Webology, Volume 18, Number 1, 2021
ISSN: 1735-188X
DOI: 10.29121/WEB/V18I1/44

THE IMPACT OF WEARABLE TECHNOLOGIES IN HEALTH CARE DISEASE DIAGNOSIS

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ABSTRACT

Wireless Sensor Networks play a vital role in modern health care monitoring systems. Currently there is a large need for recent network technology, particularly sensor-based technologies, due to the quick evolution and progressions in medical technologies around the globe. One of the promising technologies is the body area network, which connects numerous medical sensors and related applications using wireless sensor networks with design philosophies to operate autonomously through diverse applications. Due to its notable properties, such as flexibility, adaptability, minimized cost, and performance in different environments, the body sensor networks was used in the majority of health and associated applications, ranging from simple patient monitoring systems to sophisticated serious illness analysis software that offers huge level of healthcare services to both patients and healthcare professionals. Nowadays earlier disease diagnosis is one of the challenging scenarios for healthcare professionals like doctors and medical technicians, especially for a critical disease that requires immediate treatments. With great anticipation, Wireless Body Area Network (WBAN) implementation just began in the medical fields. It is a young and talented technology that will elevate the current health care delivery model. Wearable medical technology is one of the noteworthy innovations according to WBAN. Medical professionals and service providers' recent struggles to deliver high-quality healthcare services prepared the path for the adoption of emerging tools like deep learning, and the Internet of Things (IoT), Data analytics and artificial intelligence for better medical results. One of the technologies that provide quick fixes for medical diagnosis is artificial intelligence. For healthcare personnel all across the world, integrating body area network technologies with artificial intelligence will be a superior answer. This study paper covers a number of artificial intelligence frameworks for wireless body area network-based individual wellbeing maintenance systems, as well as upcoming wearable device difficulties that medical professionals will soon have to deal with.

Keywords: Artificial Intelligence, Disease, Heart, Deep Learning, Predictions, LSTM, Training Medical Domain and Testing.

Webology, Volume 18, Number 1, 2021
ISSN: 1735-188X
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INTRODUCTION

In the present pandemic situation, when there are more undiagnosed diseases around the world, health care systems are essential for early disease diagnosis. The effectiveness of treatment is greatly influenced by an early and accurate diagnosis. It also has an impact on infected individuals. For instance, unidentified patients may spread infectious diseases like Covid to other people [1]. Some disorders, such as lung illnesses and strokes, will have a significant impact on clinical outcomes and require rapid treatment because a delayed diagnosis will put patients in a more hazardous situation. To efficiently monitor the provision of healthcare services, the majority of healthcare businesses are attempting to integrate the most recent ICT (Information and Communication Technology). WBAN technologies offer better services to the health care workers and patients within hospitals and clinics, but also to their workplaces in the most effective way at the lowest possible expense with the better possible quality. The adoption of new technology for better patient outcomes was facilitated by some of the recent issues faced by medical professionals and service providers in providing excellent health care services [2].

IoT was one of the vital technologies used in the modern medical domain as per the most recent medical survey data [3]. Healthcare stakeholders now have the opportunity to positively supply best quality medical services by utilizing IoT applications for new healthcare-related issues. IoT offers a number of advantages, including continuous monitoring systems, effective ways to gather medical data, and data analysis for the subsequent results: a) to more accurately measure the complexity and severity of a patient's medical issues; b) to develop contemporary treatment strategies; and c) to build decision support systems to evaluate medical professionals and processes for more accurate illness diagnosis.

Body area networks (BAN) implementation in the health sector began in recent years with high hopes. The current medial application approach will move to an advanced degree thanks to this developing and reliable technology. For the purpose of analyzing the human body, WBAN technology was introduced based on the Wireless Personal Area Networks (PAN) communications paradigm [5]. However, WPAN-based medical equipment is employed for communications that only require a small area around the human body. WPAN is only utilized for a few applications as a result of these restrictions.

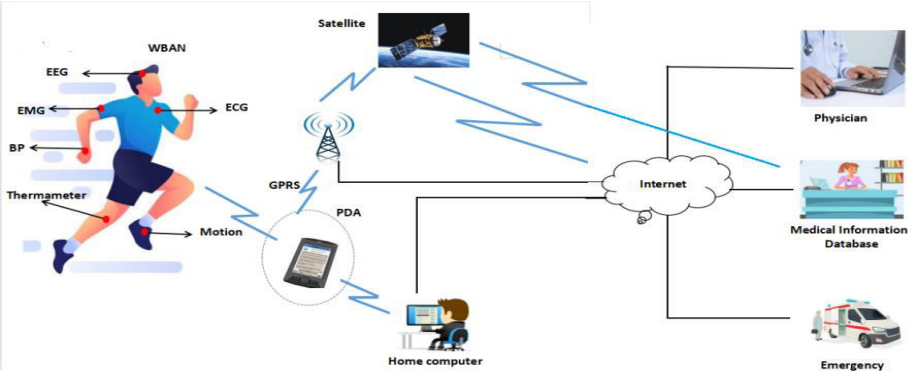

Figure 1 Wireless Body Area Networks (WBAN)

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Table 1 presents the WPAN technologies and their ranges. Wearable medical technology is a noteworthy development in the eyes of WBAN. Wearable sensor technology is more affordable and convenient to use than conventional healthcare systems [6]. It aids the healthcare sector in lowering deployment and infrastructure expenses.

Table 1 Summary of WBAN Standards

S.No	Standard	Data-rates	Frequency
1	802.11a	54 Mbps	5 GHz
2	802.11b	11 Mbps	2.4 GHz
3	802.11g	54 Mbps	2.4 GHz
4	802.11n	248 Mbps2	2.4/5 GHz
5	802.15.1	3 Mbps3	2.4 GHz
6	802.15.4	40 Kbps -250 kbps	868 / 915 MHz /2.4 GHz
7	802.15.6	>1 Gbps	1 THz

Literature Survey

By identifying numerous fatal diseases and offering real-time patient monitoring, WBANs have the potential to completely transform the way that healthcare is monitored in the future [7]. The incorporation of sensors into clinical applications has greatly enhanced the quality and security of numerous healthcare applications over the past few decades, including remote patient monitoring, medical imaging, improved diagnosis and childbirth care [8].

The use of Nano biosensors in medicine has advanced significantly over the past few decades, and now they can be implanted inside a person's body to detect cancer early, distribute drugs to specific areas of the body, and perform minimally invasive surgery. Numerous sensors, including oximeters, humidity sensors, ECG sensors, temperature sensors, location sensors, and glucose sensors, can be worn by patients in remote healthcare applications to provide updates to the healthcare provider as necessary. Authors analyzed medical sensors, healthcare applications, and services in [9] in a concise manner. The difficulties in the design and implementation of medical sensors are not sufficiently covered, though.

Similar views were offered by the authors of [10] regarding future intelligent monitoring of young people, the elderly, and patients with chronic illnesses for simple and independent living. RFID tags, ECG sensors, accelerometers, or posture sensors placed on the bodies of the patients' or kids' bodies to track their movements and physical conditions can all be used to enable their intelligent monitoring.

In-depth descriptions of the current healthcare system and several methods that can improve its performance were provided by author [11]. The study provided a general overview of IoT-based healthcare systems and identified diverse applications that IoT healthcare architectures can serve, but it lacked a detailed illustration of the many layers and protocols that make up the IoT architecture. The authors of [12] presented a WBAN, IoT gateway, and cloud server-based IoT architecture for healthcare applications. While the IoT gateway and cloud server use a Message

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Queuing Telemetry Transport Protocol to transport data, sensing devices in the WBAN use a Low-Power Wide-Area Network (LPWAN) to monitor various physiological parameters and communicate with one another (MQTT)

In a different article [13], the authors combine cloud services with a WBAN to enhance emergency response during a disaster, leading to real-time data processing and effective administration. In order to enable diverse applications for elderly, newborns, or chronically ill patients, an operational healthcare system necessitates the integration of WBAN (consisting of implanted or wearable sensors) and various heterogeneous smart objects (such as IoT devices). For better diagnosis and treatment decisions, the gadgets that are implanted within or outside the body produce a lot of physiological data. For a cutting-edge, intelligent healthcare system, efficient and cost-effective processing of the large amounts of data generated by sensing devices is also necessary.

Future challenges of wearable Technologies in Medical industry

The main uses of wearable technology are for disease detection and patient health maintenance. Wearable technology is also utilized to monitor patient biological data that is used for disease early diagnosis. These tools could aid medical professionals in making choices that will lead to better treatment outcomes. Researchers will be able to use more artificial intelligence (AI) techniques in the future to the massive volumes of data offered by wearable technology, which will present both a problem and a chance for high-quality outcomes. The majority of wearable computing technologies are still in the early phases of implementation when it comes to healthcare applications. The tools for ongoing physical activity and behavior monitoring are provided by wearable devices in the form of biological signals. Vital signs like heartbeat, blood pressure, and body temperature, as well as blood, oxygen, posture, and physical activity are the most frequently examined elements using the electrocardiogram (ECG) and other equipment. It is necessary to address problems with wearable technology such accuracy, compatibility, power management, AI, and security concerns if we are to further improve the usability and functions of this equipment for daily use.

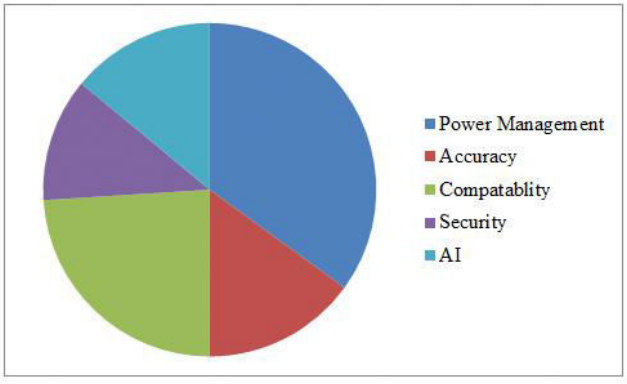

Figure 2.Future Challenges of Wearable Devices

Accuracy

Wearable technologies are able to directly sense the majority of a patient's biological signals, making data quality and clarity a major concern. Although wearable devices significantly contribute

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to the ongoing monitoring of patients' health metrics, data quality still needs to be taken seriously. The user would surely be misled by a wearable device that offers health coaching advice based on inaccurate data that hasn't been calibrated. False or incomplete data will result in a misdiagnosis of the condition. The consequences could be detrimental, if not lethal, in other situations, such as for those with chronic conditions. Concerning interoperability difficulties, additional work needs to be done. For instance, fifth-generation wireless networking technology (5G) enables us to link a variety of medical equipment to the network from both the hospital and the home; however data accuracy requires specialized monitoring tools.

Compatibility with the clinical ecosystem:
The measuring, processing, and storage criteria for the data gathered by wearable devices are aided by the compatibility feature of WBAN devices. The majority of chronic disease detection systems currently use wearable sensors to provide biological signals directly to doctors for their analysis. Consequently, computability concerns occur in this type of application at both ends of the communication chain. Prior to implementation in essential applications, such computability difficulties should be resolved. In order to ensure consistent signal collection and transmission channels across the healthcare ecosystem, clinical compliance is required. One wearable health coaching device that has solved this particular issue is wearable electrocardiograms (ECGs). The sensors used in wearable ECGs adhere to a uniform standard for measurement, communication, and the transfer of ECG measurements between medical ecosystems.

Security
In the WBAN network, where patient information will be sent over untrusted networks, security is one of the main issues. Medical data security and privacy research has a significant barrier. Even though there have been numerous studies on WBAN security, there is still a security gap between interconnected devices. The author [14] described external and behavioral attacks on the WBAN network and made the point that behavioral attacks are challenging to defend against because of the WBAN network's complexity. Another aspect of WBAN security is trust management in which several sensor nodes are used for data collection in un-trusted medical environments. So there is much need for securing medical devices across the network. The paper [15] addresses the security and privacy issues on IOT devices that are used for medical applications. The author also points the Low RaWan security mechanisms for medical applications. There is a need for further researches in security and privacy for the WBAN application.

3.4 Power supply
The power supply of the wearable gadget is one of its key components for continuous monitoring. Due to the devices' adaption to constrained surroundings, the majority of current wearable WBAN devices consume less energy. Energy efficiency can be attained by decreasing device use or employing improved batteries. The nature of sensing devices makes it challenging to reduce power usage. There are many different battery types on the market, but lithium batteries are employed in the majority of medical applications. Smart watches, head-mounted wearable, and wristbands all employ lithium batteries because of their high performance. Lithium batteries come in a variety of forms, including lithium-ion, lithium-poly, lithium-coin, and graphene. The most potent batteries used in most applications are lithium-ion and lithium-poly. The various battery types utilized in

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WBAN networks are shown in the table below.

Table 2.Communication Technologies with frequency range

Type	**Usage**	**Features**
Lithium-coin	Low power and small Wearables	Light weight, Inexpensive, safe
Lithium-ion	Wrist worn and Head Worn	Rechargeable, high power density
Lithium-poly	Wrist worn and Head Worn	Rechargeable and improved safety
Graphene	Under Testing	More storage capacity, more efficiency

Artificial intelligence has become an efficient and potent solution ranging from big data to smart sensors as a result of the quick improvement in wearable technology for health care applications. To support medical personnel, a variety of AI-based disease diagnosis techniques are available in the healthcare sector. Several AI-based architectures have been built with the most recent methods to assure smart healthcare, but some issues still need to be resolved to guarantee an effective medical system. Security and privacy of patient records, which were covered in the previous part, are two of the major concerns with wearable technology based on the healthcare system. To protect the data, the majority of the health care system employs AI-based security measures. The availability of very few medical data sets is one of the key difficulties with AI-based algorithms. Although there are a number of end-to-end architectures and synthetic data creation techniques on the market, these technologies still require more development..

4. Artificial intelligence frameworks for personal health care monitoring systems

Due to the intricacy of diseases and the structure of medical data, most health care monitoring systems now use artificial intelligence to diagnose diseases. A number of managerial procedures as well as patient care can be enhanced by AI-based solutions. Due of these characteristics, artificial intelligence (AI) is mostly employed in healthcare for treatments, diagnosis, medication research, protocol building, patient monitoring, and personalized medicine. Typically, AI algorithms operate in two ways:

- Algorithm learns from different types of knowledge and input data, or over multiple years of experience.
- Deep learning algorithms like Black Box can predict with extreme precision with little or no explanation to the logic behind its decisions.

The use of AI in the medical diagnosis process has proved extremely beneficial for both patient health and medical care. The use of AI in healthcare is not just relatively new, but there are also unprecedented ethical concerns about it, such as job automation and security. AI is continuously reinventing and reviving itself, from finding better ways to operate surgical assistance robots to creating machines that can predict, interpret, learn, and act.

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A range of medical data sources, including ultrasound, magnetic resonance, radiography, genomics, computed tomography scans, and others, are required to effectively detect illnesses utilizing artificial intelligence methods. Additionally, the use of artificial intelligence streamlined the medical experience and accelerated patient care. Adopting artificial intelligence will lead to better solutions in the future as the use of wearable technology in medical applications continues to grow rapidly. The following graph illustrates the rise in connected wearable technology over the past few years.

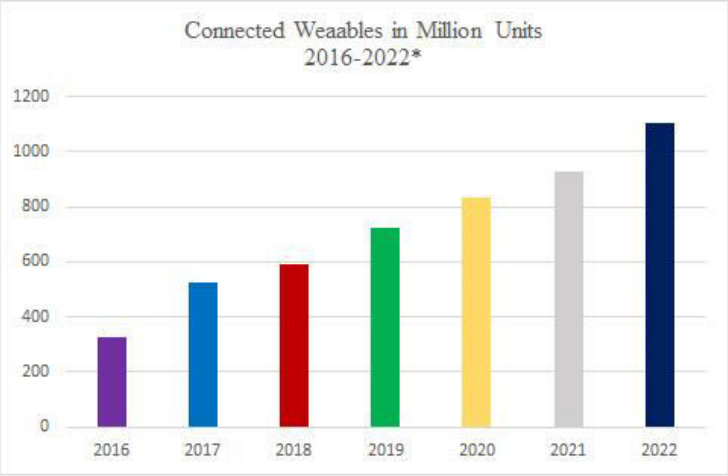

Figure 3.Connected Wearable Devices (2016-2021)

AI Based Diagnosis Models using Medical Imaging

The recent and noteworthy artificial intelligence diagnosis algorithms that explicitly employ medical imagery are presented in this area. The majority of key applications today, including radiology, pathology, and ophthalmology, use AI-based medical imaging. The most recent AI-based medical imaging models are shown in the following Table. Since 2000, AI-based medical imaging has expanded quickly. According to the most recent assessment on medical imaging for illness diagnosis, Figure 9 illustrates how more than 87% of the medical imaging concept will be used in 2022 in present medical applications. The most recent AI-based medical imaging models are shown in Table 8.

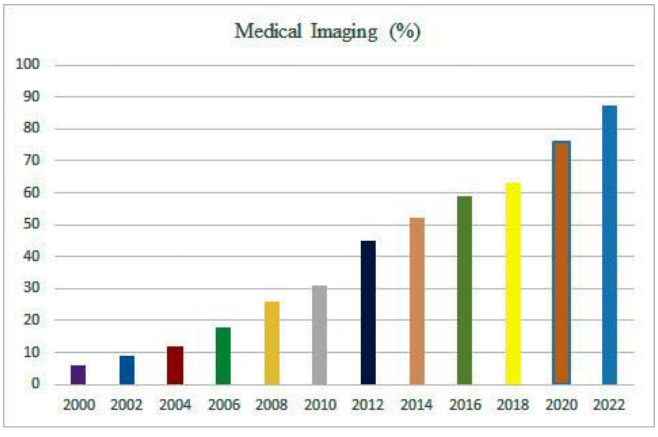

Figure 4.Improvement of AI based Medical Imaging applications (2000-2021)

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Table 3.AI based Medical Imaging Models

S.No	**Medical Imaging**	**Description**	**References**
1	Radiographic imaging	Radiography used to capture the internal structure of the human body	[16]
2	Angiography	Angiography used to check the blood vessels and flow of blood	[17]
3	Computed tomography (CT)	CT Scans generates detailed images of bone, tissues and blood vessels	[18]
4	Ultra-sound imaging	Disease diagnosis approach with imaging and sound waves	[19]
5	Electron microscopy	It is used to generate high resolution biological images of cells, tissues and organs.	[20]
6	Magnetic resonance angiography scans	It is used to detect abnormalities in the chest, abdomen and Stroke related diseases	[21]
7	Bone scan	It is an imaging procedure used to track several bone diseases	[22]
8	Nuclear medicine	Nuclear medicine is mainly concerned with the diagnosis of thyroid, cancer and bone diseases	[23]
9	Magnetic resonance imaging	Image filtering that are used in chest, abdomen and pelvis diseases	[24]
10	Fluoroscopy	It generates high definition images of the human body used in stomach and intestine diseases	[25]

6 AI Based Diagnosis Models using Deep Learning.

The majority of current research in the field of health care relies on Natural Language Processing (NLP) solutions for both home and hospital settings. Here, it would be ideal if AI were heavily included into clinical workflow. Understanding how to use and apply methods like KNN, Decision Tree, Randon Forest, SVM, Deep-CNN, RNN, and LSTM for illness diagnosis systems is crucial. With great anticipation, Wireless Body Area Network (WBAN) implementation just began in the medical fields. It is a young and talented technology that will elevate the current health care delivery model. Wearable medical technology is one of the noteworthy innovations according to WBAN. Wearable sensor technologies are less expensive and simpler to use than conventional health care systems. These networks could be used as the foundation for future health monitoring systems by the medical sector. The most recent artificial intelligence models for disease diagnosis are shown in the table below.

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Table 4.AI based Disease Diagnosis Models (2015-2022)

S.No	**Artificial Intelligence Model**	**Description**	**References**
1	Customized medicine	It is one the emerging concept in which genetic profile is used for decision making and treatment.	[27]
2	Digital health records	This work motivates the use of Data Science concept instead of using traditional EMR records	[28]
3	Information crowdsourcing	It is the clinical problem solving approach used to generate a variety of patient information using mobile technology.	[29]
4	Medical imaging diagnostics	This work presented the enhanced medical imaging model for disease diagnosis	[30]
5	Analysis and disease identification	Machine learning complex calculation are used in disease diagnosis	[31]
6	Medical trials	It is based on Machine and profound learning to evaluate medical and surgical behaviors.	[32]
7	Outbreak prediction	Machine and profound based learning approach for several disease predictions	[33]
8	Drug development	AI based Drug development process and testing	[34]
9	CSO-LSTM model	Disease diagnosis model based on deep learning algorithms	[35]
10	Cough Sound Detection and Diagnosis	Artificial intelligence based disease detection model for respiratory diseases.	[36]

Due to improvements in medical technology, there has been an increased emphasis on clinical decision support systems (CDS) in recent years. IoT was the third most widely used technology in the health care sector, according to the most recent medical survey results. Healthcare stakeholders now have the opportunity to successfully supply high-quality healthcare services by utilizing IoT technologies because to new healthcare-related issues. With the use of IoT, WBAN, and AI, there is a significant demand for integrated medical solutions. Despite the fact that AI-based techniques are becoming increasingly important in the diagnosis of diseases, there are still many issues that need to be resolved, such as limited data size, effective feature selection, security, and clinical deployment.

Conclusion

WBAN is an innovative technology with potential for use in the global health care sector. Due to the constant advancements in wearable technology, WBAN technology will soon be used in practically all applications. A comprehensive and adaptable solution for the medical industry's disease detection will be provided through the integration of WAN with Cloud, Fog, Big Data, Edge, and Green Computing. The adoption of new technologies like machine learning, the Internet of Things (IoT), artificial intelligence, and data analytics for better medical outcomes was facilitated by some of the

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recent challenges faced by medical professionals and service providers in providing quality health care services. One of the technologies that provide quick fixes for medical diagnosis is artificial intelligence. For healthcare personnel all across the world, integrating body area network technologies with artificial intelligence will be a superior answer.

References

1. Liu, Q., Mkongwa, K.G. & Zhang, C,: Performance issues in wireless body area networks for the healthcare application. A survey and future prospects. SN Appl. Sci. (2021) 155-158.
2. Humaira Abdus Salam, Bilal Muhammad Khan,: Use of wireless system in healthcare for developing countries. Vol.2, no.1. Digital Communications and Networks (2016) 35-46.
3. S. Movassaghi, M. Abolhasan, J. Lipman, D. Smith and A. Jamal pour,: Wireless Body Area Networks. A Survey. vol. 16, no. 3. IEEE Communications Surveys & Tutorials (2014) 1658-1686
4. N. O. El-Ganainy, I. Balasingham, P. S. Halvorsen and L. A. Rosseland, "A New Real Time Clinical Decision Support System Using Machine Learning for Critical Care Units," in *IEEE Access*, vol. 8, pp. 185676-185687, 2020,
5. E. Jafer, S. Hussain and X. Fernando, "A Wireless Body Area Network for Remote Observation of Physiological Signals," in *IEEE Consumer Electronics Magazine*, vol. 9, no. 2, pp. 103-106, 1 March 2020,
6. E. Jovanov, A. Milenkovic, C. Otto and P. Groen, "A wireless body area network of intelligent motion sensors for computer assisted physical rehabilitation", *J. Neuro-Eng. Rehabil.*, vol. 2, no. 6, 2005.
7. K. Kwak, S. Ullah, and N. Ullah, "An overview of IEEE 802.15.6 standard," in 3rd Int. Symp. on Applied Sciences in Biomedical and Communication Technologies (ISABEL), pp. 1 –6, Nov. 2010.
8. H. Haick et al., "Silicon nanowire sensors enable diagnosis of patients via exhaled breath", *ACS Nano*, vol. 10, no. 7, pp. 7047-7057, 2016.
9. A. Mosenia, S. Sur-Kolay, A. Raghunathan and N. K. Jha, "Wearable medical sensor-based system design: A survey", *IEEE Trans. Multi-Scale Comput. Syst.*, vol. 3, no. 2, pp. 124-138, Apr./Jun. 2017.
10. H. Alemdar and C. Ersoy, "Wireless sensor networks for healthcare: A survey", Comput. Netw., vol. 54, no. 15, pp. 2688-2710, Oct. 2010.
11. B. Ç. Uslu, E. Okay and E. Dursun, "Analysis of factors affecting IoT-based smart hospital design", J. Cloud Comput., vol. 9, no. 1, pp. 1-23, Dec. 2020.
12. F. Wu, T. Wu and M. Yuce, "An Internet-of-Things (IoT) network system for connected safety and health monitoring applications", *Sensors*, vol. 19, no. 1, pp. 21, 2018.
13. E. Khorov, A. Kiryanov, A. Lyakhov and G. Bianchi, "A tutorial on IEEE 802.11 ax high efficiency WLANs", *IEEE Commun. Surveys Tuts.*, vol. 21, no. 1, pp. 197-216, 1st Quart. 2019.
14. L. Mucchi et al., "How 6G technology can change the future wireless healthcare", *Proc. 2nd 6G Wireless Summit (6G SUMMIT)*, pp. 1-6, Mar. 2020.
15. E. Khorov, A. Kiryanov, A. Lyakhov and G. Bianchi, "A tutorial on IEEE 802.11 ax high efficiency WLANs", *IEEE Commun. Surveys Tuts.*, vol. 21, no. 1, pp. 197-216, 1st Quart. 2019.

Webology, Volume 18, Number 1, 2021
ISSN: 1735-188X
DOI: 10.29121/WEB/V18I1/44

16. Zhang F, Zhang T, Tian C, Wu Y, Zhou W, Bi B et al (2019) Radiography of direct drive double shell targets with hard X-rays generated by a short pulse laser. Nucl Fusion.
17. Katharine E, Oikonomou E, Williams M, Desai M (2019) A novel machine learning derived radiotranscriptomic signature of perivascular fat improves cardiac risk prediction using coronary CT angiography. Eur Heart J 40:3529–3543.
18. Kasasbeh A, Christensen S, Parsons M, Lansberg M, Albers G, Campbell B (2019) Artifcial neural network computed tomography perfusion prediction of ischemic core. Stroke 50:1578– 1581.
19. Sloun R, Cohen R, Eldar Y (2019) Deep learning in ultrasound imaging. IEEE 108:11–29.
20. Tegunov D, Cramer P (2019) Real-time cryo-electron microscopy data preprocessing with warp. Nat Med 16:1146–1152.
21. Fujita S, Hagiwara A, Otuska Y, Hori M, Kumamaru K, Andica C et al (2020) Deep learning approach for generating MRA images from 3D qunatitative synthetic MRI without additional scans. Invest Radiol 55:249–256
22. Gupta N, Verma R, Belho E (2019) Bone scan and SPEC/CT scan in SAPHO syndrome. J Soc Nucl Med 34:349. H
23. Nensa F, Demircioglu A, Rischipler C (2019) Artifcial intelligence in nuclear medicine. J Nucl Med 60:1–10
24. Zhou Z, Yang L, Gao J, Chen X (2019) Structure–relaxivity relationships of magnetic nanoparticles for magnetic resonance imaging. Adv Mater 31:1804567
25. Sathitratanacheewin S, Sunanta P, Pongpirul K (2020) Heliyon deep learning for automated classifcation of Alzheimer-related chest X-ray: dataset distribution shift limits diagnostic performance generalizability. Heliyon 6:e04614
26. Chatterjee A, Parikh N, Diaz I, Merkler A (2018) Modeling the impact of inter hospital transfer network design on stroke outcomes in a large city. Stroke 49:370–376
27. Luo H, Xu G, Li C, Wu Q et al (2019) Real time artifcial intelligence for detection of upper gastrointestinal cancer by endoscopy: a multicentre, case control, diagnostic study. Lancet Oncol 20:1645–1654
28. Rodrigues J, Matteo A, Ghosh A, Szantho G, Paton J (2016) Comprehensive characterisation of hypertensive heart disease left ventricular pehnotypes. Heart 20:1671–1679.
29. Nasser I, Naser S et al (2019) Predicting tumor category using artifcial neural network. Eng Inf Technol 3:1–7
30. Memon M, Li J, Haq A, Memon M (2019) Breast cancer detection in the Iot health environment using modifed recursive feature selection. Wirel Commun Mob 2019:19.
31. Romanini J, Barun L, Martins M, Carrard V (2020) Continuing education activities improve dentists self efcacy to manage oral mucosal lesions and oral cancer. Eur J Dent Educ 25:28–34
32. Chen J, Remulla D, Nguyen J, Aastha D, Liu Y, Dasgupta P (2019a) Current status of artifcial intelligence applications in urology and their potential to infuence clinical practice. BJU Int 124:567–577.
33. Memon M, Li J, Haq A, Memon M (2019) Breast cancer detection in the Iot health environment using modifed recursive feature selection. Wirel Commun Mob 2019:19’

Webology, Volume 18, Number 1, 2021
ISSN: 1735-188X
DOI: 10.29121/WEB/V18I1/44

34. R. F. Mansour, A. E. Amraoui, I. Nouaouri, V. G. Díaz, D. Gupta and S. Kumar, "Artificial Intelligence and Internet of Things Enabled Disease Diagnosis Model for Smart Healthcare Systems," in *IEEE Access*, vol. 9, pp. 45137-45146, 2021
35. K. S. Alqudaihi *et al*., "Cough Sound Detection and Diagnosis Using Artificial Intelligence Techniques: Challenges and Opportunities," in *IEEE Access*, vol. 9, pp. 102327-102344, 2021.
36. G. Cai, Y. Fang, J. Wen, G. Han and X. Yang, "QoS-aware buffer-aided relaying implant WBAN for healthcare IoT: Opportunities and challenges", *IEEE Netw.*, vol. 33, no. 4, pp. 96-103, Jul. 2019.