DOI: https://doi.org/10.33103/uot.ijccce.22.4.12

Cardiovascular Patients Monitoring Using Internet of Things And Decision Tree

Rasha Ismail Ahmed[1], Rasha Mohammed Mohsin[2], Rana Fareed Ghani[3]
[1,2,3] Computer Sciences Department, University of Technology, Baghdad, Iraq
[1]110108@uotechnology.edu.iq, [2]110119@uotechnology.edu.iq, [3]110016@uotechnology.edu.iq

Abstract— *The rapid growth of the human population and the spread of many bad habits affect the health of human beings, this leads to many health problems, such as heart disease, blood pressure, and diabetes. Some of these diseases require earlier detection and fast treatment, to avoid major risks, such as permanent damage or even life loss. The fast evolution of communications and nanotechnology nowadays is being facilitated to help with saving lives before great damage happens. This paper suggests a special architecture through which to monitor patients remotely using an Internet of Things (IoT)architecture for the purpose of notifying the paramedics and health care centers to rescue the life of cardiovascular patients. The experiments, after attempts with several types of classification algorithms, showed that The result shows that The decision tree has high accuracy for predicting the new heart attack and saving lives before happening of great damage .the result reached between(83 to 87) percentage, which is a good percentage to avoid the risk of heart attacks and thus reducing death rates.*

Index Terms— *decision tree, heart disease, health care,Internet of Things (IoT), sensors.*

I. INTRODUCTION

Internet of Things (IoT)is a system to monitor the patients of cardiac diseases, it is a much leaning system that has used based on the decision tree to implement an Internet of Things (IoT)health care system. Internet of Things (IoT)connects everyday gadgets, like mobile phones, which is connected to the World Wide Web with the possibility of transmitting and receiving data from other devises, it consists of a cloud with large storage and a powerful computation processing [1,2].

One of the most important components of Internet of Things (IoT)is sensors, existing biological Nano-machines, such as Nano-sensors and Nano-actuators, those sensors provide amediator between biological phenomena and electronic Nano-devices. In condition identification area, Nano - sensors can be used in several aspects like in detecting, identifying, and quantifying biological substances in the Liquids of the human body the thing that leads to early detection and treatments of the diseases and also, an ability of detecting environmental contaminants in the patient body [3,4].

These sensors transmit the patients' information to the Internet of Things (IoT)by using communication network such as a Bluetooth connection, Zegbee or wifi network [5,6]

The population aging problem has become more serious. Usually the medical cases of the aged people and permanent need to be checked and monitored, this approach will pose a greater challenge to the current health systems. Therefore, to identify human diseases by using some methods in an accurate and appropriate manner with low costs have gained more attention recently. using the overriding in the of heart-related diseases diagnosis, the electrocardiogram (ECG) monitoring has been vastly used in both medical research and hospitals [7,8,9].

Received 24/December/2021; Accepted 15/February/2022
 ISSN (Print) 1811-9212 ISSN (Online) 2617-3352

DOI: https://doi.org/10.33103/uot.ijccce.22.4.12

The rapid development of information and the use of nanotechnologies has led to major change in the field of health care system. It provides the HCS (health care system) with a new and advanced global field – Internet of Nano Things (IoNT) and Nano-medicine. the IoNT and Nano-medicine concepts represent the beginning to change base of the diagnosis, treatment, and prevention of the diseases. For more strength, the healthcare future is based on the Internet of Nano Things (IoNT)[10].

E-health systems will provide health observation, diagnosis and curing with more convenient personalized assistance and in time of need. Applying the improvements increase the quality and availability of the Health care and make its costs drastically low. And therefore, The analysis and study of this approach is extremely important in order to develop and improve health care systems in the future [11].

One of reloading field of Internet of Things (IoT) systems that based on sensors is the cardiovascular patient care system. Piyare R. and Lee S work was one of the early works in the field of internet of things in 2013, they presented the layout of the system, they developed an Exhaustible architecture for WSN with sensors data platform that based on Cloud "Open.Sen.se" where the info-graphic of any diverse data streams can be presented, obtained and shared with Internet connectivity from anywhere. The obtained data from the sensor nodes are processed, stored and analyzed on "Open.Sen.se" server through an Application Interface (API). They used the REST depending on the Web services to be able to exchange and use of information application layer that will be able to combined directly into other application domains like smart homes, e-health care services or even vehicular area networks (VAN) [12,13].

Also in 2013, Lui R. Wang Y. and Shu M. proposed an adaptive CSMA/CA mechanism based on low rate IEEE 802.15.4 as a network to transfer the patient statues to the Internet of Things (IoT)cloud to be processed [14]

In July 2019, Isaac Machorro-Cano, Giner Alor-Hernández and others made a connection between IOT and Overweight and obesity by proposing PISIoT system, where the proposed system consists of combining Internet Of things (IOT-based) health platform and machine learning to provide main steps like prevention, detection, treatment, and Thus controlling weight gain. The PISIoT platform system used J48 algorithm to classify patients and used RuleML and Apache Mahout to create medical recommendations [15].

In Mar 2019, D.M. Jeya Priyadharsan, K. Kabin Sanjay and others, used machine learning algorithms with Internet of Things (IoT)sensors to monitor the health of the humans. The data collected from Internet of Things (IoT)sensors are analyzed by machine learning algorithms to monitoring, analysis, diagnosis, and the health of the humans. The K-Nearest Neighbor (KNN) algorithm is used to analyze and predicate health of humans [16].

Also, there are several studies of machine learning done by Internet of Things (IoT)and Researchers are still developing in this area.

In September/2019, M. Hasan, M.M. Islam, MMI. Zarif, MMA. Hashem used the machine learning to provide protection in the Internet of Things (IoT)sensors from many attacks. Attack detection in Internet of Things (IoT)sensors represents the system that was proposed, where they compared the performance of a number of machine learning algorithms like SVM, DT, RF and ANN to predict attacks on the Internet of Things (IoT)systems, and prove that Random Forest (RF) is more accurate than other algorithms [17,18].

Received 24/December/2021; Accepted 15/February/2022

 ISSN (Print) 1811-9212 ISSN (Online) 2617-3352

DOI: https://doi.org/10.33103/uot.ijccce.22.4.12

In 2020, A. J. Abidalkareem, M. A. Abd, A. K. Ibrahim, H. Zhuang, A. S. Altaher and A. Muhamed Ali, with the use of convolutional neural networks, the authors proposed a diagnostic tool to detect Diabetic retinopathy from fundus images. The experimental results of the proposed method with two pre-trained models: VGG16 and GoogleNets. Illustrates that the sujested technique can achieve an accuracy of 93.2% by an ensemble of 10 random networks, compared to 81% obtained with transfer learning based on VGG19 [19].

In this work, an Internet of Things (IoT)system for health care using ECG sensor has been implemented. The work based on machine learning using the decision tree.
The layout of the paper includes the explanation of the decision tree in section 2, in section 3 the proposed system is explained, then section 4 presents the results of the system and section 5 draws the conclusions.

II. CLASSFICATION ALGORITHMS

Classification algorithms represent an important technique in data mining and machine learning .Classification is building to support decision by predicate new case by labeled training data. There are many algorithm using for classification, thus predicate new case, such as: Rule based, nearest neighbor, neural networks, SVM, decision tree, Naïve Bayes and others.

A- *Classification by Decision Tree (DT)*

The DT algorithm is one of best learning algorithms for applying classification and decision analysis, to help predicating unknown cases which represent key objective for any classification algorithm by identifying a decision strategy to accurately predict for reaching a goal.

The decision tree represents one of the most prevalent classification algorithms due to the easiness and fastness of interpretation by humans, also it more efficient for large datasets when compared with other techniques [20,21].

Decision tree has been classified based on the type of training data into two categories [22,23]

1. Non-Incremental Decision Tree (Classical): in this type, the training data is static, thus the update does not occur in the classification model such as ID3, C4.5 and others,

2. Incremental Decision Tree: in this type, the training data is dynamic, thus if necessary, thus the work can be updated in the classification model, such as ID4,BOAT,ID5R and other [24,25].

B- ID3 structure

There many methods for constructing an ID3 ,it is the basic algorithm for constructing decision trees.ID3 is a Depends on the principle the divide-and-conquer manner top-down recursive. ID3 algorithm based on attribute selection measured based on information theory. The ID3 algorithm starts with labeled a training set and end until the tree is being built completing.

Decision tree algorithm begins with a training set and its class labels, a basic algorithm is presented in algorithm1 and *Fig. 1* that is continoue until the tree is being built completing,a basic algorithm is presented in algorithm1[25]

Algorithm 1: basic Decision tree algorithm[20,22]

Input: attribute list.
Output: A decision tree.

Received 24/December/2021; Accepted 15/February/2022
 ISSN (Print) 1811-9212 ISSN (Online) 2617-3352

DOI: https://doi.org/10.33103/uot.ijccce.22.4.12

Method:

Step 1: Calculate entropy.

Step 2: Calculate entropy and Attribute selection method.

Step3: Define largest node and Attribute selection method.

Step4: Create nodes.

Step 5: If all Attributes are executed then

Generate decision tree

Else

Return to step1

Step 6: End.

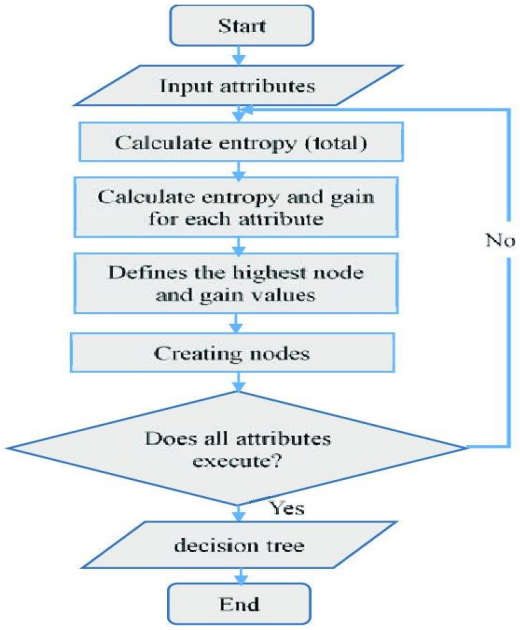

FIG. 1. FLOWCHART OF ID3[19,25].

III. THE PROPOSED INTERNET OF THINGS (IoT) SYSTEM

The Internet of Things (IoT)system was suggested to monitor a heart disease patient, for any up normal readings of the heart, but to initialize the proposed system and apply it to patients, the data must pass a number of appropriate stages(primitive statistics):

A . Data collection

the simulated dataset was extracted from the heart-disease directories in UCI Machine Learning Repository. These directories consist of four sets of databases collected from different locations but within the same instance format, all databases are concerning with heart diseases and their diagnosis, these four databases are in the following locations (Cleveland.data (Cleveland Clinic Foundation) , switzerland.data (University Hospital), hungarian.data (Hungarian Institute of Cardiology) and long-beach-va.data (V.A. Medical Center)).

B.Data preprossining and attributes Selection :

The data is processed that will be generated from the first stage (data collection) to be contain the extracted dataset consists of 727 patients and only 14 of attributes**.**

Received 24/December/2021; Accepted 15/February/2022

 ISSN (Print) 1811-9212 ISSN (Online) 2617-3352

DOI: https://doi.org/10.33103/uot.ijccce.22.4.12

C. Classification Algorithms:

The learning algorithm(Supervised learning) decision tree(ID3 classification model) to apply the suggested system ,it was used to classify the data generated from the previous stage.

the patient's data collected by using a microchip planted in the patient body(sensors), the job of this chip is to monitor and collect readings of the activities of the patient's heart with different cases, such as when the patient is sleeping, walking, sitting or claiming staircase etc. The data is transmitted to the Internet of Things (IoT)cloud database using any communication technologies such as GPRS,Wi-Fi,LTE and other then a real time processing is applied on these data, If the reading value crosses a predefined threshold, a signal is triggered and sent to the hospital monitoring this patient, *Fig. 2* illustrates the proposed Internet of Things (IoT)architecture.

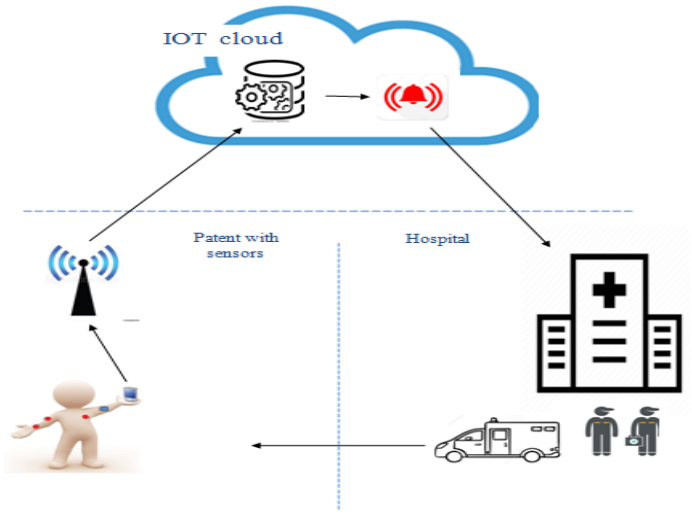

FIG. 2. THE PROPOSED INTERNET OF THINGS (IOT) ARCHITECTURE FOR HEALTH CARE SYSTEM.

IV. THE EXPERIENTIAL RESULT

The proposed system of the Internet of things is a system to monitor the patients of cardiac diseases based on the decision tree to implement an Internet of Things (IoT)health care system. The proposed system was trained on the simulated dataset that was extracted from the heart-disease directories and apply a decision tree on this dataset.

The decision tree algorithm was applied to the different split ratio for dataset, and the dataset got split into two portions: training and testing data with 0.6(60:40), 0.7(70:30) and 0.8(80:20). The sets of Split ratio have presented to a best accuracy of the proposed algorithm to be diagnosed, where 727 patient information is used for the validation set. The true positives, false positives, true negatives and false negatives are present in Confusion Matrix with different sets of Split ratio as follows:

1.Split ratio : 0.7(70:30)

Confusion Matrix:

True:	a	b
a:	79	12
b:	14	77

Received 24/December/2021; Accepted 15/February/2022

 ISSN (Print) 1811-9212 ISSN (Online) 2617-3352

DOI: https://doi.org/10.33103/uot.ijccce.22.4.12

2.Split ratio : 0.8(80:20)

Confusion Matrix:

True:	a	b
a:	59	08
b:	14	64

3.Split ratio: 0.7(70:30)

Confusion Matrix:

True:	a	b
a:	135	21
b:	26	109

The Confusion Matrix is used to find the precision, kappa, recall and accuracy Metrics
Where:
High Precision: positive predictive value: no false positive
High Recall: sensitivity: no false negative.
Table I presents the performance results for the proposed system.

TABLE I. THE PERFORMANCE RESULTS FOR THE PROPOSED SYSTEM

Performance Vectors(0.8,0.7,0.6)			
Accuracy:84.83% and kappa: 0.697			
	True a	True b	Class precision
Pred. a	59	8	88.06%
Pred. b	14	64	82.05%
Class recall	80.82%	88.89%	
Accuracy:85.71% and kappa: 0.714			
	True a	True b	Class precision
Pred. a	79	12	86.81%
Pred. b	14	77	84.62%
Class recall	84.95%	86.52%	
Accuracy:83.85% and kappa: 0.674			
	True a	True b	Class precision
Pred. a	135	21	86.54%
Pred. b	26	109	80.74%
Class recall	83.85%	83.85%	

Received 24/December/2021; Accepted 15/February/2022

 ISSN (Print) 1811-9212 *ISSN (Online) 2617-3352*

DOI: https://doi.org/10.33103/uot.ijccce.22.4.12

Through the results shown in Table I that, when selecting the first split ratio 0.6 from the three sets, the decision tree made the worst accuracy form the rest of the sets, while when selecting the split ratio 0.7 the result present is the best in the sets.

Therefore, after the application of different split ratios to the proposed dataset, the decision tree has proved to be the most accurate method to diagnose the critical situation of cardiovascular patient.

V. CONCLUTIONS

This paper has illustrated the use of the Internet of Things (IoT)architecture to remotely detect heart disease, by developing a system that measures ECG and blood pressure using sensors, then sends data to the server via a Wi-Fi module over the Internet. In case of any detection for any up normal data reading where the patient has a high probability of a heart attack, the server must send an emergency notification to the hospital in order to help the patient and save his life.

The proposed architecture helps doctors to follow the patients remotely as well as assists in avoiding sudden heart attacks, thus reducing the number of heart failure.

Experiments have proved that the decision tree can achieve good results depending on the accuracy measurements.

Regarding the accuracy, when selecting the first split ratio 0.6 from the three sets, the decision tree made the worst accuracy form rest of the sets, while when selecting the split ratio 0.7, the result preset is the best in the sets.

REFERENCES

[1] F. Akyildiz, J.M. Jornet, Internet of Nano Things, IEEE Wireless Communications, vol. 17 ,pp: 58-63,2010.

[2] P. Gope and T. Hwang, BSN-Care: A Secure IoT-Based Modern Healthcare System Using Body Sensor Network, IEEE SENSORS JOURNAL, ,vol.16,pp: 1368- 1376, 2016.

[3] H. Kang, C. Kim, S. Koh, ISO/IEEE 11073-based Healthcare Services over IoT Platform using 6LoWPAN and BLE: Architecture and Experimentation, International Conference on Networking and Network Applications,2016.

[4] F. Miao , Y. Cheng , Y. He, A wearable context-aware ECG monitoring system integrated with built-in kinematic sensors of the smartphone. Sensors, vol.15,pp: 11465-11484,2015.

[5] I. F. Akyildiz, J.M. Jornet, Internet of Nano Things, IEEE Wireless Communications Jornal, 2010.

[6] O. Banos, C. Villalonga, R. Garcia, Design, implementation and validation of a novel open framework for agile development of mobile health applications, Banos et al. BioMedical Engineering , vol. 14,2015.

[7] S. Korsakas, The mobile ECG and motion activity monitoring system for home care patients, Computers in Cardiology, et. al., vol. 33, pp: 833-836, 2006.

[8] Cheng S, Keyes MJ, Larson MG, Long-term outcomes in individuals with prolonged PR interval or first-degree atrioventricular block, JAMA , vol. 301, pp:2571-2578, 2009.

[9] J. Wamto , A mobile phone-based ECG monitoring system. Biomed Sci Instrum, et. al., vol.42, pp: 217-222, 2006.

[10] J. Tomcsanyi , P. Beezeg, Home ECG monitoring of high-risk post-myocardial infarction patients, Orv Hetil, et. al., vol. 150, 985-988, 2016.

[11] Z. Yang, Q. Zhou, K. Zheng, L. Lei, W. Xiang, An IoT-cloud Based Wearable ECG Monitoring System for Smart Healthcare, Jornal of medical system, 2016.

[12] M. Valdés-Dapena, E. Gilbert-Barness, Cardiovascular causes for sudden infant death. Pediatr Pathol Mol Med., vol. 21 ,pp:195-211, 2002.

[13] Y. Kawamoto, H. Nishiyama, N. Kato, N. Yoshimura, and S. Yamamoto, Internet of Things (IoT): Present State and Future Prospects, IEICE Transactions on Information and Systems, 2014.

[14] R. Lui,Y. Wang and M. Shu , Internet of things healthcare cloud system based on IEEE 802.15.4, Jornal of applied science ,vol.13, pp:1582-1586, 2003.

[15] I. Machorro-Cano, G. Alor-Hernández, M. Andrés, PISIoT: A Machine Learning and IoT-Based Smart Health Platform for Overweight and Obesity Control, Appl. Sci., vol. 9, pp:3014-3037, 2019.

Received 24/December/2021; Accepted 15/February/2022

 ISSN (Print) 1811-9212 *ISSN (Online) 2617-3352*

DOI: https://doi.org/10.33103/uot.ijccce.22.4.12

[16] D. Priyadharsan, K. Sanjay , K. Karthik and K. Prasath, Patient health monitoring using IoT with machine learning, IRJET, vol. 6, 7514 -7520, 2019.

[17] M. Hasan, M.M. Islam, MMI Islam Zarif, MMA Hashem, Attack and anomaly detection in IoT sensors in IoT sites using machine learning approaches, Internet of Things journal, 2019.

[18] A. Pathak, M. Sehgal and D. Christopher, A Study on Fraud Detection Based on Data Mining Using Decision Tree, IJCSI International Journal of Computer Science Issues, vol. 8 , pp: 258-261, 2011.

[19] A. J. Abidalkareem, M. A. Abd, A. K. Ibrahim, H. Zhuang, A. S. Altaher and A. Muhamed Ali, "Diabetic Retinopathy (DR) Severity Level Classification Using Multimodel Convolutional Neural Networks," 2020 42nd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC), 2020, doi: 10.1109/EMBC44109.2020.9175606.

[20] Abeer Tariq and Rasha Mohammed , Enhancing supervised detection using decision tree and decision table, Iraqi Journal of Information Technology. Vol. 9, pp: 62-76, 2018 .

[21] G. Krzysztof **,**Techniques of Decision Tree Induction, Toruń Poland, 2013.

[22] C. Shikha**,** Survey paper on improved methods of ID3 decision tree classification, International Journal of Scientific and Research Publications, 2013.

[23] A.S. Al-Hegami **,**Classical and Incremental Classification in Data Mining Process, International Journal of Computer Science and Network Security, vol. 7 , pp: 179-187, 2007.

[24] R. kumar, K.A. kapil and A. Bhatia , modified tree classification in data mining, Global journal of computer science and technology, vol. 12, 2012.

[25] A.S. Al-Hegami , Classical and Incremental Classification in Data Mining Process , International Journal of Computer Science and Network Security, vol.7, pp: 179-187, 2007.

Received 24/December/2021; Accepted 15/February/2022

 ISSN (Print) 1811-9212 *ISSN (Online) 2617-3352*