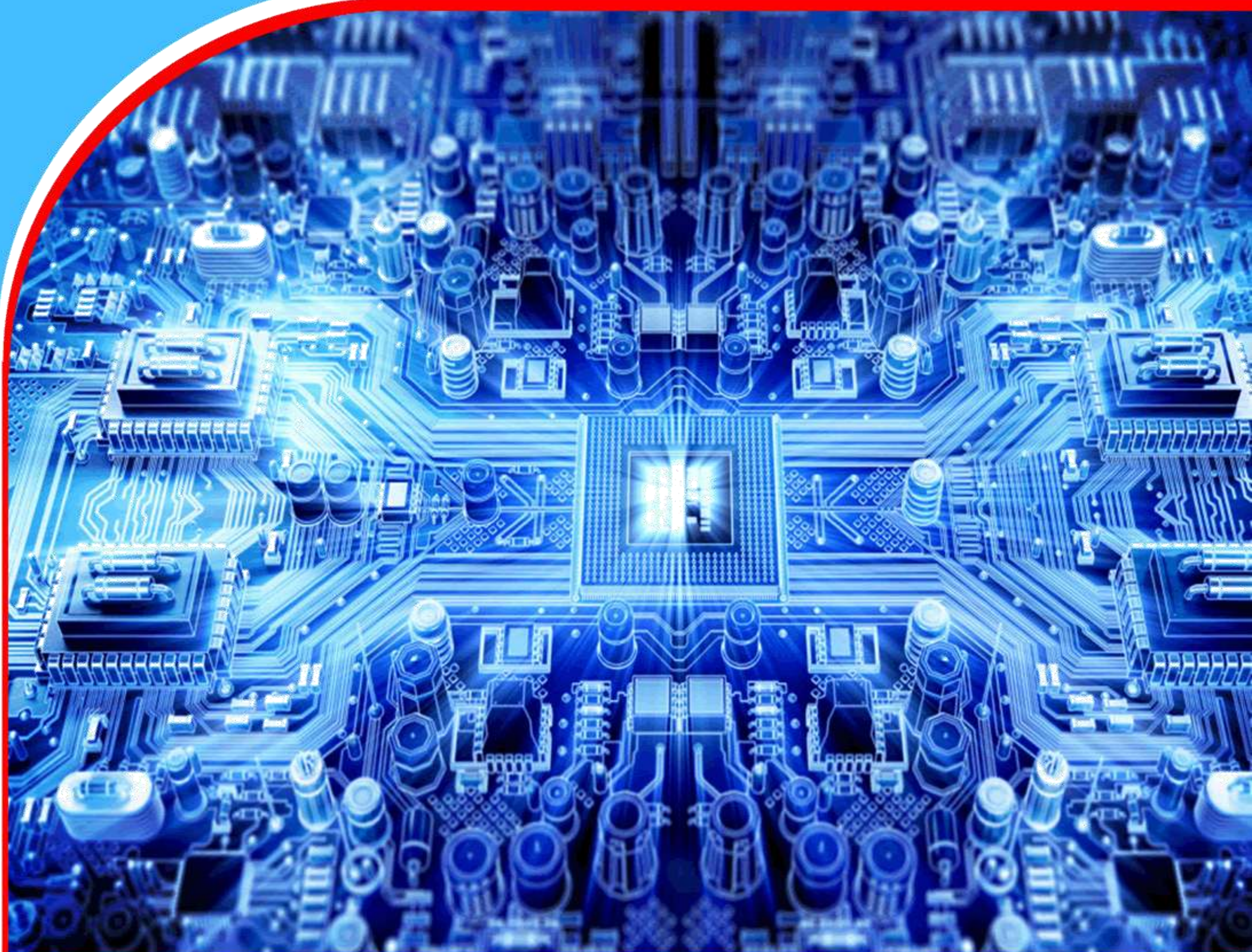
American Journal of
Computing and Engineering
(AJCE)



E-disease monitoring using radio frequency identification sensor link technology (RFID-SLT) to improve public health information system in Nigeria

Otagburuagu Obinna Richard and Ogbonnaya Irukwu Joe

AJPO

American Journal of Computing and Engineering
ISSN 2790-5586 (Online)
Vol.5, Issue 1, pp 58- 78, 2022
www.ajpojournals.org

E-disease monitoring using radio frequency identification sensor link technology (RFID-SLT) to improve public health information system in Nigeria

Otagburuagu Obinna Richard[1*], Ogbonnaya Irukwu Joe[2]

[1,2]Department of Electrical and Electronics Engineering, Abia State Polytechnic Aba, P.M.B 7166, Abia state Nigeria

[*]Corresponding Author's Email: richard.obichi@gmail.com

Abstract

Disease detection and monitoring using electronic means called E-disease monitoring cannot be over emphasized. This work goes to the in depth of how infected specimens can be tracked using radio frequency waves, and also how sensed information can be transmitted using sensor tags. The present study also demonstrates the algorithm for the process of RFID-SLT by applying the Radio Frequency Identification (RFID) sensor system designed in Matlab/simulink with sensor-tags in order to indicate how communication is carried out throughout the system. Comparisons were carried out to show the performance of the system with and without the RFID sensor links. The results obtained shows that RFID-SLT can detect certain human body vitals to be able to detect infected specimen at any tag range and the data obtained transmitted to a host network via node tags.

Keywords: *E-disease*, *RFID-SLT*, *sensor tags*, *tag range*, *tag sensitivity.*

1.0 Introduction

E-disease (Electronic disease) is simply the application of electronic means of detection, monitoring and data transfer to the surveillance of infectious diseases. The world today has outgrown the possibility of detection and monitoring of infectious diseases by traditional means. Monitoring Disease detection and monitoring is a leading threat to public health, economic stability, and other key social structures. Efforts to mitigate these impacts depend on accurate and timely monitoring to measure the risk and progress of disease. Traditional, biologically-focused monitoring techniques are accurate but costly and slow; in response, new techniques based on social internet data, such as social media and search queries, are emerging. These efforts are promising, but important challenges in the areas of scientific peer review, breadth of diseases and countries, such as Nigeria. Diseases detection and monitoring in such populated country and forecasting hamper their operational usefulness (Soumen and Polash, 2015).

Electronic application to surveillance of infectious disease can incorporates the use of electromagnetic or electrostatic coupling in the radio frequency portion of the electromagnetic spectrum to uniquely identify an object, animal or person possessing the said symptoms of the infectious disease.

Healthcare technology has developed rapidly in recent years and innovations in remote monitoring are gaining more attention towards those systems that are capable of early identification of the deteriorating patient (Soumen and Polash, 2015). Electronic disease monitoring using (RFID-SLTT) is capable of obtaining continuous accurate monitoring of vital signs and a range of other human body properties, which includes body temperature, coughing pressure, breathing rate, high fever, This can be achieved with radio wave devices that are able to generate radio frequency. Radio-frequency identification sensors (RFIDS) use electromagnetic fields to automatically identify and track tags attached to objects, humans. An RFID system consists of a tiny radio transponder, a radio receiver and transmitter. When triggered by an electromagnetic interrogation pulse from a nearby RFID reader device, the tag transmits digital data, usually an identifying inventory number, back to the reader. This number can be used to track symptoms of infectious diseases in humans if these symptoms are tagged.

Current so many technological advances in remote disease monitoring can record symptoms and observations related to varying physical phenomena. Continuous monitoring of human vital signs such as heart rate, pulse rate, breathing rates and patient movements could act as important symptoms indicators for early detection of diseases (Ritu et al., 2012). Alterations in any of these parameters could be used to predict serious symptoms events [5]. Installation of RFID sensors at entrance of important centers such as hospitals, airports, institutions will definitely help monitor the identified symptoms. Other recent technologies on Internet of Things (IoT), including Heterogeneous Brain Storming (HBS) for object recognition tasks (Kamran et al., 2010), also have great potential to advance remote disease monitoring.

There are known benefits to using radio frequency identification (RFID) technology in healthcare asset tracking and predicting future events with machine learning tools by analyzing RFID tag data (Soumen and Polash, 2015). These techniques can also be used for direct patient care by providing alerts to indicate potential human errors in managing patients such as misidentification of patients and medication (Lei Kang et al., 2012). However, traditional RFID systems are intrusive and need dedicated sensors to be attached and can cause considerable inconvenience in psychiatric clinical care. Recent innovations have employed this technology to detect vital signs without making contact with the patient using techniques such as near-field coherent sensing of signal generated from the antenna of the RFID tag, however, little is known about how these methods can be used monitor vital signs of incoming individuals into a highly sensitive location. There are formidable challenges with integrating this type of technology into a certain settings and location, such as where best to deploy equipments for t not to interfere with routine individual incoming appearance or locations where it won't interfere with other incoming signal to avoid jam.

1.1 RFID Technology

RFID technology consists of Reader and Tag (Jin Li and Cheng Tao, 2006). A reader transmits information to a tag by modulating an RF signal in the 860 MHZ – 960 MHz frequency range. The tag receives this RF signal. A reader receives information from a tag by transmitting a continuous wave RF signal to the tag (Soumen and Polash, 2015). It deals with air interface communication format and data exchange protocols. It mainly addresses the tag reader communication, which includes physical characteristics of the radio communication, structure of commands and responses and an anti-collision algorithm in multi tag environment (Lei Kang et al., 2012). Each RFID tag contains a unique identifier (id). Once a tag is affixed to a physical object, the id becomes a representation of that object (Kamran et al., 2010). Types of RFID tags: There are three general types of RFID tags, active, semi-active, and passive RFID tags.

1. Active tags: This type of RFID tag contains an internal battery which is used to let the tag perform more complex operations, such as monitor temperature, as well as boost the communication with an RFID reader. The communication range of an active tag can be over 100 meters. It has longer read range (300 feet). An active tag is the most powerful type of RFID tag, and is also the most expensive.

2. Semi-active tags: This type of tag also contains an internal battery, but unlike an active tag, the battery is only used for the tag's internal operations, and not for communication. a semi active RFID tag relies on RFID reader to supply the necessary power for communication. It has longer read range (300 feet). Note that semi-active tags are sometimes known as semi-passive tags.

3. Passive tags: This type of RFID tag have the lowest cost (pennies per tag), and unsurprisingly, are the most prevalent type of RFID tags. A passive tag has no internal batteries, and relies on the RFID reader to supply the power needed to perform all tag operations and communication. It has shorter read ranges (4 inches to 15 feet). In the rest of this work, our focus is on this type of tags.

4. Communication range: The conventional range of the tag can range from several centimeters, for RFID tags operating in the 13.56 Hz, to over a dozen meters for RFID tags operating in the 902-928 MHz's Due to the physical characteristics of the reader and tag, the signal being passed from the reader to the tag is stronger than that from the tag to the reader. This means that for certain operations like eavesdropping, it will be easier to hear the RFID reader's commands than it is for the tag's response (Soumen and Polash, 2015).

5. RFID advantages over barcodes: No line of sight required for reading, multiple items can be read with a single scan; each tag can carry a lot of data (read/write).With the help of RFID individual items identified and not just the category. Passive tags have a virtually unlimited lifetime; active tags can be read from great distances. It can be combined with barcode technology.

1.2 RF sensor components

The components used in RF front communication in consumer electronics devices are

- Receivers
- Transmitters
- Filters
- Power amplifiers
- Duplexers
- Antenna switches
- Demodulators
- Sensors

Receivers: these components are designed to receive radio frequency signals from other devices, i.e body vital signals

Transmitters: these is the generator of the radio frequency current which is delivered to the antenna switches

Filters: these are circuits that allow the right signals to pass while they cancel out undesired signals, they include; high pass and low pass filters

Power amplifiers: these is an electronic circuit that converts a low power radio frequency signal into a high power signal, the RF power amplifier drives the antenna of the transmitter.

RF antennas: these are specialized transducers that converts radio frequency (RF) fields into alternating currents or vice versa.

Demodulators: the RF demodulator strips data the encoded data by creating amplitude and phase components of the signal.

RF Sensors: these are devices that are measure signals by four different parameters: the real and imaginary part of electrical permittivity and magnetic susceptibility.

RF Duplexers: these are electronic devices use in RF communication transceivers to allow sharing of the same antenna. This is important because transmitter are high power large signal devices, and receivers are extremely sensitive small signal; devices.

2.0 Materials and methods

2.1 Proposed model of RFID-SLT based data acquisition system

We want to make a simple system where tag will collect the data from the real world and send the collected data to the Receiver/reader. The acquired data after encoding and modulating is sent to the receiver/reader, for the case of covid-19 symptoms. We have used here a temperature sensor. After conditioning the output it is digitized by analog to digital converter in the transmitter end and this digitized output is sent through the tag to reader after tag receiver/reader communication is established. The basic block diagram of proposed model is shown in Figure 1. In this block diagram there is a Sensor Array by which physical parameter like temperature is sensed then it is modified by signal conditioning unit and after processing the data using microcontroller it is sent to tag using SPI (Serial Peripheral Interface) or I²C (Inter-Integrated Circuit) protocol (Shiva et al., 2015). Both protocols are well-suited for communications between integrated circuits. The programmable tag contains memory to store the data and program. Then tag data is sent to the reader after authentication and communication is established. The collected data is stored in the server or hard drive.

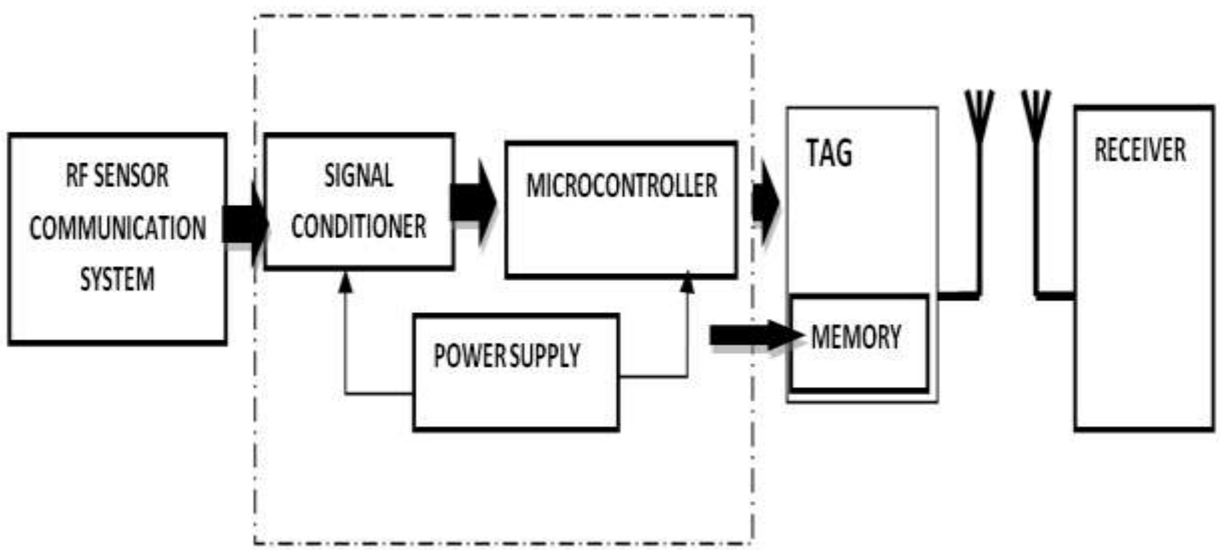


Figure 1: Schematic diagram of proposed RFID based data Acquisition.

A single channel data acquisition system consists of a signal conditioner followed by an analog to digital converter, performing repetitive conversions at a free running, internally determined rate (Shiva et al.,2015). The outputs are in digital code words including over range indication, polarity information and a status output to indicate when the output digits are valid. In the proposed system reader is connected to the computer and also with LCD for displaying the result.

2.2 Tag Performance Characteristics

There are several tag performance characteristics described hereinafter. Some of them are important for forward link (reader-to-tag), while others are important for the return link (tag-to-reader). Some of the tag characteristics (such as tag sensitivity or backscatter efficiency) depend only on the tag, while others (such as read range and backscatter range) depend also on the reader and the environment. All of these characteristics can be measured as functions of frequency in different scenarios (e.g., for tag in different orientations, on various materials, etc.). Important forward-link tag characteristics are as follows:

- Tag sensitivity;
- Tag range.

Tag sensitivity is the minimum incident power (signal strength) at the tag location needed to either read or write the tag. Tag range is the maximum distance at which the tag can be read or written in free space. It is an easily understandable, directly measurable, and thus commonly used tag performance characteristic. In passive UHF RFID systems, the maximum range is currently limited by the forward link, and thus, the tag range is the same as the forward range. In a fixed-distance testing setup, the fundamental measured quantity from which both of these characteristics are calculated is the measured minimum power $\boldsymbol{S_{min}}$ needed to read or write to the tag. Other quantities (such as field sensitivity, etc.) can be easily calculated from this measurement. Both of these characteristics can be defined either for read or write operation. Write sensitivity differs from read sensitivity, typically by about 3 dB, because RFID IC needs more power for performing write operation. Accordingly, read and write ranges differ as well by about 30%. In this paper, we concentrate on measuring read sensitivity and read range

Tag sensitivity S_{tag} and range r_{tag} in free space are related as

$$\boldsymbol{S_{tag} = EIRP\left(\frac{\lambda}{4\pi r_{tag}}\right)^2} \quad (1)$$

Where $\lambda$the wavelength and EIRP is is the equivalent isotropic power radiated power by the reader. In a fixed distance free-space testing setup, tag sensitivity and range can be calculated from the measured minimum power S_{min} as

$$S_{tag} = S_{min}T_g\left(\frac{\lambda}{4\pi d}\right)^2 \quad (2)$$

$$r_{tag} = \sqrt[d]{\frac{EIRP}{S_{min}T_g}} \quad (3)$$

Where d is the distance to the tag and $\boldsymbol{T_g}$ is the gain of the transmitting reader antenna.

The relation of backscatter efficiency E_b and backscatter range $\boldsymbol{r_{bs}}$ is given by

$$P_{reader} = P_tT_g^2\left(\frac{\lambda}{\boldsymbol{4\pi r_{bs}}}\right)^4 E_b \quad (4)$$

Where P_{reader} is the receive sensitivity of the reader and P_t is the output power of the reader (Shiva et al., 2015). Another quantity often used for characterization of the tag backscatter is the differential radar cross section $\Delta\sigma$ (Nikitin et al., 2007) (also known as delta RCS), which defines the power of the modulated backscattered signal. Backscatter efficiency and delta RCS are functions of incident power but can be uniquely defined for each tag at the power level where the incident power is equal to the tag sensitivity.

At this threshold power level, both of these characteristics, as well as the backscatter range, can be calculated from the measured minimum power $\boldsymbol{S_{min}}$ and corresponding received tag signal power $P_{received}$ as

$$\Delta\sigma = \frac{\lambda^2}{4\pi} E_b = \frac{P_{received}(4\pi)^3 d^4}{S_{min} T_g^2 \quad \lambda^2}$$

(5)

2.3 Algorithm for the RFID-SLT system using sensor-tag

This section presents an algorithm for RF monitoring system by applying RFID technology to demonstrate how human vital signals detected and how communication to the host application. Figure 2 shows the process of proposed algorithm

At the beginning, sensor-tags are placed in certain locations to detect abnormal temperature vitals in humans (specimen). Each sensor tag is able to send the unique ID number, which contains the location and sensed data to the reader. Besides, a memory is embedded in the tag with the intention of storing and retrieving information (Shiva et al., 2015). Whole commands are formed and transferred to the rest of process through host computer as shown in the algorithm. Then, the reader wakes up the corresponding tags while it transmits radio waves. The main advantage of aforementioned method is that no battery is required as a startup. So, there will not be any maintenance cost. A tag collects sensed information and combines them with its own information. It utilizes the radio wave to send the merged data back to the reader. In the current method, the number of readers and sensor tags depend on the application. In case of receiving data through reader, it is transferred to the computer for the rest of procedure. In order to detect failure, a threshold may be set up according to its special purpose. For instance, identification of temperature changes can be realized. Since sensed data rises higher than a predefined threshold, an alarm will be delivered to host application via a reader. The condition statement highlights whether data type indicates an abnormal rise in temperature. It then transfers categorized messages to host where various parameters are monitored (Shiva et al., 2015). In case of detected abnormal human temperatures, alarm arises in host application.

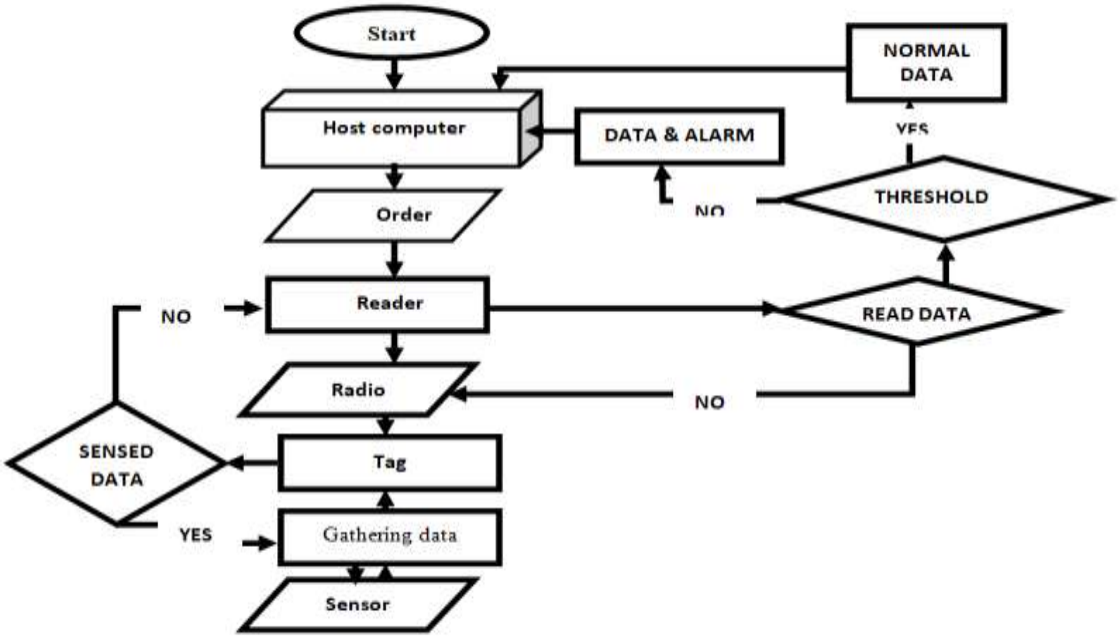


Figure 2: process of data (temperature) detection algorithm

2.4 MIMO RF SENSOR MODEL

To model the RF sensor system, a baseband beam forming algorithm is used. The model considers antenna coupling effects and RF imperfections. The simulation of the system-level model includes the RF receiver baseband beam forming algorithms, RF imperfections, and the antenna array radiation pattern. Figure 3(a) gives a schematic diagram of the RF sensor tag (Matlab/simulink, 2021).

In the following sections, you will see more details about the transmitter, receiver, and beam forming algorithm.

The schematic diagram of the RF SENSOR tag is shown in figure 3(a)

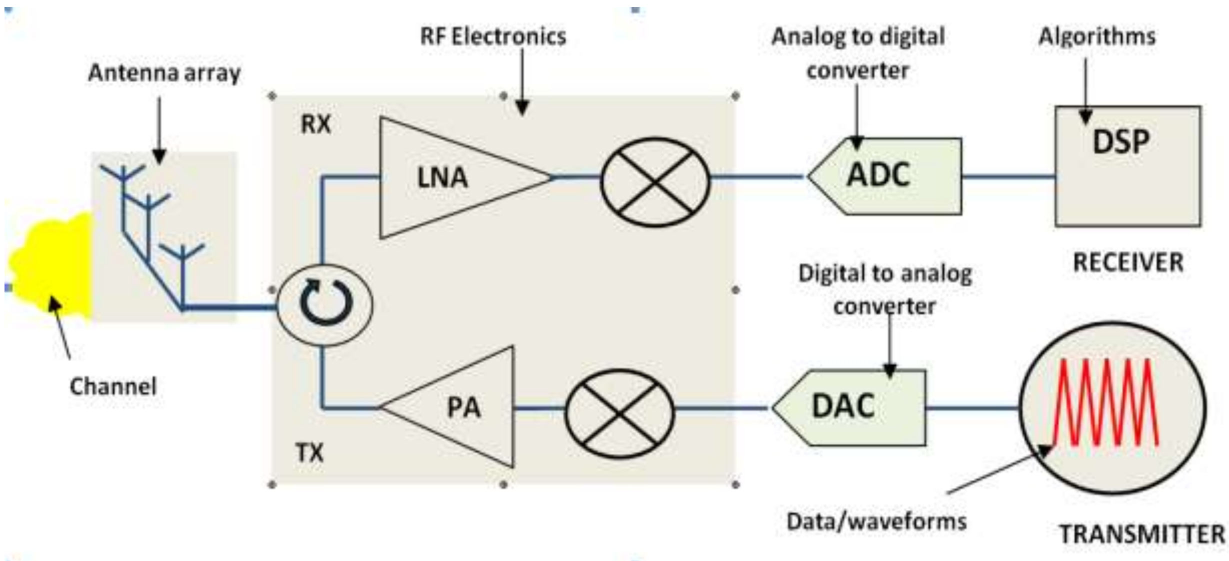


Figure 3(a): block diagram of the RF SENSOR system

The RFID_SL system can be simulated in Matlab simulink using the communication toolbox, the following assumptions are made about the system

Assumptions 1: The transmitter and channel models are ideal.

Assumptions 2: The transmitter constructs a simple modulated signal transmitted using a single antenna.

Assumptions 3: The channel model introduces path loss attenuation and adds an interfering narrowband signal with power level similar to the desired signal.

Assumptions 4: The model assumes that transmitter and receiver are positioned on the same plane. You can change the angle of arrival of the desired transmitted signal and of the interfering signal by turning the dials on the Simulink diagram.

Assumptions 5: An angle of 90 degrees indicates that the transmitter is in front of the receiver, where the main lobe of the antenna array radiation pattern is located.

Assumptions 6: An angle of 120 degrees indicates that the transmitter is 30 degrees away from the normal axis to the array, where a null of the radiation pattern is positioned.

Assumptions 7: Changing the relative angle of arrival for desired and interfering signals will change the relative signal powers in the Spectrum Analyzer scope "Spectrum without Beam forming.

The Matlab/simulink model describing the RF identification sensor with beam forming is shown in figure 3(b)

American Journal of Computing and Engineering
ISSN 2790-5586 (Online)
Vol.5, Issue 1, pp 58- 78, 2022

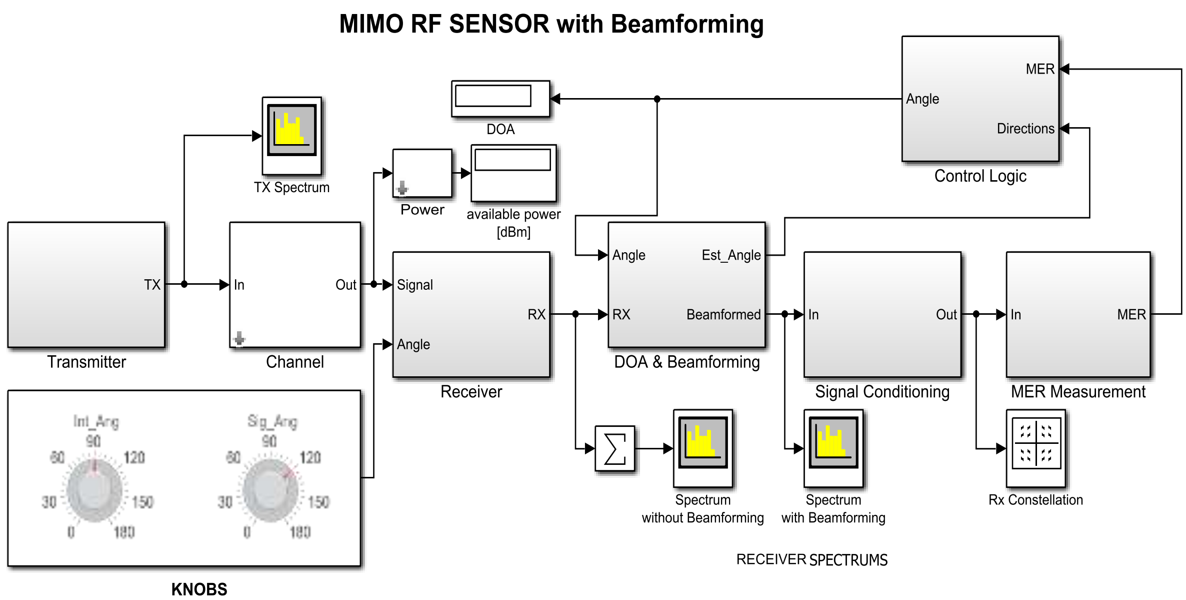


Figure 3(b): simulink model of RF identification sensor

2.5 Design the Receiver Antenna Array

The receiver antenna array is designed using Antenna Toolbox™ in Matlab/simulink. The Antenna Toolbox helps you design an antenna at the desired operating frequency and verify that the pattern superposition of the isolated element is an acceptable approximation for the array simulation (Matlab/simulink, 2021).

The antenna array consists of 8 dipole antennas resonating at 5 GHz. The comparison of the far-field radiation pattern of the array computed with full-wave analysis and pattern superposition of the isolated element shows modest differences:

However, the S-parameters show a non-negligible leakage between adjacent antennas.

RF Receiver

The receiver model includes:

- Model of receiver antenna array. The receiver antenna array is composed using 8 dipole antennas operating at 5 GHz. The array radiation pattern is modeled with Phased Array System Toolbox" Narrowband Rx array". The array is simulated using pattern superposition of the isolated element stored in the variable P_antenna, computed using Antenna Toolbox and the script. You can visualize the radiation pattern by clicking the **Analyze** button in the sensor array tab.
- Model of RF receiver. The RF receiver is composed with eight non-linear super heterodyne receivers and filters described with S-parameters. Each chain is designed with the RF Toolbox™ **RF Budget Analyzer** app as described in: RF Receiver Design example.

American Journal of Computing and Engineering
ISSN 2790-5586 (Online)
Vol.5, Issue 1, pp 58- 78, 2022
www.ajpojournals.org

- Antenna array impedance is described with the eight-port S-parameters computed using Antenna Toolbox. The S-parameters capture the loading of the antenna array on the RF receiver as well as the coupling between the antenna elements. A lumped inductance for each receiver is used to retune the respective antenna.
- Eight 12-bit ADCs capturing the finite dynamic range of the data converters by modeling saturation and quantization.

DOA & Beam forming

The baseband receiver algorithm consists of four main elements in a closed feedback loop.

- Root MUSIC algorithm to determine the Direction of Arrival assuming that two signals are present. The two estimated DOA angles are passed to a state machine that determines which angle produces the higher Modulation Error Ratio (MER). This state machine includes some time delay in between state transitions to avoid decision jitter (Matlab/simulink, 2021).
- MVDR Beam forming algorithm for the receiver to focus on the desired signal and suppress interference and noise from other directions. It uses the angle chosen by the Control Logic to maximize the MER.
- Signal Conditioning and estimation of the Modulation Error Ratio. The MER is used to determine which angle to select for the beam forming algorithm.

3.0 Results and Discussions

3.1 Sensitivity

The sensor sensitivity indicates how much an output quantity changes when an input quantity is measured, figure shows the rate of transmission of sensed body temperatures over a period of 60 minute to the host station, the spikes shows sensed abnormal temperature of the test specimen. Figure (4) gives a plot comparing the sensitivity of the of the RFID-SLT model and sensor A (without RFID-SLT)

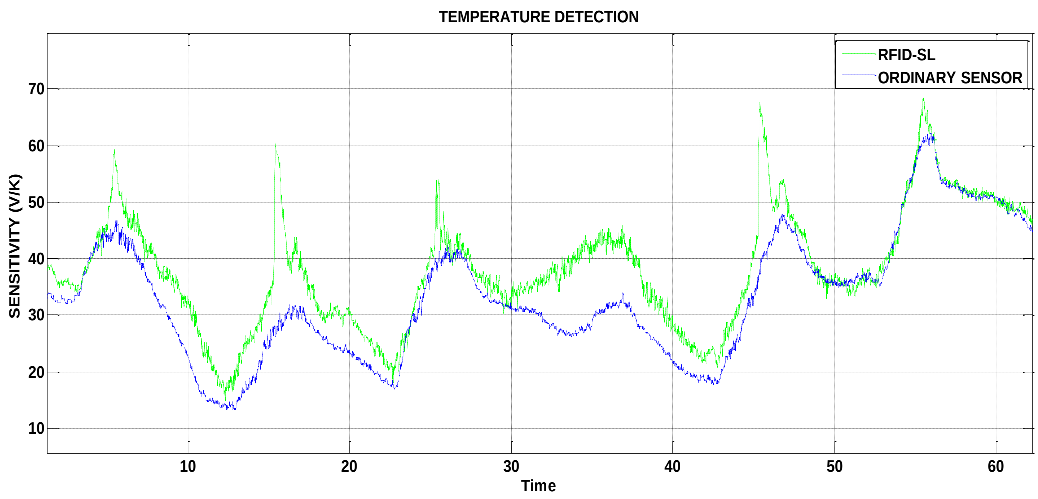


Figure 4: transmission sensitivity of network with and without RFID-SLT

American Journal of Computing and Engineering
ISSN 2790-5586 (Online)
Vol.5, Issue 1, pp 58- 78, 2022
www.ajpojournals.org

3.2 Data effect detection

the data effect detection describes the frequency response identification sensor process using the covid-19 symptom of high fever (temperature) as the data, from figure (5), at sensed temperature of 60°F showed by the red dot, temperature (data) is being detected and sent to the tag reader as indicated by the blue dot, the green dot shows information gathering, which is to be sent to the host computer and the event process continues as such.

Figure (5) shows the simulated event for duration of 60 minutes, from the plot the rise shows the points at which abnormal temperature surges are detected as shown in figure (6), from the figure the spike shows the abnormality in the transmission as a results of detected noise from the RF signal gathered during the simulation.

Figure (7) shows the receiver power spectrum and a rise in the spectrum power when a noise is detected by the sensor system.

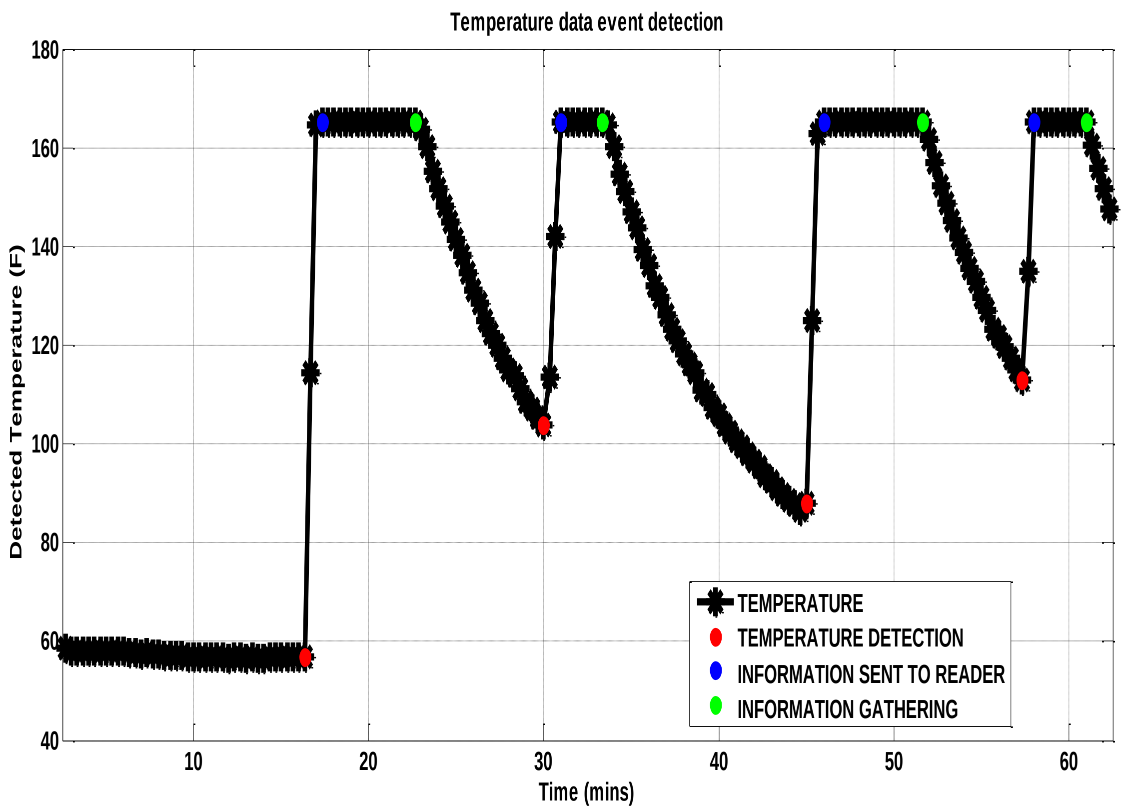


Figure 5: plot data event detection

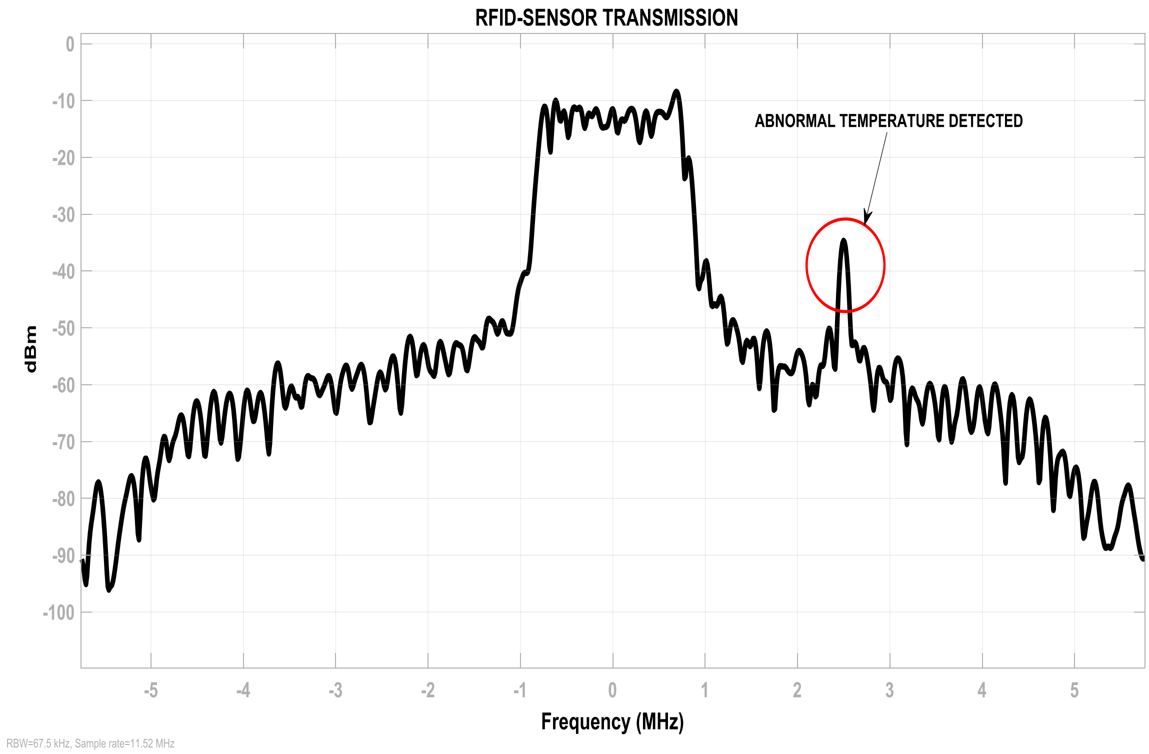


Figure 6: transmitter data transmission spectrum

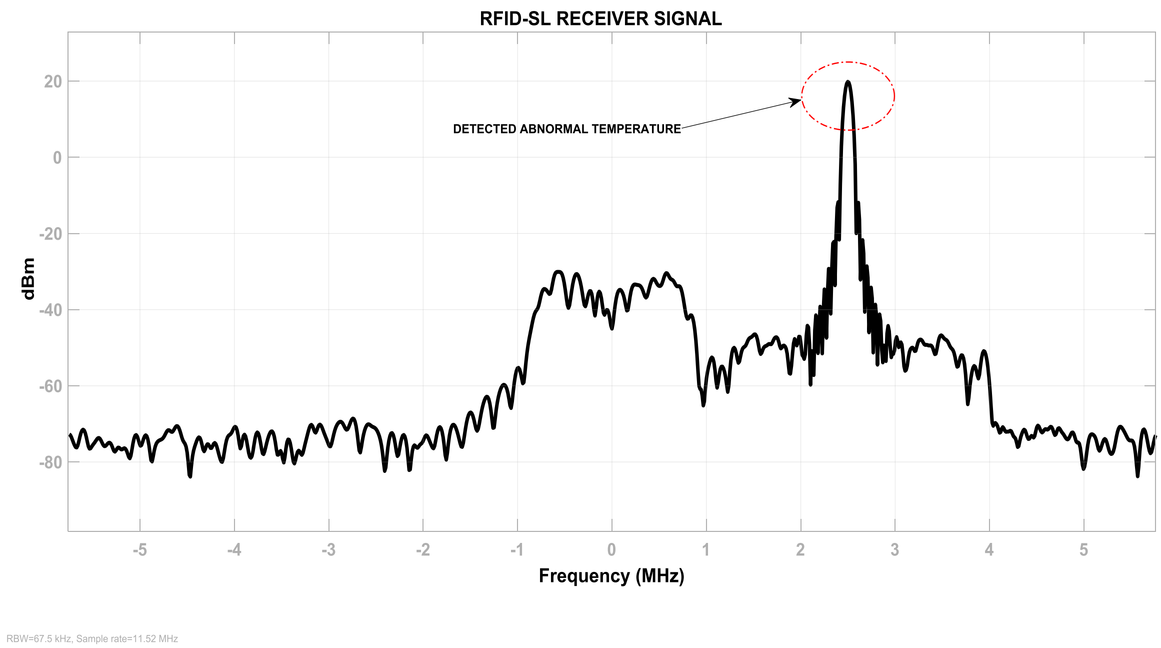


Figure 7: receiver data transmission spectrum

3.3 Tag Performance Characteristics

From The relationship between tag range and sensitivity given by (1), the plot of tag range and tag sensitivity for the RFID sensor and sensor A is shown in figure (8), where the reader transmits 4kW power in free space at 50 MHz The incident power (dB) at the tag location defines whether the tag will be powered up or not. That power can be interpreted as the power which would be absorbed by the RFID sensor device. If it was connected to a perfectly matched 0-dBi tag antenna, the tag range vs tag sensitivity comparison shows that the RFID sensor link detects the abnormal temperature of a specimen at a faster rate than sensor A, i.e, RFID sensor having a sensitivity of 10.8 dB at a tag range of 25m, while sensor A having the same tag sensitivity at a tag range of 28m as shown in table 1, from table 1, it can be seen that the tag sensitivity decreases with increase in tag range, at tag ranges of 25m and 30m, the tag sensitivity for sensor A becomes zero.

Table 1: table showing tag performances of sensor links with and without RFID at 50Hz

@FREQUENCY=50Hz	**SENSOR A (without RFID-SLT)**	**RFID-SLT**
TAG RANGE (m)	TAG SENSITIVITY (dB)	TAG SENSITIVITY (dB)
0	13.8	11.8
4	10.9	9.3
5	8.1	6.8
7	5.9	5
10	3.2	2.6
15	1.85	1.7
18	0.61	0.5
25	0.33	0
30	0	0

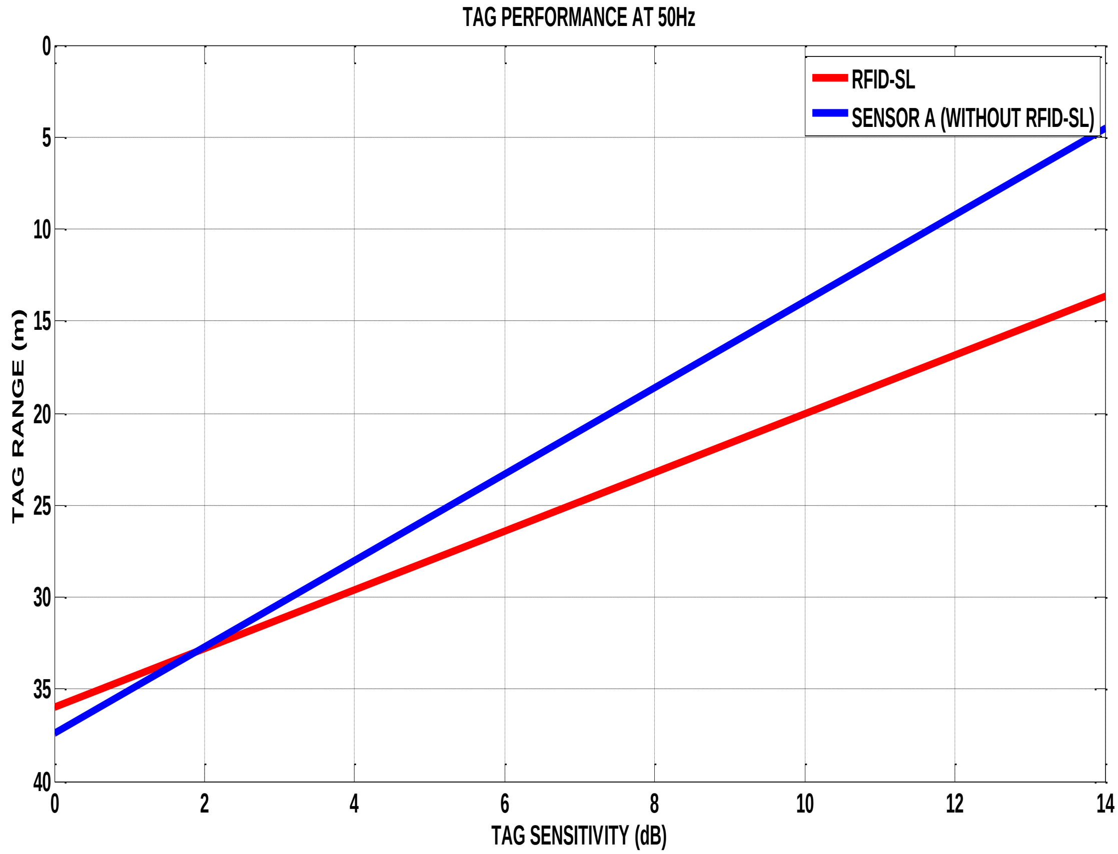


Figure 8: plot of tag range against tag sensitivity at 50Hz

From table 2, at a radio frequency of 100Hz, the tag sensitivity is seen to increase, but at tag range of 30m, the RFID-SLT becomes out of range (O/R), while sensor A becomes at of range from tag ranges of 25m and above, figure (9) shows the comparison plot.

Table 2: table showing tag performances of sensor links with and without RFID at 100Hz

@FREQUENCY=100Hz	**SENSOR A (without RFID-SLT)**	**RFID-SLT**
TAG RANGE (m)	TAG SENSITIVITY (dB)	TAG SENSITIVITY (dB)
0	14	11.9
4	10.9	9.3
5	8.3	7.1
7	6.2	5.3
10	3.61	2.65
15	2.2	1.8
18	0.5	0.3
25	O/R	O/R
30	O/R	O/R

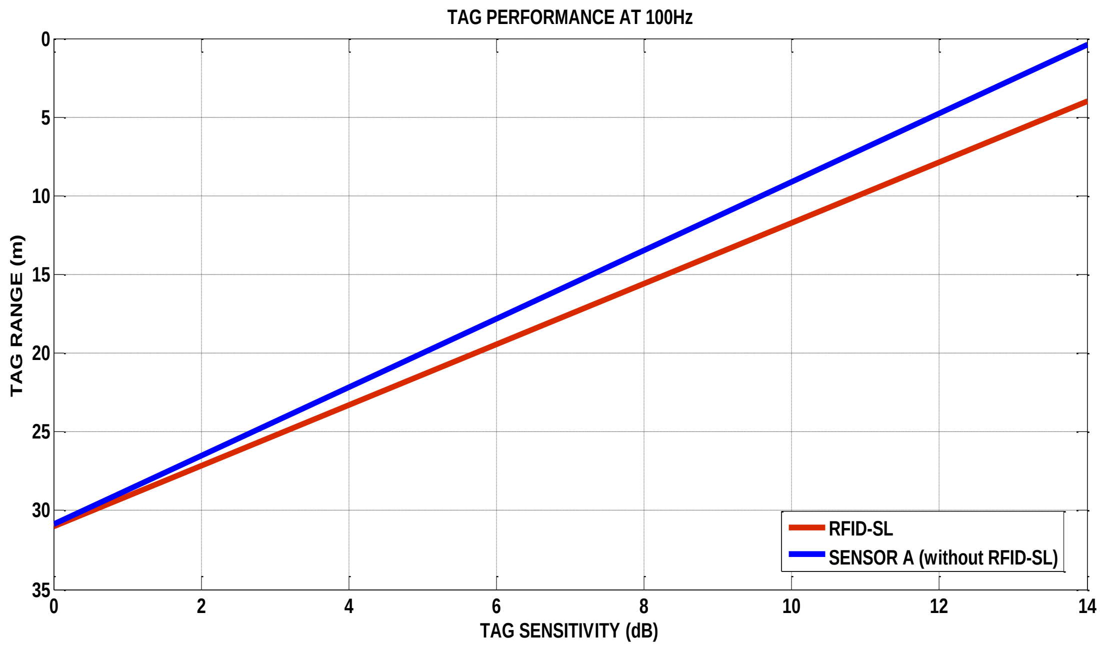


Figure 9: plot of tag range against tag sensitivity

3.4 Tag backscatter efficiency

Tag backscatter efficiency is the tag characteristic which shows how much of the incident RF power is "converted" by the tag to the modulated backscattered power. Table 3 shows the tag performances of this characteristic towards sensed body temperature.

Table 3: Tag backscatter characteristics at RF of 50Hz

@FREQUENCY=50Hz	**RFID-SLT**	**SENSOR A (without RFID-SLT)**
TAG BACKSCATTER	BACKSCATTER EFFICIENCY	BACKSCATTER EFFICIENCY
0	O/R	O/R
10	O/R	0
15	O/R	1
20	O/R	20
25	0	25
30	40	27
40	52	35
50	64	44
60	72	56
70	80	62
80	87	68
90	93	74

From table 3, the RFID-SLT model gives a better backscatter efficiency for increasing tag backscattering, but the tags in the RFID-SLT are not sensed at very close ranges as low as 0-10m, figure (10) shows the plot of the backscattering efficiency of the compared sensor links.

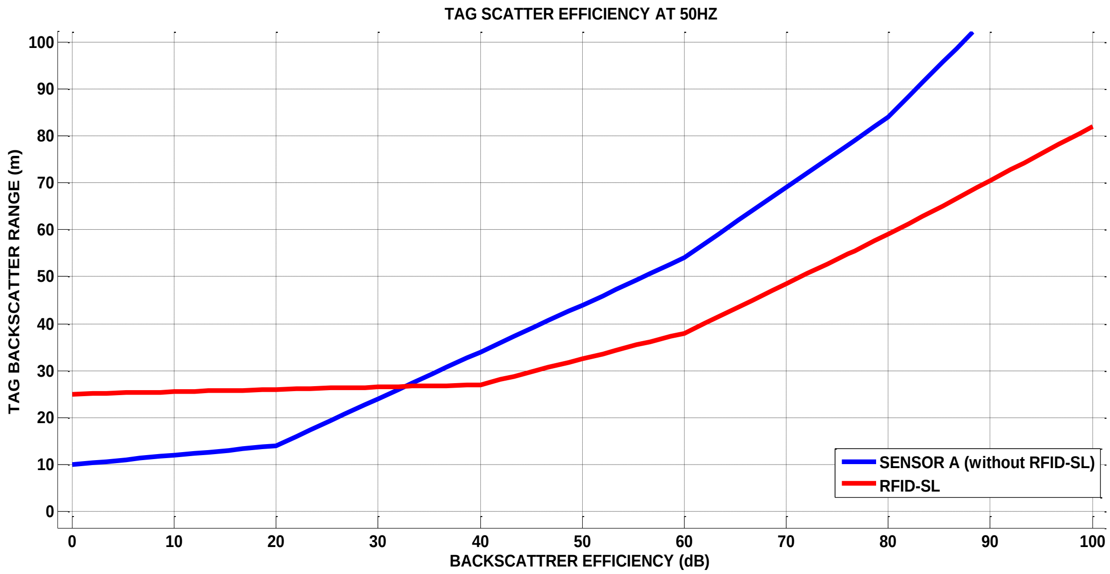


Figure 10: plot of tag backscattering against backscattering efficiency at RF of 50Hz

However for more efficiency of the RFID-SLT, there is need to increase the RF, so as to detect selected human body vitals (temperature) at further ranges, from table 4, when the RF is doubled, the backscattering efficiency increases for further ranges than closer ranges for the RFID-SLT. Figure (11) shows the comparison plot

Table 4: Tag backscatter characteristics at RF of 100Hz

@FREQUENCY=100Hz	**RFID-SLT**	**SENSOR A (without RFID-SLT)**
TAG BACKSCATTER	BACKSCATTER EFFICIENCY	BACKSCATTER EFFICIENCY
0	O/R	O/R
10	O/R	0
15	O/R	15
20	O/R	21
25	0	26
30	40	28
40	54	36
50	63	45
60	73	58
70	80	63
80	89	67
90	95	74

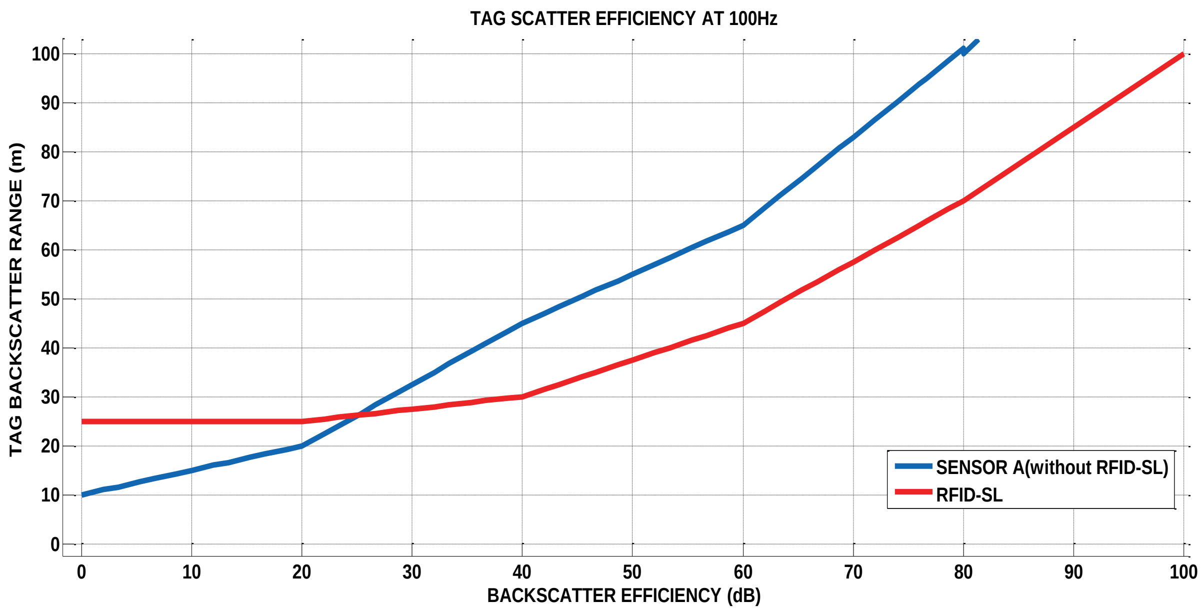


Figure 11: plot of tag backscattering against backscattering efficiency at RF of 100Hz

The backscatter range is the maximum distance at which the reader with certain receiving sensitivity can decode the backscattered tag signal. In semi passive (battery-assisted) UHF RFID systems, the maximum range is currently limited by the return link. In the fixed-distance setup, the fundamental measured quantity from which both of these characteristics are calculated is the power of the received tag signal. Other quantities (such as modulation loss, backscatter efficiency, delta RCS, differential EIRP, link margin, etc.) can also be easily computed from this measurement. For monostatic antenna configuration in free space, assuming that tag sensitivity is not a limitation, power-dependent tag backscatter efficiency E_b and backscatter range r_{bs} are related as given in equation (4).

Figure (12) shows the transmission sensitivity of the sensor links with and without the RFID at tag ranges of 10m and 25 m, from the plot the magnitude of the sensitivity depends on the distance of the tag reader from the specimen.

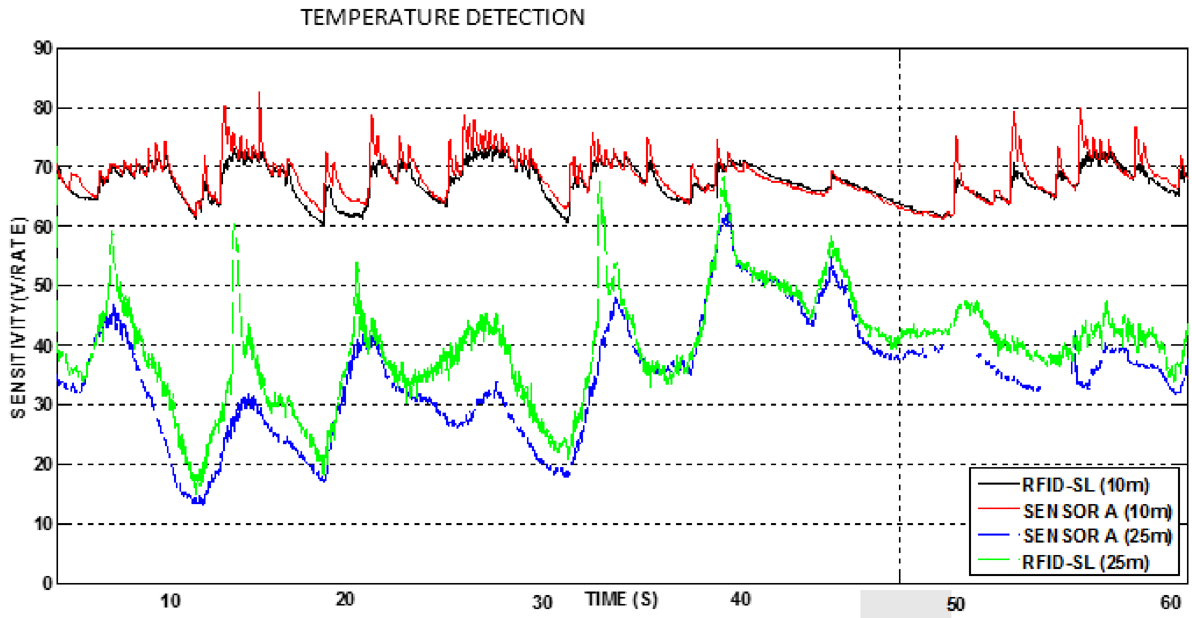


Figure 12: sensitivity plot of RFID-SLT and sensor A (without RFID) at tag range of 10m and 25m

3.5 Sensor response

From figure (13) the sensor response of the RFID-SLT shows a higher sensor response by leading sensor A by 90°, the result shows the strong sensing performance of the RFID-SLT compared to the SL without the RFID after a repeatability of the sensor response.

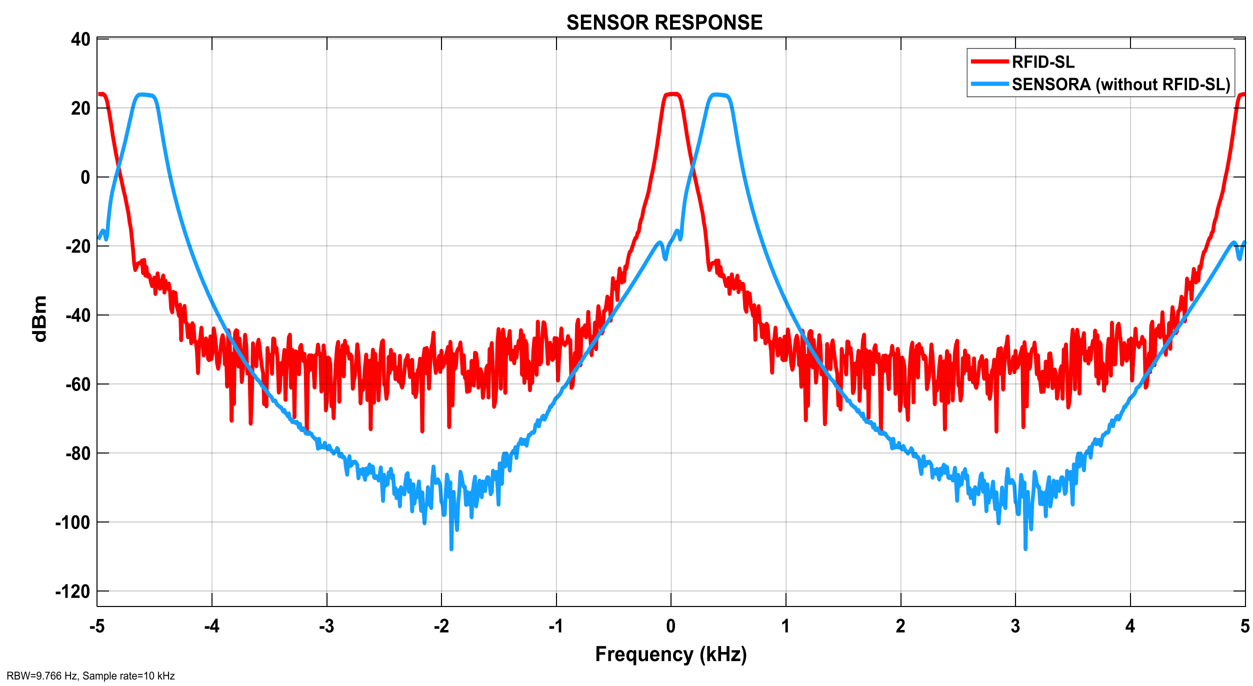


Figure 13: sensor response of the RFID-SLT and sensor A (without RFID)

4.0 Conclusion

The present article investigated the performances of the RFID-SLT system and its efficiency as a monitoring tool in E-disease detection and transmission. From the work, the one of the covid-19 commonest symptom which is high fever (abnormal temperature rise) has been used as vitals to detect a carrier of the covid-19 virus. It is also important to know that any other symptoms of a particular disease could be used as a case study.

Matlab/simulink has been used to model the RF sensor link and also used to establish a relationship between the proposed RFID-SLT algorithms, so as to have efficient detection of disease carrying humans at any distant location. For the purpose of monitoring, the tag nodes approach has been implemented in the algorithm so as to enable efficient transmission of the gathered data and communicate to the reader. Moreover, performance of the system was measured in terms of two systems, an RFID systems and a system without RFID called sensor A, The outcome showed the superiority and importance of the RFID-SLT antenna in wide range coverage in order to provide reliable monitoring.

Using E-disease Monitoring System, health care providers (e.g., hospitals) improve patient's safety by capturing basic data (such as patient unique ID, name, blood group, drug allergies, drugs), prevent/reduce medical errors, in-creases efficiency and productivity, and cost savings through wireless communication. The RFID-SLT technology has tangible benefits such as reduced cost and time, reduced human resources and improves productivity. In the future version of health monitoring using RFID-SLT, we will explore the functionality to access patient's medical well being

ACKNOWLEDGEMENT

I use this medium to appreciate the management of Abia State Polytechnic Aba for their willingness and support with the Tertiary Education Trust Fund (TETFUND) for their full sponsorship of this Research work and Publication.

References

Andrei V. S., Vasile G. G, Elisabeta T., Mihai F., U., Simona A. G., (2012), ”Integrating RFID readers for data acquisition in SCADA systems”, in Proceedings of the 11th International Conference on Development and Application Systems, Suceava, Romania, pp. 21-24.

EPCglobal, (2004), ‘’EPC radio-frequency identity protocols classe-1” generation-2 UHF RFID, protocol for communications at 860 MHz - 960 MHz, version 1.2.0.

Jin Li, Cheng Tao,(2006), ‘’ Analysis and Simulation of UHF RFID System’’, in Proceedings of the 8th International Conference on Signal Processing (ICSP'06), Beijing, China, pp. 1-5.

Kamran A., Hanifa S., Paul K., (2010), “RFID Applications: An Introductory and Exploratory Study” , International Journal of Computer Science Issues (IJCSI), Vol. 7, Issue 1, No. 3, pp. 1-7.

Lei K., Jin Z., Kaishun W., Dian Z., Lionel M. Ni, (2012), “RCSMA: Receiver-Based Carrier Sense Multiple Access in UHF RFID Systems” , IEEE Transactions on Parallel and Distributed Systems, Vol. 23, No. 4, pp. 735-743.

Matlab/simulink, 2021a, (2021), 'modeling and simulation of MIMO RF receiver with and without beamforming', help center/documentation

Nikitin P., Rao K. V. S. , and Martinez R.,(2007) "Differential RCS of RFID tag," Electron. Lett., vol. 43, no. 8, pp. 431–432.

Ritu D., Ravinder D., (2012), "RFID Authentication Protocol: A Review" , International Journal of Advanced Research in Computer Science and Software Engineering, Vol. 2, Issue 11, pp. 145-152.

Shiva M., Ali A. D., Sener U., (2015), "Implementation of Structural Health Monitoring based on RFID and WSN "Conference Paper in Canadian Conference on Electrical and Computer Engineering.

Soumen, T., Palash K., (2015), "MATLAB Simulation of RFID Communication Protocol for Sensor Data Acquisition ", West Bengal 700032, India, Received: 11 February 2015 /Accepted: 15 April 2015 /Published.