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Enhanced Data Security in Medical Information System using IoT, ANN and SVM

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ABSTRACT: Trust in embedded systems is a combination of people, process, and technology. Also, Trust requirement in IoT is related to identifying management and access control issues. Developing trust is very essential for a system and trustworthiness can never be guaranteed by applying high amount of care, concern, or validation. The evidences that support the trustworthiness of a system can come from different sources such usability, past performance or quality of outcomes for designers, implementers, etc. However, after implementing our hardware (IoT fingerprint scanner) and training it with Artificial Neural Network, trust in the system was enhanced. deep and lasting affected. Object-Oriented System Development Methodology (OOSDM) which has proven to be the best method for IoT-based embedded systems design was adopted. The adopted AI technic by the proposed system encompassed the hybrid of Support Vector Machine (SVM) and Artificial Neural Network (ANN). The role of ANN and SVM encompassed making the proposed system robust and more intelligent than the existing system. We evaluated the integrity and accuracy of the new and improved CASE System below by judging it on the four main IoT parameters which are Trust, Security, Confidentiality and Privacy. The result values based on the mentioned parameters are 1, 1, 1, 1, 0, 50, 47, 69, 65, and 72 respectively, while that of the existing system is 1, 1, 2, 1, 1, 100, 95, 100, 90, and 100 respectively. In other words, performance evaluation of both systems based on the mentioned parameters clearly showed that the proposed system performed better than the existing system.

KEYWORDS: Data Security, Medical Information Systems, Internet Of Things, Artificial Neural Network, Support Vector Machines**.**

1. INTRODUCTION

Secured computing is a common goal that can enhance trust in many automated domains. In order to achieve secure computing, data in itself has to be kept safe using appropriate measures. A good measure capable of enhancing data protection is restricting access to vital information to only selected users such as an administrator of the organization in charge of managing the information and the owner of the information who we term customers or users. The use of biometrics in addition to the regular data access validation methods that involve username and password will prove to be effective. Biometric data such as data from finger prints, face recognition, speech detection is unique to each individual; hence they have the capability of protecting data effectively. Secured data is one that fulfills all the requirements of a user and the integrity of the data cannot be tampered by hackers and saboteurs. Data protection requires security of IoT hardware and software infrastructure and development of correct application codes that extend security to enable trusted applications. A secured computing platform is a computing infrastructure that provides a variety of hardware-supported security functions. Although trust, trusted, and trustworthiness are hardly defined, it is hoped that trusted computing platforms with resulting improvements in the security of computing infrastructure and applications will enable trustworthy applications and systems [1].

Trust in the embedded systems is a combination of people, process, and technology. It may be seen far from being a technical concern; however, in most cases the culprit is often engineers going down to the technical details. The users of the embedded systems often have some means to access the information and this has to be carefully dealt with, as irrespective of the strength of the authentication technique, it is largely evident that the user has a major role in knowledge building on the use and reuse of the authentication method. Technology is another major component of trust, where it can play a significant role in securing the processes and information through automated tools, and automated machine-learning methods that can track and object to anomaly.

IoT has already turned into a serious security concern that has drawn the attention of prominent tech firms and government agencies across the world. The hacking of baby monitors, smart fridges, thermostats, drug infusion pumps, cameras and even the radio in your car are signifying a security nightmare being caused by the future of IoT. So many new nodes being added to networks and the internet will provide malicious actors with innumerable attack vectors and possibilities to carry out their evil deeds, especially since a considerable number of them suffer from security holes.

Support vector machines (SVMs) are powerful yet flexible supervised machine learning algorithms which are used both for classification and regression. SVMs have their unique way of implementation as compared to other machine learning algorithms. Lately, they are extremely popular because of their ability to handle multiple continuous and categorical variables. This study intends to enhance Data Security in medical information systems using the Internet of Things (IoT), Artificial Neural Networks and Support Vector Machine (SVM).

II. RELATED WORKS

A hybrid security model for securing the diagnostic text data in medical images was researched by [2]. Their model was developed through integrating a steganography technique with a hybrid encryption scheme. The hybrid encryption scheme was built using a combination of Advanced Encryption Standard, and Rivest, Shamir, and Adleman algorithms. This model proved its ability to hide the confidential patient's data into a transmitted cover image with high imperceptibility, capacity, and minimal deterioration in the received stego-image. However, analysis of the study showed that the authors failed to implement their design in a way that a patient can have access to his medical records for further clarification and understanding.

[3] looked at Software Security Durability. The study discussed the definition and classification of existing security factors. For software, identified that security factors are affected with durability and discussed about software security factors with object-oriented design properties and how it can be done. However, they were unable to carry out additional survey to quantify the specific effects of language type on usage.

Machine Learning Algorithms: A Review. In the study, various machine learning algorithms were discussed by [4]. The algorithms were used for various purposes like data mining, image processing, predictive analytics, etc. to name a few. However, the authors failed to implement the reviewed machine learning algorithms with a machine learning model which would have provided more clarification and understanding.

[5] looked at Deep Learning for Computer Vision: A Brief Review. The study provided a brief overview of some of the most significant deep learning schemes used in computer vision problems, that is, Convolutional Neural Networks, Deep Boltzmann Machines and Deep Belief Networks, and Stacked Denoising Autoencoders. However, the discussed deep learning algorithms were not implemented with a model for further clarification and understanding.

[6] researched on how IoT Applications in Healthcare Devices has helped healthcare professionals to monitor and diagnose several health issues, measure many health parameters, and provide diagnostic facilities at remote locations. This has transformed the healthcare industry from a hospital-centric to a more patient-centric system. However, they failed to provide a secured means of computing health data of patients 'medical information.

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III. MATERIAL AND METHODS

A. Methodology

Object-Oriented System Development Methodology (OOSDM) is a technical approach for analyzing and designing an application, system, or business by applying object-oriented programming, as well as using visual modeling throughout the software development process to guide stakeholder communication and product quality. This research work will be achieved following the Object-Oriented System Development Methodology (OOSDM). This is aimed at viewing, modeling and implementing the proposed system as a collection of interacting classes and objects. OOSDM is adopted because it is more effective, efficient, reliable, reusable and a faster way of developing systems.

B. Proposed System

The Improved Data Security System will integrate fingerprinting in the computing of patients' medical records after an ailment has been detected; and further secure trust in the process. This is because the Internet of Things (IoT) is already one of the dominating technologies presently due to the fact that it enables communication by making networking accessible anytime, anywhere. Security for IoT will be given more focus as the principle needs to unite different technologies and have to communicate with diverse kind of networks. The anatomy of the proposed system architecture is depicted in figure 1.

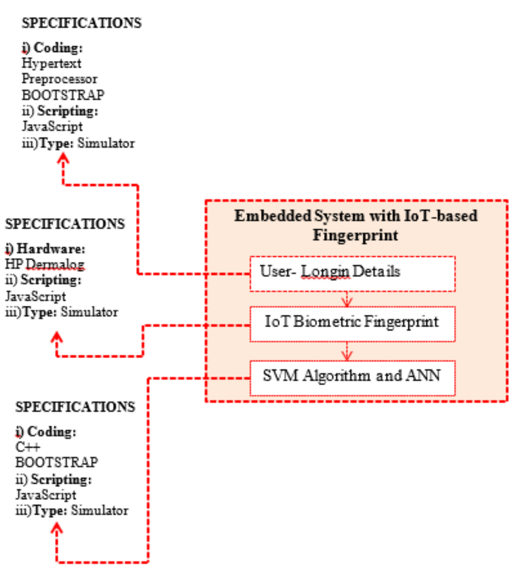

Figure 1: Labelled Anatomy of the Proposed System

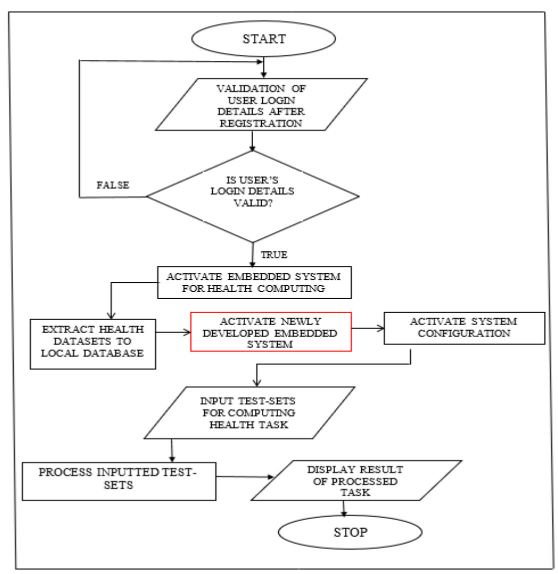

Figure 2: Flowchart of the Proposed System

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Step 1:	Start
Step 2:	Initialize input and output layers of Neural Networks for training Models
	Input = 0
Step 3:	Increment Input
	Input = Input + 1
Step 4:	Access Learning Rate of Model Weight
	$W_i^{n+1} = w_i^n + n(y_i - y_1)x_i$
Step5:	Test Learning Rate of Model Weight
Step 6:	Transfer learned model to output layer of Neural Networks
Step 7:	End

Figure 3: Artificial Neural Network Algorithm for training the Proposed System

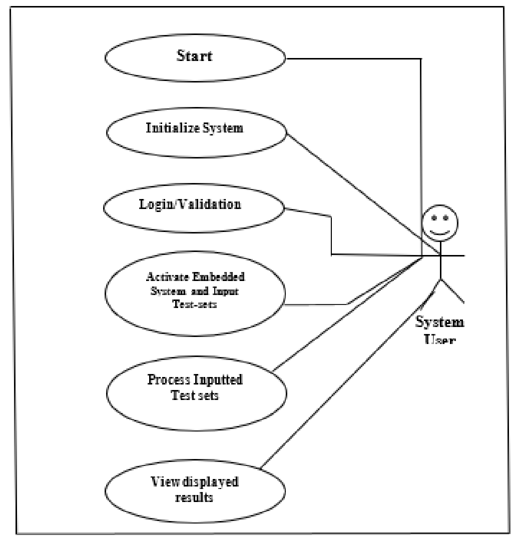

Figure 4: Use-Case Activity Diagram of Proposed System

An ANN is an efficient data-driven modelling tool which is widely used for nonlinear systems dynamic modelling and identification, due to their universal approximation capabilities and flexible structure that allow capturing complex nonlinear behaviours. Feed-forward multi-layer perceptron ANNs type is frequently used in engineering applications. Furthermore, Artificial Neural Network (ANN) uses the processing of the brain as a basis to develop algorithms that can be used to model complex patterns and prediction problems. In addition, Figure 4 shows the ANN application process to the training of the Proposed System.

1. Datasets

This section discusses the means collecting all the information for training and testing the Proposed System and managing it in a way that maximizes the speed and comprehensiveness with which critical information can be extracted, analyzed and used.

2. Training Set

The training set was adopted during the learning process of the proposed system as illustrated in Figure 2, figure 3 and figure 4 respectively. Furthermore, a supervised learning algorithm looks at the training dataset to determine, or learn, the optimal combinations of variables that will generate a good predictive model. The goal of the training process is to produce a trained (fitted) model that generalizes well to new, unknown data. The fitted model is evaluated using “new” examples from the held-out datasets (validation and test datasets) to estimate the model’s accuracy in classifying new data.

3. Test Set

The test set is independent of the training dataset, but follows the same probability distribution as the training dataset. If the proposed system fits to the training set, it also fits the test. Furthermore, a better fitting of the training dataset as

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opposed to the test dataset usually points to overfitting. In addition, the test set is used only to assess the performance of the proposed system.

C. Advantages of the Proposed System

The benefits of the Proposed System are:

1. Enhanced trust and security in embedded system computing.

2. A graphical user interface that allows the administrator to mark diseases for detection, choose the detection methods to be applied to each diagnosis/subtype and manage the list of epidemiologists that will receive alerts in case a warning is generated. The settings are stored in a local database that is also accessed by the other two components.

Furthermore, the system can be administered by multiple users who access the same local database. When additional reports arrive, the original case report is automatically updated with the new information. Depending on the number of days that have elapsed since the last time a patient received a particular diagnosis, a new case report might be created for the same diagnosis and patient. In addition, the proposed system would help in improving the future embedded systems especially in IoT.

IV. SIMULATION & RESULTS

Table 1: Proposed System Result

SN.	NAME	BLOOD GROUP	LOCATION LAST VISITED	DATE OF LAST MEDICAL CHECK	TRACE RATE OF DISEASE SYMPTOM (%)	SYSTEM INTERPRETATION
1.	Felix Kamsy	O^+	Rivers	15th June, 2017	72	Heart Disease Detected
2.	Nkiru Jackson	O^+	Jos	8th February, 2019	91	Diabetes Detected
3.	Maxwell Thompson	O^+	Akwa-Ibom	22nd May, 2015	74	Diabetes Complications Detected
4.	Ben Ndawele	O^+	Rivers	8th July, 2018	2	Hypertension Detected
5.	Akin Richards	O^+	Rivers	17th October, 2018	3	Hyperlipidemia Detected
6.	Ndak Silas	O^+	Benin	5th June, 2014	89	Arthritis & Muscuskeletal inflammation Detected
7.	Mabel Nwachukwu	O^+	Calabar	13th February, 2020	18	No Disease Detected
8	Kunle Coker	O^+	Ekiti	4th November, 2010	44	COPD Detected
9	Sarah Williams	O^+	Rivers	17th May, 2020	17	No Disease Detected
10	Olivia Duke	O^+	Rivers	13th July, 2016	10	No Disease Detected
11	Nathan Alwell	O^+	Rivers	30th September, 2020	55	Asthma Detected
12	Mercy Jackson	O^+	Rivers	3rd September, 2020	4	No Disease Detected
13	Camila Mberekpe	O^+	Rivers	19th April, 2010	8	No Disease Detected
14	Walter Samuel	O^+	Rivers	12th March, 2016	6	No Disease Detected
15	Caitlin Andre	O^+	Rivers	3rd July, 2010	7	No Disease Detected
16	Grace Amah	O^+	Rivers	14th August, 2020	20	No Disease Detected
17	Tayo Adeladan	O^+	Lagos	1st December, 2020	10	No Disease Detected
18	Tubor Akpabio	O^+	Ibadan	27th April, 2011	21	No Disease Detected
19	Micah Dike	O^+	Lagos	5th November, 2020	7	No Disease Detected
20	Haajarah James	O^+	Lagos	8th September, 2018	8	No Disease Detected

Table 2: Proposed System Result (Contd.)

SN.	NAME	BLOOD GROUP	LOCATION LAST VISITED	DATE OF LAST MEDICAL CHECK	TRACE RATE OF DISEASE SYMPTOM (%)	SYSTEM INTERPRETATION
21	Emma Matt	O^+	Abuja	23rd January, 2020	14	No Disease Detected
22	Savior Ethan	O^+	Aba	13th February, 2020	48	Bronchitis Detected
23	Ahmed Anyila	O^+	Rivers	4th November, 2010	31	Emphysemia Detected
24	Maria Isaac	O^+	Rivers	10th March, 2018	32	Cancer Detected
25	Leah Armand	O^+	Rivers	6th November, 2020	42	Total Chronic Disease Detected
26	Chizim Okonmah	O^+	Rivers	4th February, 2016	16	No Disease Detected
27	Ella Brendan	O^+	Lagos	22nd December, 2020	35	Depression Detected
28	Rachel Jumbo	O^+	Lagos	5th January, 2020	69	Other Mental health Detected
29	Bright Aniekan	O^+	Ekiti	8th July, 2018	81	Hearing loss Detected
30	Ifon Samuel	O^+	Niger	17th October, 2018	21	Influenza Detected
31	Chibu Uche	O^+	Bayelsa	5th June, 2014	52	Injury Detected
32	Nnenna Mike	O^+	Rivers	13th February, 2020	74	Oral Health Disease Detected
33	Danya Fedink	O^+	Akwa Ibom	4th November, 2010	28	No Disease Detected
34	Mailaika Nkwabi	O^+	Delta	17th May, 2020	19	No Disease Detected
35	Lily Errol	O^+	Lagos	13th July, 2016	41	Reproductive Health Disorder Detected
36	Frank Eldest	O^+	Rivers	30th September, 2020	17	No Disease Detected
37	Monday Emershan	O^+	Rivers	3rd September, 2020	45	High Cholesterol Detected
38	Ukpong Inimfon	O^+	Rivers	4th September, 2019	19	No Disease Detected

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Table 3: Proposed System Result (Contd.)

SN.	NAME	BLOOD GROUP	LOCATION LAST VISITED	DATE OF LAST MEDICAL CHECK	TRACE RATE OF DISEASE SYMPTOM (%)	SYSTEM INTERPRETATION
39	Laila Suleiman	O^+	Rivers	11th April, 2012	4	No Disease Detected
40	Aina Markafi	O^+	Rivers	17th October, 2018	74	Arthritis Detected
41	Sonia Umuezirike	O^+	Lagos	5th June, 2014	61	Influenza Detected
42	Mia Sharief	O^+	Enugu	13th February, 2020	19	No Disease Detected
43	Mishka Sbusiso	O^+	Ukwa	4th November, 2010	15	No Disease Detected
44	Masha Michael	O^+	Abeokuta	17th May, 2020	70	Depression Detected
45	Ugochukwu Ajah	O^+	Ekiti	13th July, 2016	24	Mental Health Disorder Detected
46	Sonia Umuezirike	O^+	Osun	30th September, 2020	14	No Disease Detected
47	Peter Eli	O^+	Rivers	3rd September, 2020	23	Heart Disease Detected
48	Joella Nuigbo	O^+	Akwa Ibom	19th April, 2010	22	Cancer Detected
49	Pamela Alfred	O^+	Rivers	12th March, 2016	84	Bronchitis Detected
50	Sylvia Boma	O^+	Rivers	3rd July, 2010	42	Diabetes Detected
51	Oke Lucent	O^+	Rivers	14th August, 2020	52	Diabetes Detected
52	Agbai Barrat	O^+	Rivers	1st December, 2020	50	High Cholesterol Detected
53	Chioma Ujowundu	O^+	Rivers	15th June, 2017	12	No Disease Detected
54	Duzie Abba	O^+	Jos	8th February, 2019	60	Hypertension Detected
55	Caleb Ajuzie	O^+	Akwa-Ibom	22nd May, 2015	19	No Disease Detected
56	Joseph Czar	O^+	Rivers	8th July, 2018	14	No Disease Detected
57	Matthew Owoh	O^+	Rivers	17th October, 2018	42	Influenza Detected

Table 4: Proposed System Result (Contd.)

SN.	NAME	BLOOD GROUP	LOCATION LAST VISITED	DATE OF LAST MEDICAL CHECK	TRACE RATE OF DISEASE SYMPTOM (%)	SYSTEM INTERPRETATION
58	Ndem Chika	O^+	Benin	5th June, 2014	8	No Disease Detected
59	Eliozu Felix	O^+	Calabar	13th February, 2020	49	Influenza Detected
60	Batugbo Chris	O^+	Ekiti	4th November, 2010	18	No Disease Detected
61	Grace Abraham	O^+	Rivers	17th May, 2020	6	No Disease Detected
62	Dim Juliana	O^+	Rivers	13th July, 2016	69	Asthma Detected
63	Markson Tobin	O^+	Rivers	30th September, 2020	88	Hyperlipidemia Detected
64	Ernest Asuzu	O^+	Rivers	3rd September, 2020	15	No Disease Detected
65	Emma Ebumadu	O^+	Rivers	19th April, 2010	12	No Disease Detected
66	Linda Uchendu	O^+	Rivers	12th March, 2016	34	Muscuskeletal inflation Detected
67	Ndibe Okon	O^+	Rivers	3rd July, 2010	20	No Disease Detected
68	Phillip Chris	O^+	Rivers	14th August, 2020	47	Myopia Detected
69	Best Wendy	O^+	Lagos	1st December, 2020	31	Osteoporosis Detected
70	Friedel Jones	O^+	Ibadan	27th April, 2011	13	No Disease Detected
71	Atuegbu Benson	O^+	Lagos	5th November, 2020	90	Preeclampsia Detected
72	Idem Ikah	O^+	Lagos	8th September, 2018	8	No Disease Detected
73	Igwe Benson	O^+	Abuja	23rd January, 2020	80	Heart Disease Detected
74	Hope Chijindu	O^+	Aba	13th February, 2020	71	Influenza Detected
75	Promise Bakare	O^+	Rivers	4th November, 2010	18	No Disease Detected
76	Temitope Balogun	O^+	Rivers	10th March, 2018	41	Diabetes Detected

Table 5: Proposed System Result (Contd.)

SN.	NAME	BLOOD GROUP	LOCATION LAST VISITED	DATE OF LAST MEDICAL CHECK	TRACE RATE OF DISEASE SYMPTOM (%)	SYSTEM INTERPRETATION
77	Agbo Loretts	O^+	Rivers	6th November, 2020	11	No Disease Detected
78	Frederick Maduabuchi	O^+	Rivers	4th February, 2016	6	No Disease Detected
79	Erimkpong Joseph	O^+	Lagos	22nd December, 2020	55	Hearing loss Detected
80	Chichiezu Aleruchi	O^+	Lagos	5th January, 2020	41	Hypertension Detected
81	Solomon Akachukwu	O^+	Ekiti	8th July, 2018	2	No Disease Detected
82	Joshua Ephraim	O^+	Niger	17th October, 2018	33	No Disease Detected
83	Ime Essiet	O^+	Bayelsa	5th June, 2014	53	Preeclampsia Detected
84	Suanu Abiikor	O^+	Rivers	13th February, 2020	14	No Disease Detected
85	Akon Rita	O^+	Akwa Ibom	4th November, 2010	32	Scoliosis Detected
86	Edidiong Thomas	O^+	Delta	17th May, 2020	7	No Disease Detected
87	Wendy Uchechi	O^+	Lagos	13th July, 2016	6	No Disease Detected
88	Fred Cebak	O^+	Rivers	30th September, 2020	51	Arthritis Detected
89	Mirabel Okoli	O^+	Rivers	23rd September, 2020	4	No Disease Detected
90	Chijioke Festus	O^+	Lagos	5th December, 2018	60	Cataract Detected
91	Akanimor Michael	O^+	Akwa-Ibom	11th July, 2019	22	Influenza Detected
92	Bayo Ayodele	O^+	Rivers	6th April, 2020	6	No Disease Detected
93	Cyril Akunne	O^+	Enugu	23rd June, 2014	9	No Disease Detected
94	Ndidi Elumemi	O^+	Benin	31st July, 2017	67	Diabetes Detected

Table 6: Proposed System Result (Contd.)

SN.	NAME	BLOOD GROUP	LOCATION LAST VISITED	DATE OF LAST MEDICAL CHECK	TRACE RATE OF DISEASE SYMPTOM (%)	SYSTEM INTERPRETATION
95	Stella Okorie	O^+	Rivers	31st July, 2017	5	No Disease Detected
96	Maryam Dabo	O^+	Abuja	20th December, 2015	44	Depression Detected
97	Emmanuel Edet	O^+	Akwa Ibom	13th January, 2019	17	No Disease Detected
98	Loreta Johnson	O^+	Rivers	20th November, 2020	8	No Disease Detected
99	Akan Joshua	O^+	Rivers	23rd March, 2019	65	COPD Detected
100	Christy King	O^+	Bayelsa	11th June, 2020	56	Asthma Detected

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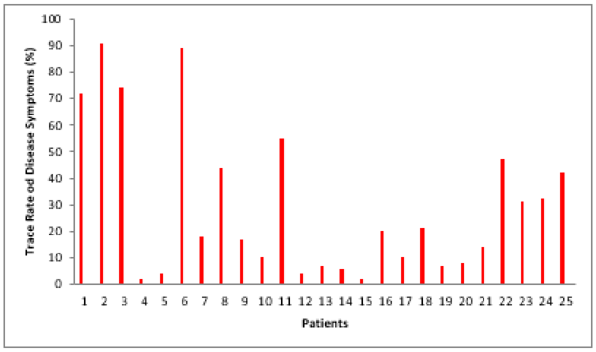

Figure 5: Proposed System Result Chart
(Patients: 1-25)

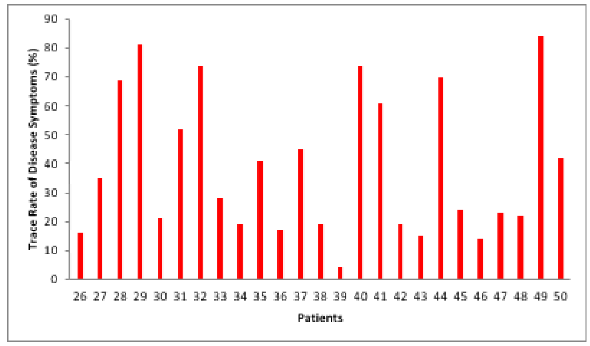

Figure 6: Proposed System Result Chart
(Patients: 26-50)

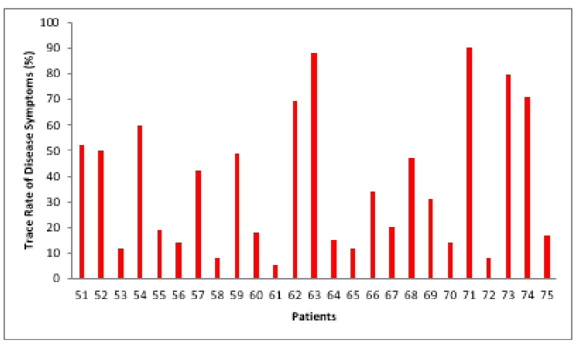

Figure 7: Proposed System Result Chart
(Patients: 51-75)

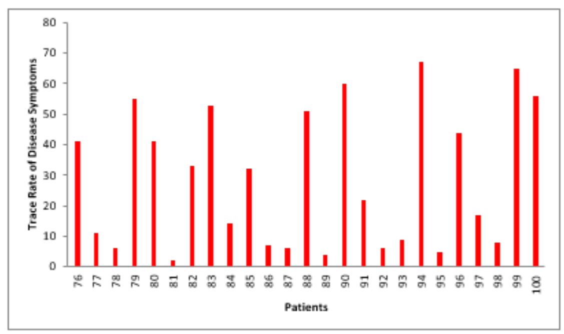

Figure 8: Proposed System Result Chart
(Patients: 76-100)

Table 7: Comparative Analysis of the Existing and Proposed Systems

SN.	RESULT PARAMETERS FOR COMPARISON	VALUES	
		Existing System	Proposed System
1.	No. of Adopted Algorithms	1	1
2.	No. of Adopted Methods	1	1
3.	No. of Adopted Technologies	1	2
4.	No. of Created Databases	1	1
5.	No. of Implemented Hardware Devices	0	1
6.	No. of Tested Records	50	100
7.	Trust	47	95
8.	Security	69	100
9.	Confidentiality	65	90
10.	Privacy	72	100

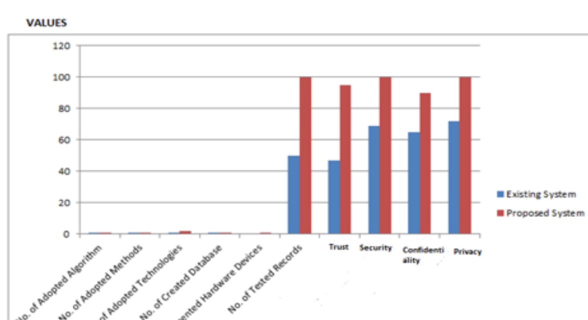

Figure 9: Comparative Analysis Chart of the Existing and Proposed System

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IV. DISCUSSIONS

Tables 1 to Table 6, show the result obtained from the proposed system and figure 5 to figure 8 shows the charts of the obtained result. Table 7, show the comparative analysis and performance evaluation of the existing and proposed system. Parameters of the result for both systems encompassed the number of adopted algorithms, the number of adopted methods, the number of adopted technologies, the number of created databases, the number of implemented hardware devices, and the number of tested records, trust, security, confidentiality, and privacy. The result values based on the mentioned parameters are 1, 1, 1, 1, 0, 50, 47, 69, 65, and 72 respectively, while that of the existing system is 1, 1, 2, 1, 1, 100, 95, 100, 90, and 100 respectively. In other words, performance evaluation of both systems based on the mentioned parameters clearly showed the Improved Data Security on medical information system of the proposed system performed better than the existing system as shown in figure 9. This IoT fingerprint scanner makes the system extra secure because access to a user's health information is confidential to the user alone and can only be accessed by the user after login with a username, password and biometric fingerprint identification have been verified. The adopted AI technic by the proposed system encompassed the hybrid of Support Vector Machine (SVM) and Artificial Neural Network (ANN). The role of ANN and SVM encompassed making the proposed system robust and more intelligent than the existing system. Furthermore, we evaluated the integrity and accuracy of the new system by judging it on the four main IoT parameters which are Trust, Security, Confidentiality and Privacy.

V. CONCLUSION

Trust has always been an issue in embedded system computing due to frequent security lapses and compromise. The study covered health disease tracking using secured biometric internet-of-things. Due to the recent Covid-19 pandemic that ravaged the entire world, the tracking of potential patients has been done via embedded systems. However, most patients are reluctant to determine their health status via embedded systems due to insecurity and issues of confidential health information leakage. Furthermore, most embedded systems for disease tracking where user input is taken as text focus only on symptom to disease relationships. The study covered only the secured tracking and authentication of health-related data using a biometric fingerprint device. In addition, the study was only able to obtain few cases of detected health related issues for the proposed embedded model to process. This was as a result of confidentiality concepts exhibited by the relevant health institutions.

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