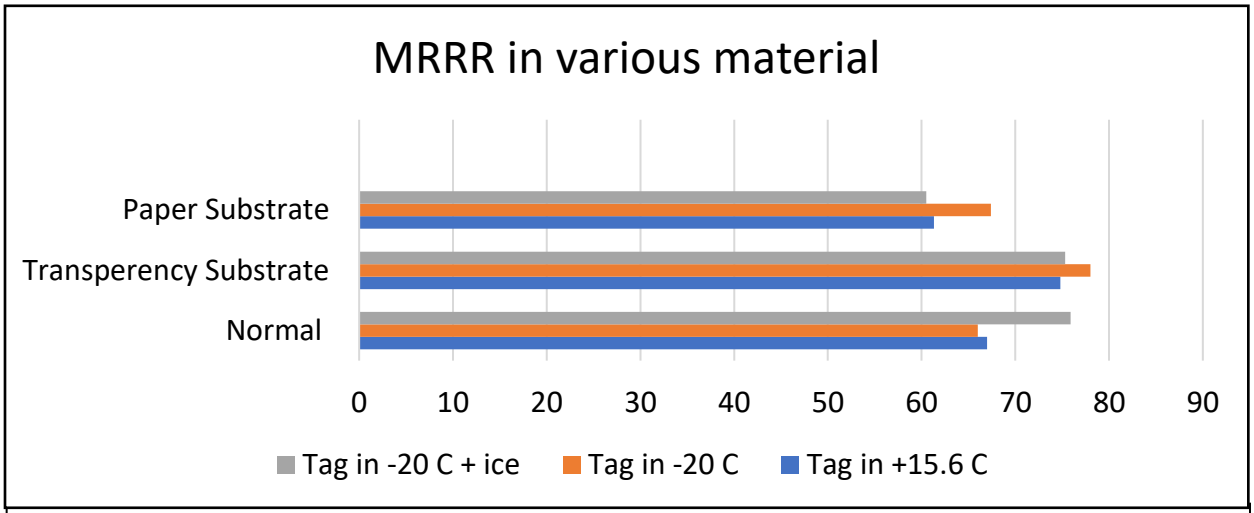

Table 1 : The MRRR for different Gen1 tag types in different circumstance [cm]

tag through the red zone. UHF RFID Reader Price -

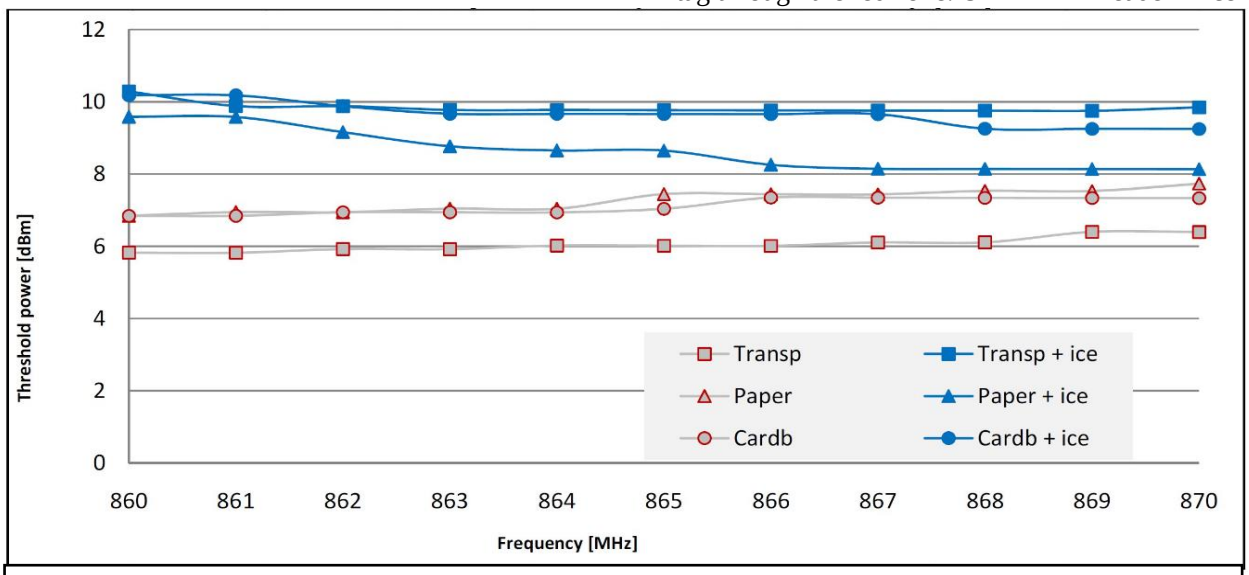

Table 2 : The threshold power for Gen2 tags with and without ice coverage[dBm]
Reference: Jussi Nummela, L. U. (2008). *International journal of communications.* "*Passive UHF RFID Tags in Arctic Environment"* (Vol. 2).

EQUIPMENT	$450-$4000

RFID tags have started to get less expensive although far from being at a reasonable price. We also have to keep in mind the return of investment as it is an important part of any application.

A. RFID Tags

Selection of equipment is based of several factors such as – type of surface, read range, size, environmental conditions and method of attachment. Price – $0.13 - $25

B. Antennas

Read Range, orientation of tag to antenna, environmental condition and size limitation. IP Rating – Indoor 54 while outdoor 66-67, Polarization, Connector type, price - $100-$1000

C. Reader RFID

Fixed Reader – Require ethernet cable to send & receive data, WIFI RFID reader communicate over secure wireless network which could be a possible option. Power – Fixed (AC Power) Read Range – 10-30 meters, with ability to withstand extreme weather conditions. Ratio of tags to antenna distance should be specified. Speed of

RESULTS & LIMITATIONS

Practical working model and integration of blockchain with IoT is underway. Equipment also needs to be acquired for experimentation. Table 2 gives us a representation of the relationship between power level and frequency. We can infer from that, in ice condition the RFID tag's threshold power reduces at various frequencies. Thus, reduction in power led to reduction in signal strength. This direct relationship between signal strength (RSSI) and Power helps us understand the application of RFID tags for preventing road accidents by keeping a database of power level reduction and based on that identifying at what level does the road conditions needs attention.

CONCLUSION

Preventing and ensuring safety of roadways have always evolved over a period of time and with new advancements we can reduce the percentage of accidents even further. For prevention of black ice, early detection of it gets a lot more important so as to anticipate its formation and alerting the drivers

regarding it. Through experiment we proved that RSSI value reduction occurs due to formation of a layer of ice over the tags this data can be integrated through blockchain and internet of things for better alerting system on road.

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