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SH-SAW RFID SYSTEM FOR INDOOR LOCALIZATION OF ASYLUM PATIENTS

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ABSTRACT—*SAW RFID system tags are an automatic identification technology. SAW RFID tags are universally accepted because they do not necessitate any external power for working, very cost effective as well as lead to miniaturization. Here a model is designed for localization of asylum patients via SH-SAW RFID tag system on time basis. The simple SAW or Rayleigh SAW is vertical in nature which introduces noise error while transmitting or receiving signal. Therefore in this model SH-SAW is used which travel along the surface between inter digital transducer (IDTs)horizontal in direction and have lower sensitivity as the acoustic wave travel beneath into the substrate. We use the trilateration method for calculating the observed position and actual position of tag. SH-SAW RFID tag system dwell by three devices operator, tag and controller. The operators of room consecutively send the desired signal which are then imitated from different tags and recognized by the operator. Trilateration `method is employed to calculate the round trip TOA (time of arrival) of signal among tag and operator. Our goal is to reduce the SNR (signal to noise ratio) during the process of transmitting and receiving of information up to 10-15dB. The situation of patient will be observed by per set threshold i.e. their multiple positions in the room are identified sending to the controller. This paper proposed localization of the patient is in 7*7*3 m room and model is implemented in MATlab and simulation results shows the correct situation of patient as well as improved SNR.*

Keywords: SAW (surface acoustic wave), RFID (radio frequency identification system), Shear horizontal.

I. INTRODUCTION

Chip less RFID tags has an admirable opportunity to conventional Barcode tags because of their capability of producing identities. RFID is a wireless data capturing technology, which was used initially for military aircraft identification. Further with improvement in technology by researchers and engineers, RFID tags become smaller in area and available at minimum cost and its application widen up. RFID tags can be classified as active or passive tags. Active RFID tag requisite external power on the other hand passive RFID tag can draw out their power from interrogating beam. The passive RFID tag can be implementing by the use of SAW devices [1].

SAW RFID tags are non printable time domain reflectometry (TDR) based chip less tags. Reader sends the chirp Gaussian pulse that aroused the SAW RFID tags. Inter digital transducer (IDT) change over the interrogatory pulses into SAW wave, which are channelized across the piezoelectric crystal surface. These pulses again converted back to EM wave after reflecting from the reflectors via IDT and are detected at the operator end where the ID of tags is decoded. SAW based RFID tags or sensors have many positive points :

i. They are wireless devices, so can be remotely interrogated by means of RF beam.
ii. SAW RFID tags are come under the passive device due to this they can educe power straightly from the interrogating beam.
iii. They can well interspersed with present technologies e.g. IC (Integrated Circuits), MEM'S (Micro Electromechanical Device).
iv. SAW RFID tag exempt to many environment aggressions e.g. Humidity, temperature, chemical agents.
v. They are able to interrogate in real time with fast response and per unit cost of SAW RFID tags is low as compared to IC based RFID tags [2].

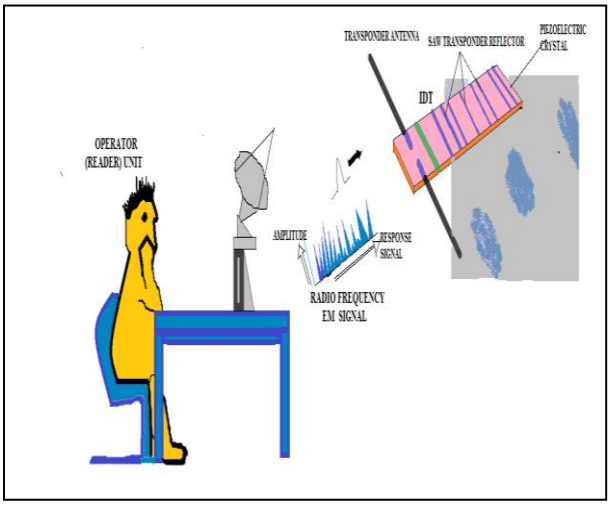

Fig. 1: SH-SAW RFID tag system

In 1990 Robert Russell Hay proposed a digitally tunable SAW. This research describes two architecture designs and verify with simulations. This research paper based upon the executing of phase controlled interface between the SAW transducer finger and input and output signals [4]. In 2003 Leonte et al. proposed a system for liquid sensors by practicing the configuration of HF dual SH-SAW devices and resonator SAW sensor. In this paper researcher refined the liquid flow system of an automated low cost. The precise results of this system visualize and boost the subjacent cost screening of liquid samples in the food and potable industries as well as in environmental and biomedical monitoring [5]. In 2007 Clinton S. Hartmann et al. describes the fundamental limitation in between the reading range of passive IC based RFID and SAW based RFID. This is the beginning of requirement of read range in different applications [6].

In 2012 Shala Arabshahi et al. proposed a model for simulation of SAW RFID tag with diminution of size and data capacity eubstancy. In this paper piezoelectric plane strain of COMSOL multiphysics is used to simulate the SAW RFID tag which is intentional by the FEM method [7]. In 2014 Donald C. Malocha et al. demonstrate the ongoing endeavor on wireless passive SAW sensor transceiver development for aerospace pertinence NASA patron the SAW sensor work for the past ten years to develop wireless sensing for ground base and space expedition in harsh environment [8].

In 2015 T.M. Bhide et al. has proposed a system for chemical and anatomical detection by using SH-SAW sensors. As in recent years SH-SAW has been attaining more diligence for liquid phase chemical and biological detection [9]. In 2016 Lio Bo et al. presented various examples, related issues, technological trends and future developments in surface acoustic wave devices. As SAW devices are passive, wireless sensors they do not need any kind of external power, very cost efficient, fabricate easily and have high performance in harsh environment [10].

In this paper a model is proposed for localization of asylum patient in a room i.e. his different position in the room are detected on the basis of information which is send to the controller. In the case of necessity the alarm is turned on and the doctor will reached immediately to the patient. This process is carried out by using SH-SAW RFID that minimizes the occurrence of noise during the information transmitted or received.

II. METHODOLOGY

For proposed approach simulation results MATlab software is used. MATLAB i.e. Matrix Laboratory is a programming language specifically designed for quick and easy scientific calculations and I/O. It has precisely hundreds of built-in functions for a wide variety of computations and many toolboxes designed for specific research method, including statistics, optimization, solution of partial differential equations, data analysis etc [11].

Localization technique is widely accepted for location tracking in recent years. Localization technique can be classified either as outdoor localization or indoor localization. This technique determines the location of something on the basis of time.GPS technique is developed for the outdoor localization but for indoor localization it is not convenient for the application. Therefore SAW RFID tags are good choice for indoor localization application due to its worth, expediency and miniaturization. Here we use SH-SAW RFID tag for locating the position of asylum people in 7'*7'*3' room.

SAW RFID tags are capable to detect an object with much more efficient manner than other techniques but with the use of conventional SAW RFID tag system for localization, it is precarious to obtain a good performance and positioning accuracy and not able to control the interruption of noise for outer environment. The proposed approach is by using SH-SAW RFID implemented by trilateration method of localization technique. In shear horizontal SAW RFID the signal to noise ratio factor will be amended. As vertical SAW influenced by the perturbation in the harsh environment, this is not happen with SH-SAW RFID. Shear horizontal SAW transit along the surface between the interdigital transducers (IDTs) horizontal in direction and have lower sensitivity as the acoustic wave travel beneath into the substrate[13].

Trilateration method is able to determine the proportionate relationship among known reference nodes and observed node and then evaluate the node position by adopting proper algorithm. The calculative distance between reference node and searched node explain the location illumination. Trilateration equation can be explained in many fashion i.e. circles, sphere or triangles. Here, we express three spherical equations as:

$$O_1 = \sqrt{(X_1 - x)^2 + (Y_1 - y)^2 + (Z_1 - z)^2} \quad (1)$$

$$O_2 = \sqrt{(X_2 - x)^2 + (Y_2 - y)^2 + (Z_2 - z)^2} \quad (2)$$

$$O_3 = \sqrt{(X_3 - x)^2 + (Y_3 - y)^2 + (Z_3 - z)^2} \quad (3)$$

Where (x, y, z) represent the tag position (Xi, Yi, Zi) represents known coordinates of the i^{th} RF operator. Tag position can be estimated by these three equations above [12].

Trilateration method based on TOA (time of arrival) is demonstrated for indoor localization system. The used constants and variables describe in table1 and table 2

Table 1: constant parameters

NAME	SYMBOL	UNIT
Length of room	l	m
Width of room	m	m
Height of room	n	m
Speed of light	C	m/s
Jitter	jitter	p/s
Time resolution	Δt	n/s

Table 2: Variables parameters

NAME	SYMBOL	UNIT
Tag position	(x,y,z)	m
i-th operator's position	(X_i, Y_i, Z_i)	m
Distance between a observed tag and operator i	O_i	m
Actual distance between tag and operator i	O_i	m
Distance from tag to room edge	L	m
Distance from tag to room edge(critical value)	L	m
Uncertainty of the estimated distance between a tag and a operator	Δd	m
round trip TOA	t_i	s

III. HARDWARE ARRANGEMENT

System setup mainly dwell by following three components SH-SAW RFID tag, operators and a controller. Controller guarded the whole system. It monitors when and how the operator sends pulse signals. The operator convert radio wave comes from SH-SAW RFID tag into a form that is useful for preceding the information. In this model we place the SH-SAW RFID tag on the patient body and several operators in a room. The operators of the room consecutively send the impulse signal. Which are then imitated from different tag and acknowledge by the operator and the round trip time of arrival of signal between tag and the operator is calculated by using trilateration method. The system arrangement is shown below [12].

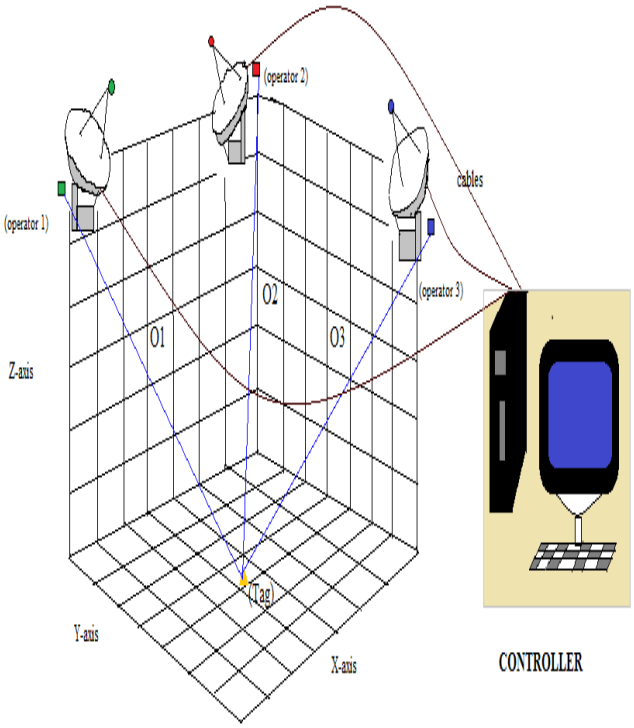

Fig 2: Trilateration system for 3 operators

IV. SIMULATION RESULTS

Simulation results are shown in the figure below. Here we determine the actual and observed position of a person. And with the use of SH-SAW we can able to achieve the SNR up to 10Db, which shows less noise will be interrupted during transmission or reception of signal from tag to the operator and correct location of a person will be calculated. MATlab simulation result of patient in a room, either fall down or normal state or motionless state as.

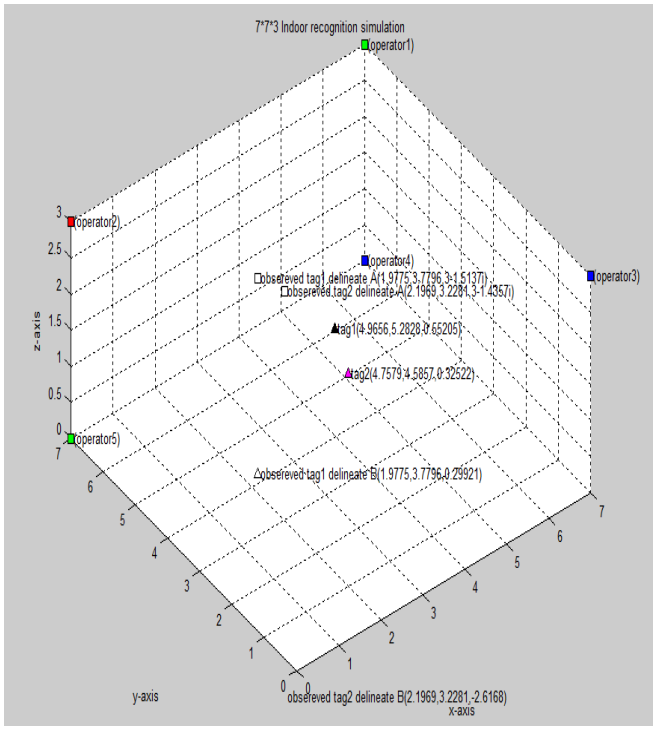

Fig 3: The patient fall down all tags beneath

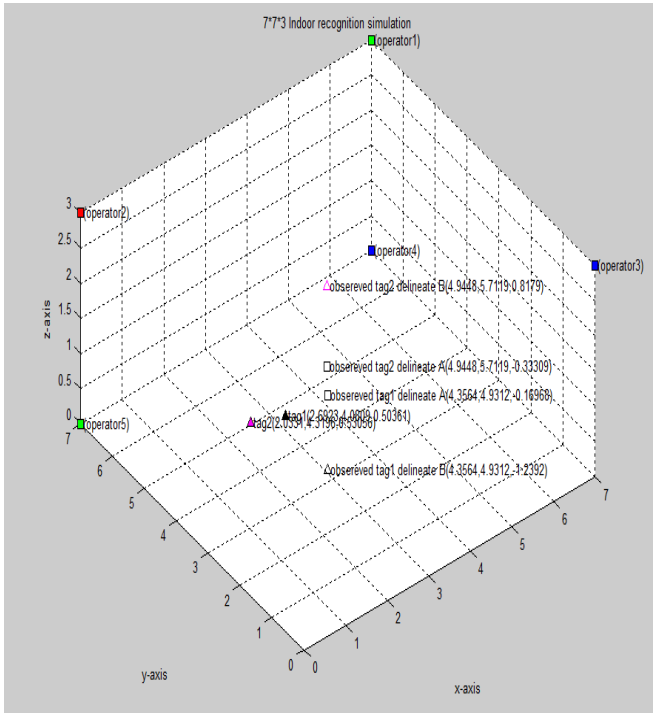

Fig 4: The patient is in normal state all tags up

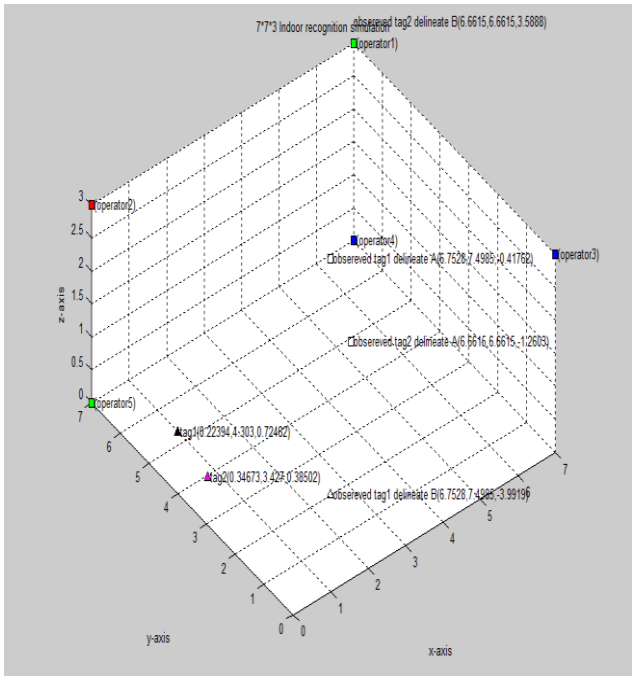

Fig 5: The patient is in motionless state

V. CONCLUSION

This paper model a SH-SAW RFID system for localization of asylum patients in a room. By using SH-SAW we can locate people or an object in harsh environment with less noise interruption. System uses a trilateration method of localization which is simplest method, cost efficient and easy to understand. Results are based on observed data and actual data for obtaining the correct position of patient in a room and also able to improve the SNR value during the process. In this paper scrutiny of patient position will be acknowledged with the help of MATlab and simulation results are discussed.

VI. FUTURE SCOPE

The signal to noise ratio will be improved up to 20dB. And the localization of object or people will be done by using different methods. This method of localization which is discussed in this paper is further be improvised by taking different other parameters.

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