ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Issue 2, February 2016

Variations in the read-range of RFID with soils

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Abstract— ***RFID stands for Radio Frequency Identification. The main goal of an RFID system is to carry data on a transponder (tag) that can be retrieved with a transceiver through a wireless connection. The ability to access information through a non line-of-sight storage in a tag can be utilized for the identification of goods, locations, animals, and even people. Radio frequency identification (RFID) is a rapidly growing technology that has the potential to make great economic impacts on many industries. While RFID is a relatively old technology, more recent advancements in chip manufacturing technology are making RFID practical for new applications and settings, particularly consumer item level tagging. These advancements have the potential to revolutionize supply-chain management, inventory control, and logistics. . In the proposed work the average read-range for tag 1 is 118.18 mm, for tag 2 is 100.9 and for tag 3 is 137.4 mm for the setup with no soil layer in between RFID tag & reader, at room temperature and maintained humidity (35% RH).***

Keywords- RFID, TAGS, ALLUVIAL SOIL, DUNE SOIL

I. INTRODUCTION

RFID was first invented in 1948 and has subsequently undergone several developmental. stages. In the 1950s, the explorations of RFID technology were confined to laboratory experiments while the development of theory and field trials with RFID took place in the 1960s. The next decade saw an explosion in the development and testing of RFID technology. The commercial applications of RFID started in the 1980s, but in the 1990s, RFID became more widely deployed. RFID technology is increasingly utilized to identify and track items and people via an automated passive process that uses the tags. RFID technology is already used in several consumer applications. Commuters around the world use RFID tags to automatically pay for public transport and tolls without waiting in line for a teller.

At its most basic, RFID systems consist of small transponders, or tags, attached to physical objects. RFID tags may soon become the most pervasive microchip in history. When wirelessly interrogated by RFID transceivers, or readers, tags respond with some identifying information that may be associated with arbitrary data records. Thus, RFID systems are one type of automatic identification system, similar to optical bar codes.

There are many kinds of RFID systems used in different applications and settings. These systems have different power sources, operating frequencies, and functionalities. The properties and regulatory restrictions of a particular RFID system will determine its manufacturing costs, physical specifications, and performance. Some of the most familiar RFID applications are item-level tagging with electronic product codes, proximity cards for physical access control, and contact-less payment systems. Many more applications will become economical in the coming years.

While RFID adoption yields many efficiency benefits, it still faces several hurdles. Besides the typical implementation challenges faced in any information technology system and economic barriers, there are major concerns over security and privacy in RFID systems. Without proper protection, RFID systems could create new threats to both corporate security and personal privacy.

RFID systems have been used quite extensively for various types of applications which involve tracking, identification, access management, etc. These applications have to interface with different RFID hardware devices-readers and tags, to get data. RFID devices have different connection-interfaces to connect to the system. Different tags and readers use different protocols to communicate often in different frequency ranges. The porting of an application becomes very difficult when it is migrated from one hardware to another. This poses a great hindrance to wide adoption of RFID in small and medium enterprises as the cost of porting becomes very high.

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There are a large number of parameters of the RFID hardware which have to be configured before they can be used efficiently. These parameters include various kinds of antennae to be used, the power level, the communication parameters, etc. To configure these parameters, the application has to be aware of the RFID device it is using.

An application also has to apply different logical rules to infuse intelligence into the system. It has to actually process the data and present the data to the end-consumer in an understandable manner.

All these requirements from an application put a huge cost to develop RFID based applications in terms of knowledge and time. There is a need to separate out the hardware related processing and configuration from the application level processing and presentation. This will lead to effort being channelized to the development of applications with sound business logic and efficient processing and presentation. It will also lead to easier and faster development of RFID based applications.

RFID and barcodes

Although it is often thought that RFID and barcodes are competitive technologies, they are in fact complementary in some aspects. The primary element of differentiation between the two is that RFID does not require line-of-sight technology. Barcodes must be scanned at specific orientations to establish line-of-sight, such as an item in a grocery store, and RFID tags need only be within range of a reader to be read or 'scanned.' Although RFID and barcode technologies offer similar solutions, there are significant advantages to using RFID:

- Tags can be read rapidly in bulk to provide a nearly simultaneous reading of contents, such as items in a stockroom or in a container.
- Tags can be read in no-line-of-sight conditions (e.g. inside packaging or pallet).
- Tags are more durable than barcodes and can withstand chemical and heat environments that would destroy traditional barcode labels. Barcode technology does not work if the label is damaged.
- Tags can potentially contain a greater amount of data compared to barcodes, which commonly contain only static information such as the manufacturer and product identification. Therefore tags can be used to uniquely identify an object.
- Tags do not require any human intervention for data transmission.
- Changing the data is possible on some RFID tags.

It is easy to see how RFID has become indispensable for a wide range of automated data collection and identification applications. The distinct advantages of RFID technology, however, introduce an inevitably higher cost. RFID and barcode technologies will continue to coexist in response to diverse market needs. RFID, however, will continue to expand in markets for which barcode or similar optical technologies are not as efficient.

Evolution of RFID

The origins of RFID technology lie in the 19th century when luminaries of that era made great scientific advances in electromagnetism. Of particular relevance to RFID is Michael Faraday's discovery of electronic inductance, James Clerk Maxwell's formulation of equations describing electromagnetism, and Heinrich Rudolf Hertz's experiments validating Faraday and Maxwell's predictions. Their discoveries laid the foundation for modern radio communications.

Precursors to automatic radio frequency identification systems were automatic object *detection* systems. One of the earliest patents for such a system was a radio transmitter for object detection system designed by John Logie Baird in 1926 . More well known is Robert Watson-Watt's 1935 patent for a "Radio Detection and Ranging" system, or RADAR. The passive communication technology often used in RFID was first presented in Henry Stockman's seminal paper "Communication by Means of Reflected Power" in 1948 .

One of the first applications of a radio frequency identification system was in "Identify Friend or Foe" (IFF) systems deployed by the British Royal Air Force during World War II. IFF allowed radar operators and pilots to automatically distinguish friendly aircraft from enemies via RF signals. IFF systems helped prevent "friendly fire" incidents and aided in intercepting enemy aircraft. Advanced IFF systems are used today in aircraft and munitions, although much of the technology remains classified.

II. *EXPERIMENT SETUP AND COMPONENTS*

RFID Reader – RS-232: The rhydoLABZ RFID reader reads EM4100 family transponder tags that are brought in proximity to the reader and output the unique tag identification number through serial port @9600 bps. The reader output 12 byte including one start, stop byte and 10 unique data byte. The start byte and stop byte are used to easily identify that a correct string has been received from the reader. The middle ten bytes are the actual tag's unique ID. Vertical and horizontal parity checking has been done in

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card reading algorithm to ensure data integrity. One status LED is provided to indicate card detection. The normal detection range is 10-15cm for Card Type TAGs. The RFID Reader (as well as the RFID tags sold by rhydoLABZ) uses the EM4102 protocol. Any other tags that also use the EM4102 protocol can be used with the rhydoLABZ RFID reader.

Fig.1 FID Tags

When the RFID Card Reader is powered, the module will be in active mode and the current consumption of the module will increase. A visual indication of the state of the RFID Card Reader is given with the on-board LED's. When the module is successfully powered-up, the Green LED (PWR) will be ON. When the module is in an active state and the antenna is transmitting, the Red LED (STS) will be blinking.

The face of the RFID tag should be held parallel to the front or back face of the antenna (where the majority of RF energy is focused). If the tag is held sideways (perpendicular to the antenna) you may have difficulty getting the tag to be read. Only one transponder tag should be held up to the antenna at any time. The use of multiple tags at one time will cause tag collisions and confuse the reader. Actual distance may vary slightly depending on the size of the transponder tag and environmental conditions of the application.

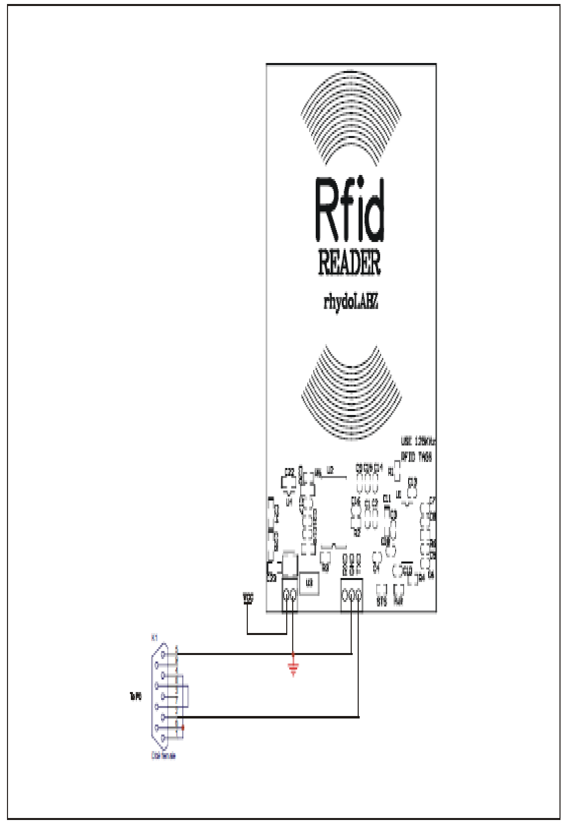

Fig.2 serial port connection for RFID reader with pc

- **<u>Components Used</u>**

a. Digital Hygrometer

Digital hygrometers measure both humidity and temperature to give you an idea of the relative humidity. Relative humidity is a value that communicates more accurately how hot or cold you "feel," rather than the exact heat or coldness of the air. Homes, offices, museums, factories, and greenhouses can all use small, handheld digital hygrometers to monitor their environments.

b. Digital Vernier Caliper

The Digital Caliper (sometimes incorrectly called the Digital Vernier Caliper) is a precision instrument that can be used to measure internal and external distances extremely accurately. The example shown below is a digital caliper as the distances/measurements, are read from a LCD display. The most important parts have been labeled.

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c. Heating Rod

A **heating element** converts electricity into heat through the process of Joule heating. Electric current through the element encounters resistance, resulting in heating of the element. Most heating elements use Nichrome 80/20 (80% nickel, 20% chromium) wire, ribbon, or strip. Nichrome 80/20 is an ideal material, because it has relatively high resistance and forms an adherent layer of chromium oxide when it is heated for the first time. Material beneath this layer will not oxidize, preventing the wire from breaking or burning out.

d. Temperature Controller

As the name implies, temperature controller is an instrument used to control temperature. The temperature controller takes an input from a temperature sensor and has an output that is connected to a control element such as a heater or fan. To accurately control process temperature without extensive operator involvement, a temperature control system relies upon a controller, which accepts a temperature sensor such as a thermocouple or RTD as input. It compares the actual temperature to the desired control temperature, or setpoint, and provides an output to a control element.

- **Types of Soil used**

While one-quarter to one-third of the world's deserts are covered with sand, little research has taken place in ergs (sand-covered desert areas) relative to non-sandy areas. The great distances and hardships involved in reaching sandy areas, the general lack of wind data and other meteorological records, the almost total lack of human activity in ergs, and the difficulty of getting a macro-scale view of sand seas from the surface have all contributed to the lack of knowledge of the movement and accumulation of sand in deserts.

A **sand dune** is a mount, hill or ridge of sand that lies behind the part of the beach affected by tides. They are formed over many years when windblown sand is trapped by beach grass or other stationary objects. Dune grasses anchor the dunes with their roots, holding them temporarily in place, while their leaves trap sand promoting dune expansion. Without vegetation, wind and waves regularly change the form and location of dunes. Dunes are not permanent structures. Sand dunes provide sand storage and supply for adjacent beaches. They also protect inland areas from storm surges, hurricanes, flood-water, and wind and wave action that can damage property. Sand dunes support an array of organisms by providing nesting habitat for coastal bird species including migratory birds. Sand dunes are also habitat for coastal plants. The Seabrook dunes are home to 141 species of plants, including nine rare, threatened and endangered species. Construction of beachfront homes and hotels can encroach on sand dune habitat. Increased tourism, foot traffic, and removal of plant species can cause severe erosion. Beach litter is aesthetically unpleasing, and can be harmful to shorebirds and other animals.

1. **Dune Soil:** These are accumulation of fresh sand blown by the wind. In stabilized sand dune, there is a slight evidence of some illuviation, since the line content in the soil increases with depth and Calcium Carbonate concentration in increasing numbers are seen in 3 – 4 meters depth.

2. **Alluvial soil :** There are three parallel belts widely apart from Forest and Hill soils, one stretching from Poonch to Kathua in Jammu province second North West of Jhelum valley in Kashmir province and the third belt stretching from south eastern part of Ladakh range. The soils are generally mixed with pebbles. In southern part of Udhampur and Doda district brown soil under Deciduous Forest are found. Colour of the soil is dark-brown and varies from dry loams to silt loams with gravels in a small percentage. In middle Ladakh range two isolated patches (one in Ladakh and another in Doda district) of Podzolised soil occur over a long stretch. In Poonch, Udhampur and Anantnag district sub-mountain soils are mainly found. In the valley this soil is cultivated intensively and rice is the main crop.

III. EXPERIMENT AND IMPLEMENTATION

In the present work objective is to map the variations in the read-range of RFID system gets affected due to the presence of two types of soil and their different grain size in between RFID tag & reader. With varying soil layer thickness from 0 mm to 90 mm.

In the objective 1, the variation in the read-range of the RFID system has been observed in presence of 5 different types of soils (Pali, Binawas, Hariom Sagar, Dune, Jalor) with different gain sizes (3 types– .450 mm, 1.18 mm, 2 mm) by applying variable soil layer thickness from 0 mm to 90 mm in between the RFID tag and the reader, at maintained room temperature value and humidity (35% RH) inside the glass chamber.

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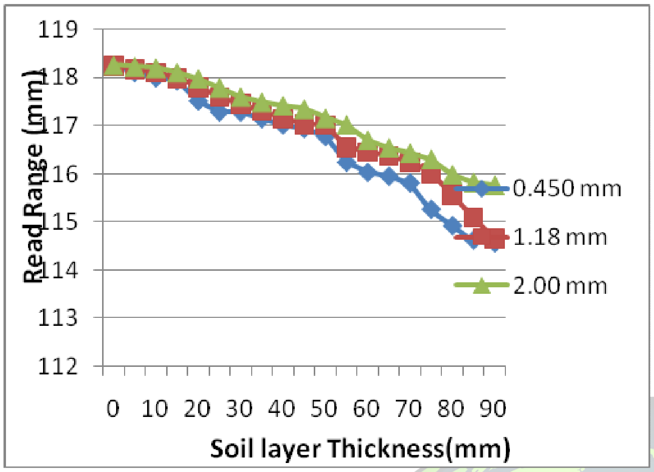

Fig.3 - Dune Soil, Tag 1

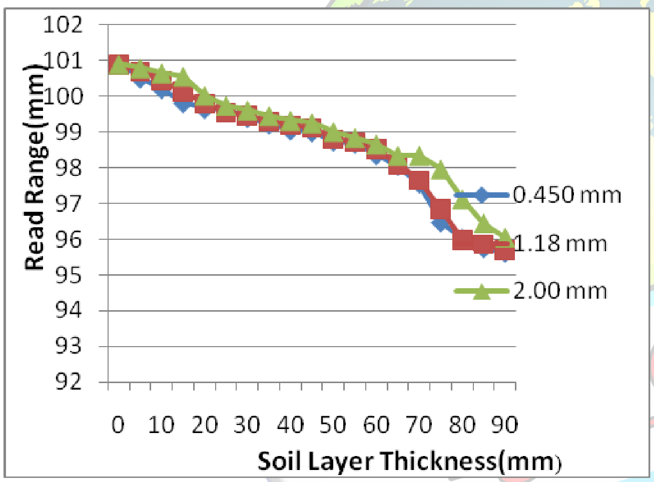

Fig.4 - Dune Soil, Tag 2

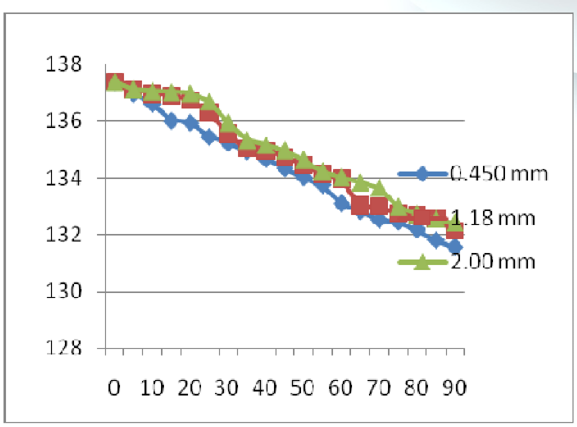

Fig.5 - Dune Soil, Tag 3

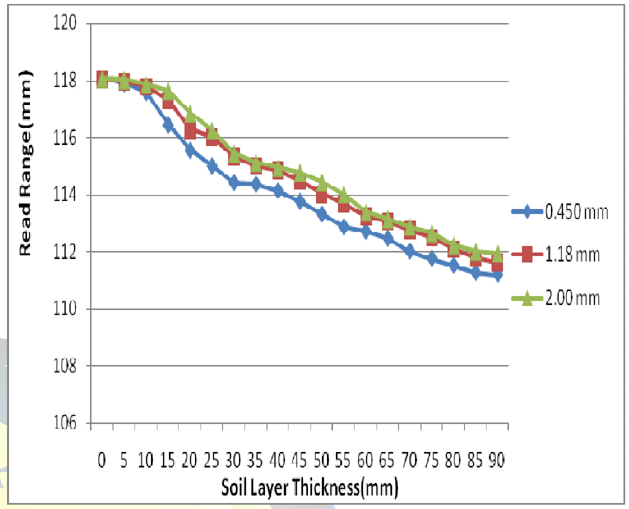

Fig.6 **Alluvial soil**, Tag 1

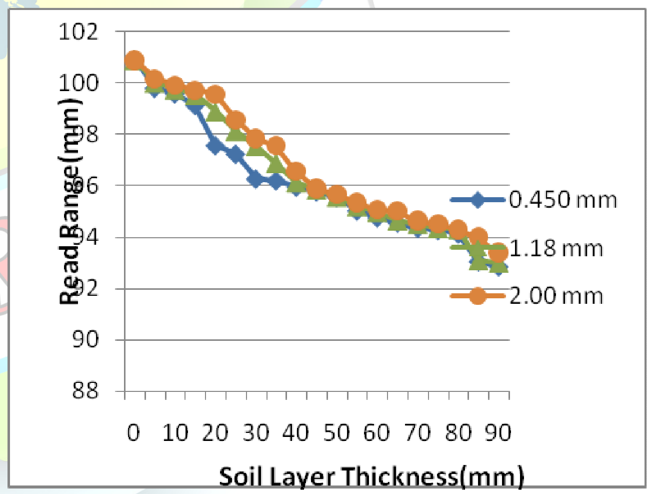

Fig.7 - Alluvial soil, Tag 2

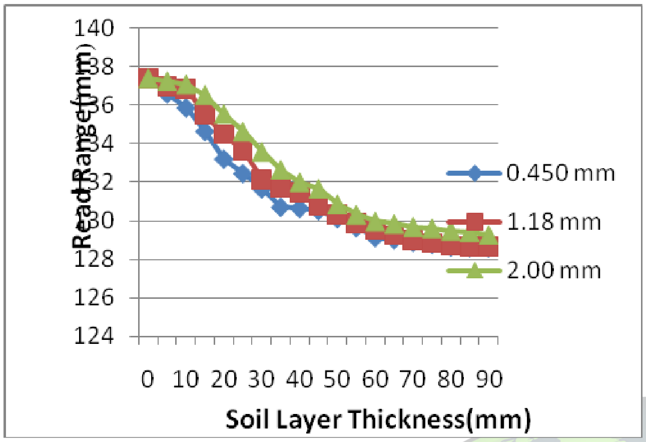

Fig.8 Alluvial soil, Tag 3

From figure 3 to figure 5, for the Dune soil it has been observed that the read-range for each grain size (0.45 mm, 1.18 mm and 2.0 mm) of tag3 is highest than that of tag 1 and least for the tag 2 and % detectability is achieved by tag 1.

From figure 6 to figure 8, for the Alluvial soil, it has been observed that the highest read-range for each grain size (0.45 mm, 1.18 mm and 2.0 mm) is of tag3 than that of tag 1 and least for the tag 2.

IV. Conclusion

In a typical RFID system, RFID tags are attached to objects, which will identify themselves when detecting a signal from a RFID reader by emitting a radio frequency transmission. An RFID middleware, located between readers and RFID applications, manages the flow of information from a multitude of readers to RFID applications. An RFID middleware collects tags data from readers and passes on only relevant information to the RFID applications. RFID application performs business logic by using collected information from the RFID middleware. In the proposed work the average read-range for tag 1 is 118.18 mm, for tag 2 is 100.9 and for tag 3 is 137.4 mm for the setup with no soil layer in between RFID tag & reader, at room temperature and maintained humidity (35% RH).

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ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

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Vol. 3, Issue 2, February 2016

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