International Journal of Engineering and Management Research e-ISSN: 2250-0758 | p-ISSN: 2394-6962
Volume-12, Issue-1 (February 2022)
www.ijemr.net https://doi.org/10.31033/ijemr.12.1.16

IoMT Supported COVID Care – Technologies and Challenges

R. John Martin
Faculty of Computer Science & Information Technology, Jazan University, KSA

Corresponding Author: jmartin@jazanu.edu.sa

ABSTRACT

The Internet of Things (IoT) has sparked substantial progress in the recent days of pandemic and achieved several milestones especially in healthcare. Wearable technologies have gained in popularity as a means of ensuring the health and safety of users in medical and disaster relief activities, facilitating the evolution of the Internet of Medical Things (IoMT). The IoMT is a phenomenon in which computer networks and medical equipment are linked over the Internet to allow physicians and patients to interact in real time. This coronavirus pandemic has demonstrated how unprepared our systems are for a disaster of this magnitude, as well as the necessity for robust, computationally intelligent, and profound meddling. This study piece looks at the many IoT-enabled smart solutions that could be used to respond to various aspects of this rising epidemic, from diagnosis to treatment to prevention. The paper provides a retrospective survey and identifies several obstacles and obstructions to IoT integration as an attempt to deal with coronavirus pandemic. The work concludes with a discussion of challenges and future scope to the difficulties mentioned in the bench marked works.

Keywords-- IoT, IoMT, COVID-19, Sensors, Edge Computing, Wearable Technology

I. INTRODUCTION

Portable and intelligent wearable devices have become increasingly popular in numerous countries throughout the world as microelectronics, communication technology, and sensor technology have advanced in recent years [1]. Wearable gadgets feature built-in sensors with specific functionalities and autonomous computational capacity, allowing them to monitor physiological data such as heartbeat, blood pressure, and breathing, as well as body movement such as speed, posture, direction, and position. Temperature, humidity, and air quality, among other things, can be monitored by such devices. Wearable devices can communicate with smart phones, tablets, laptops, and other devices via Bluetooth, WiFi, and ZigBee [2], [3]. As a result, they are frequently employed to monitor human health in medical care, sports, and fitness [4]. The IoMT evolves with the key technologies of physiological information collection and remote data transmission as wearable technology improves and upgrades [5].

The Internet of medical things (IoMT), often known as healthcare IoT, is a collection of medical technologies and applications that connect computer networks to the healthcare field. Medical devices with wireless network connectivity facilitate interaction between the devices, which is at the heart of IoMT. During this COVID-19 pandemic, IoMT has received a lot of attention. The concept entails the use of electronic instruments for information supervision [6]. Medical experts have recently been watching the evolution of IoT to see if it may be used in the medical field. This reality is currently exposed, in which life has become comfortable for both patients and medical practitioners. Network-associated instruments, which are monitored by the Internet, have been popular among patients in the previous decade [7]. As a result, the patient-doctor interaction has significantly decreased. Smart medical beds, which can regulate their weight and provide assistance to patients without the intervention of health workers were among the earliest IoMT implementations [8]. Figure 1 shows how several medical-related tools/technologies are brought together to build IoMT in a convincing manner.

e-ISSN: 2250-0758 | p-ISSN: 2394-6962
Volume-12, Issue-1 (February 2022)
https://doi.org/10.31033/ijemr.12.1.16

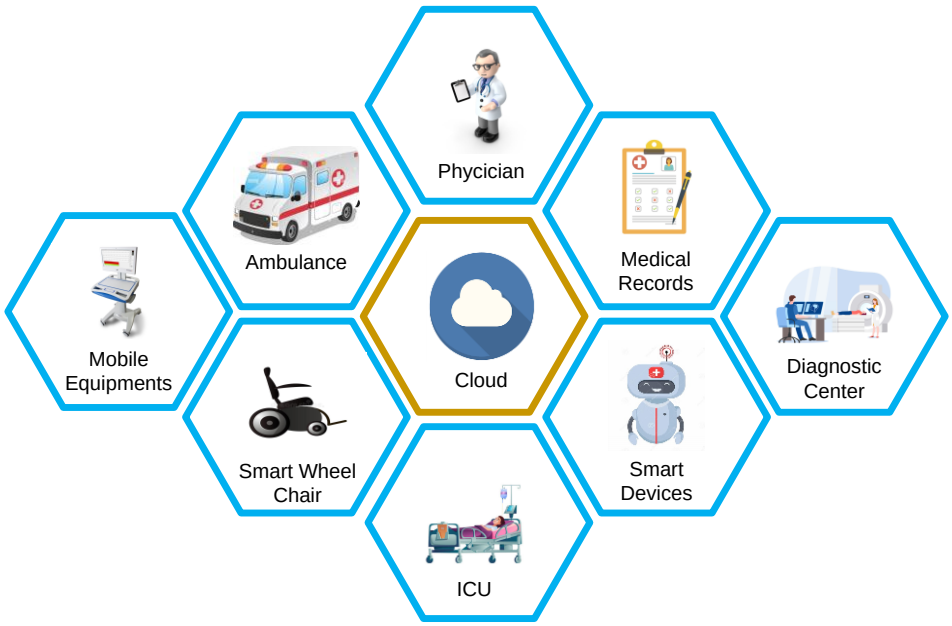

Figure 1: Internet of Medical Things in a Nutshell

The global COVID-19 pandemic, which was caused by the n-SARS-COV-2 virus, has emerged as the most serious public health disaster since the 1918 influenza pandemic. According to WHO figures as of March 12, 2022, verified COVID positive cases had surpassed 58 million as illustrated in figure 2 [9]. Despite having symptoms that are comparable to the flu, the infection has proven particularly lethal, catching the healthcare system off guard. This highlighted the importance of taking reasonable steps to improve the situation in this sector through technical innovation.

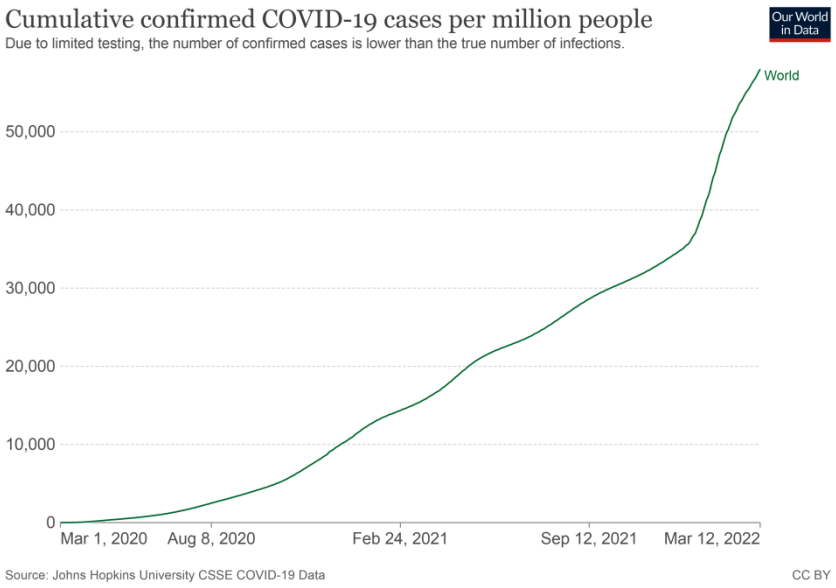

Figure 2: Cumulative Covid-19 Cases as on 12-March 2022

e-ISSN: 2250-0758 | p-ISSN: 2394-6962
Volume-12, Issue-1 (February 2022)
https://doi.org/10.31033/ijemr.12.1.16

The aim of this article is to analyse technical landscape of IoT-enabled developments designed to combat and mitigate COVID-19. The relevance of this paper at this point of time is multifaceted, as it not only describes IoMT device integration but also introduces a unique industry that will serve as a reference point for managing future health emergencies. The structure of this article is divided into four sections. Following section presents the architecture of IoMT healthcare monitoring system and the related technologies in real-time healthcare environments. Section three highlights the key categories of applications in COVID-19. Section four briefs the present challenges in IoMT and the most promising solutions. The article will be concluded with the future challenges and prospects in the field of health care IoT in order to face similar pandemic like situation.

II. IoMT ARCHITECTURE FOR SMART HEALTH CARE

The IoMT is always used for individual health monitoring in daily life and is based on wearable technology. In this section, we'll go through the design of the individual health monitoring system, as well as the related enabling technologies and existing energy-saving research for individual health monitoring systems.

The IoMT has become the most extensively employed technique for health monitoring due to the rapid growth of wearable devices [25] [27]. Patients connect to the computer via wired monitoring terminals in traditional health monitoring. The most significant disadvantage is that patients are unable to move at will. In reality, lying in bed for an extended period of time is harmful to one's health. This issue has been resolved by the IoMT. Figure 3 depicts the architecture of an IoMT-based individual health monitoring system. Health signals such as blood pressure, heartbeat, and others can be monitored via sensors on the body. The microcontroller in the human body provides the connection to the family and the doctor over the internet.

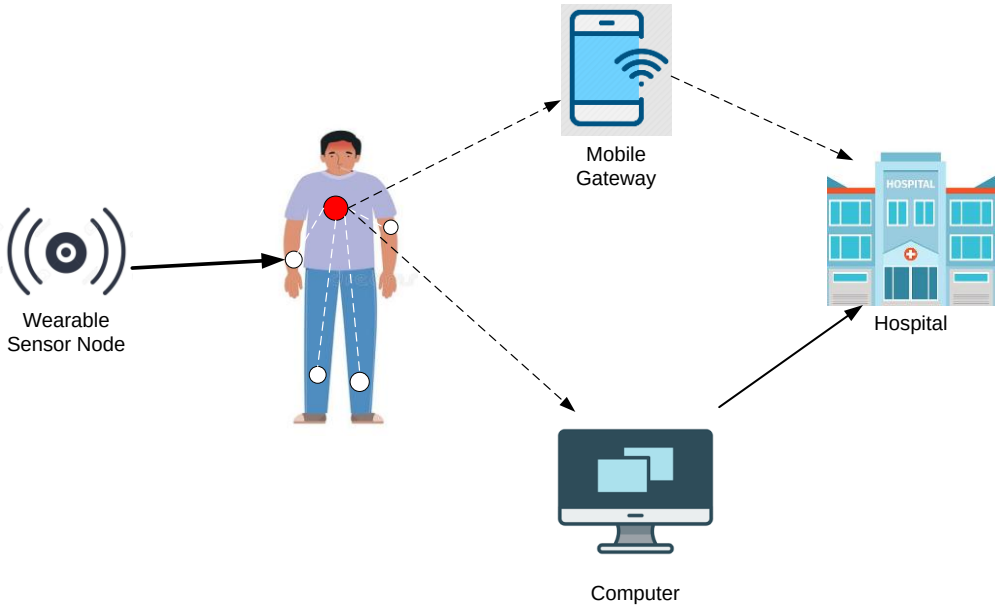

Figure 3: Smart Healthcare Monitoring System Architecture

Some fundamental technologies of an IoMT-based individual health monitoring system are becoming increasingly crucial the data grow enormously. Few of the most significant are presented here.

Marcov Model: The stationary stochastic process is frequently described using the Markov model. The common postures for users in an individual health monitoring system based on the IoMT are standing, sitting, laying, walking, and running, which can be characterized using the Markov model. There is a chance that one postural state will lead to another. In the IoMT, the Markov model is also commonly utilized for various purposes. Y. Yin et al. [10] used a constrained Markov decision method to schedule sensors for channel use dynamically. The access probability of each sensor is calculated using the discrete time Markov chain approach as in Ref. [11].

***Mobility Model*:** One of the most appealing features of an IoMT-based individual health monitoring system is that the devices do not limit human activities, allowing users to

walk whenever they choose. However, the motion mode has a significant impact on network performance. Some researchers are now investigating the mobility model in the IoMT. A. Awang et al. [12] presented a typical mobility in a hospital room and looked at two different standing and walking scenarios. The mobility model presented by S. Misra et al. [13] allows the user to pick a random room, walk to it at a random speed, and stay there for a period of time after arriving. The research proposed by Y. Liao et al. [14] demonstrated that predicting where patients desire to travel is difficult. The authors employed a nomadic mobility model after restricting the scope of patients' activities to one floor.

III. IoMT IN COVID CARE

3.1 Wearable Technologies for COVID-19

The unprecedented COVID-19 epidemic has impacted negatively on the global economy, and with several governments gradually reducing lockdown restrictions in effort to resurrect their economies, there is an urgent need for proper methods to assist slow the virus's spread and prevent it from spreading further. Smart thermometers with Internet connections can be used to screen passengers at airports, hotels, stores, and other locations, limiting exposure to symptomatic disease carriers. These thermometers are linked to a smartphone application, allowing authorities to monitor and analyze data more efficiently [15].

M. Otoom *et al.*, [16] has developed a comprehensive model which employs the IoT framework to collect the necessary data from users in order to identify early symptoms, cognitively comprehend the data that could be used to accurately predict COVID cases, and track the responses of people who have recovered from the virus. Symptoms such as fever, fatigue, sore throat, and hard breathing can be identified using a set of wearable biosensors that collect data. The data is fed to a data center, where it is analyzed extensively using cognitive machine learning (ML) models[17], and if the subject is suspected of being infected by the virus, he or she is treated quickly by physicians and placed in an isolation ward or quarantine center.

Wearable gadgets that track heart rate, body temperature, and even a more detailed assessment of oxygen levels in the bloodstream have become a hot topic in IoT discussions and are rapidly altering the healthcare industry. M. N. Mohammed *et al.*, [18] offered an inventive IoT-enabled smart helmet that is equipped with thermal imaging technology for COVID detection and is GPS-enabled to provide real-time notifications to a smartphone. It does have facial recognition and can actively reveal the pedestrian's specific records as well as monitor their body temperature.

3.2 COVID-19 Predictions

Despite the fact that the vast majority of COVID-19 patients have moderate symptoms, clinicians should use the same level of caution in isolating, examining, and treating all patients. Cognitive AI models [19] can assist the physicians involved in pandemic management. It can be deployed to classify patients into three groups: mild symptoms, moderate symptoms, and patients with a high risk of mortality. With numerous vaccinations now available and widely distributed, AI approaches can be useful in the discovery of prospective new medications for the treatment of diseases that are cost-effective. ML techniques can be used to extrapolate disease growth and track it effectively, hence reducing the disease's global impact. A study has been proposed that uses mathematical modeling techniques to forecast the total number of cases utilizing ML methodologies and a cloud-based framework [20]. It uses the Robust Weibull model to compute and predict COVID-19 instances, which is based on iterative weighting and takes factors like populous areas, climate conditions, and medical services into account for improved accuracy. In comparison to the baseline Gaussian model, which showed overly optimistic forecasts, the researchers' model was able to anticipate realistic results from a statistical standpoint. The need of a precise model that will assist physicians in making the best decisions and better forecasting the number of cases should be emphasized; it will also assist government agencies in better planning and handling the crisis.

3.3 Telemedicine and IoT

With the number of patients increasing at an alarming rate around the world, all healthcare facilities are under tremendous strain and are grappling with serious difficulties such as a lack of beds, insufficient medical staff, and infrastructure constraints, to name a few. Telemedicine offers the potential to address some important issues and assist in the decongestion of the COVID-19 strain. Telemedicine is a collection of procedures that allows clinicians to examine, diagnose, monitor, and provide greater access to medical services while monitoring patients remotely using devices such as tablets and mobile phones.

With the virus's spread, demand for telemedicine devices has risen dramatically, with many businesses now offering portable telemedicine kits that include ECGs for vital sign monitoring, digital stethoscopes, and high-resolution webcams. In the case of the coronavirus, telemedicine technology can be quite beneficial because it reduces the burden on medical personnel and reduces the possibility of human transmission of the virus. Although this technology is rapidly advancing, it faces a number of significant challenges, including technical training, high installation costs, privacy and security concerns, convoluted policy guidelines and repayment rules, and

others that are areas of concern and must be addressed appropriately.

3.4 Deployment of Drones

Drones can play a critical role in addressing and resolving the pandemic's unprecedented collection of issues. Many countries are increasingly employing drone technology to mitigate the detrimental effects of extreme weather in emergency circumstances. Spain was one of the first countries in Europe to use drones to sanitize public spaces. These drones were outfitted with cleaning sprays that were sprayed over huge areas. This technology can be quite beneficial, especially in relieving the pressure on health centers and hospital administration by allowing medicines and other commodities to be delivered quickly. They can also be used to keep track of patients who are quarantined at home and have only minimal symptoms of the illness. Marut Drones, an Indian made drone can be used for sanitization, pharmaceutical distribution, and crowd observation. These drones are far faster than traditional methods, and can go up to 12 kilometers in 8 minutes [21].

3.5 IoT Enabled Emergency Vehicles

There is a need for smart emergency vans that can help deal with high-pressure scenarios that are prone to faults in emergency situations where time is short on the ground and every second might potentially increase the effectiveness and efficacy leading to optimum decision making. Physicians can instruct medical personnel handling a patient in an IoT-enabled ambulance on the essential and required actions. These emergency vehicles have the potential to save a lot of lives. According to P Manikanta et al [22], an IoT-equipped smart emergency vehicle facilitates patient data collection by sensors and sent to clinicians via a cloud infrastructure. Furthermore, the ambulance has the ability to manage traffic lights so that it has a clear path on the road and can get to the hospital quickly.

3.6 IoT Enabled Robots

Previously, robots were mainly used in workshops and laboratories; but, with the recent surge in the AI sector, robots are now present in practically every aspect of life. The medical business is no exception when it comes to reaping the benefits of robot technology. Robots can increase production, work for longer periods of time, take up less space, and make fewer mistakes. In hospitals, IoT-enabled robots are increasingly being utilized for a variety of activities, including collecting samples, cleaning surfaces, and checking temperature. Self-isolation or quarantine can have a negative physiological influence on mental health and lead to a variety of physiological disorders. Smart robots are now coming to the help of patients suffering from these challenges in order to combat this problem. The Paro therapeutic robot, which is utilized in nursing homes and hospitals to reduce tension and generate a relaxing effect [23], is an example that supports the previous assertion.

IV. CHALLENGES AND FUTURE HOPE

There are a number of roadblocks to development, which will be examined in relation to IoT technology as a reaction to the coronavirus pandemic.

***Scalability*:** The scalability of these IoT devices in use is the first barrier we see. The emergence of the digital realm has resulted in erratic development in the number of IoT devices, which are frequently utilized for several purposes. As various IoMT devices are tasked with sensing the vital signs of patients and making them available on the cloud server, scalability is a key hurdle to IoT's implementation in the fight against the pandemic. With the number of coronavirus patients on the rise around the world and hospitals at capacity, IoT implementation necessitates the ability to cope with a crisis on such a massive scale.

IoMT Devices: The second key difficulty we see is that with the development in the number of IoMT devices, more bandwidth is needed so as to transfer data gathered through various sensors to the cloud. This increase is due to technological improvement and expansion in these devices. Intermittent connectivity and latency are problems associated with this, slowing down data transfer. The increased number of IoT devices, like scalability, increases instability because most of these devices will be connected to WiFi networks. LTE, 3G, and 4G are now used by devices; however their spectrum will not be large enough to accommodate IoT devices. These errors and delays could cost lives in the midst of a global pandemic; thus, more bandwidth is a prerequisite for IoT's deployment in the battle against COVID.

***Security*:** There is a crucial need for long-term security solutions for IoT-enabled networks that are computationally less difficult while yet providing end-to-end data protection, user privacy, and trustworthy authentication, which are three security fundamentals. The pandemic's breakout has highlighted the need of these security issues, and the recent cyber-attack on COVID medical and vaccine research facilities, as reported by the UK's National Cyber Security Centre (NCSC), attests to the importance of IoT-based device security. With the outbreak of this pandemic, these IoMT devices have suddenly become crucial infrastructures.

***Handling of Big Data*:** The final difficulty we're considering is the presence of large data centers in this area. The data size, which includes electronic health records (EHRs), will be massive, and it will be delivered to the cloud via an application programming interface. The big data centers must be prepared and upgraded to manage such massive volumes of data without being overburdened,

and to do the necessary processing in order to be dynamic in their operations. When it comes to coronavirus patients, a delay in data retrieval, delivery, or processing can be especially dangerous.

***Cloud Computing and Fog Computing*:** Massive data is generated by the IoMT nodes continuously sensing, collecting, and transferring the signal data of monitored users. As a result, in health monitoring, architecture that allows for safe storage, powerful processing, and scalable topology is required. Cloud computing, as the Internet's third revolution, is an excellent solution for the aforementioned difficulties. Cloud-assisted IoMTs have been proposed in certain research to reduce node energy consumption and transmission delay [24]. These studies, however, did not include inter-human communication and relationships in the suggested cloud-assisted IoMTs paradigm. Fog computing, in contrast to cloud computing, is significantly closer to consumers in IoMTs and can boost throughput and reduce delay [25]. The energy-efficient and delay-aware techniques for cloud-assisted and fog-assisted IoMTs in health monitoring are still in the early stages of development. In addition, we may employ cutting-edge technologies like edge computing [26], network coding [27], and hierarchical method [28] in our IoMT-based applications.

***Network Integration*:** The integration of heterogeneous networks is an inevitable trend in the future due to the diversity of network types such as Internet of Vehicles (IoV) [29], 5G [30], and other technologies. IoMTs will be a generic framework to integrate with other advanced networks due to the demand of human-centered societal development. Though there are promising studies of the IoMT-based health monitoring system, the combinations of the above said technologies with IoMT, on the other hand, are scarce.

V. CONCLUSION

IoT is a technology that has been widely used in a range of fields and may do a variety of tasks depending on the goal, such as monitoring, tracking, distribution, and data collection. This can help us tackle the pandemic's different effects while also complementing healthcare systems. From early diagnosis to post-recovery, the IoT proves to be incredibly diversified and dynamic in its approach and fight against the pandemic. The author discussed the burgeoning IoMT in this paper and focused on its application in healthcare monitoring system in the pandemic context. The technology landscape of numerous IoT-enabled technologies that are directly and indirectly responding to COVID-19 on various fronts are manifested in this article. The synergies and imminent hurdles of seamless IoT integration in the medical domain, particularly from the standpoint of a pandemic are presented. Finally, this study composition finishes with a variety of issues highlighted, as well as a future scope in this field. The future of IoMT is bright and it must reach diversified areas of healthcare by integrating the technological advancements in edge computing, affective computing, wireless and sensible technologies, and machine learning.

REFERENCES

[1] H. Yi, S. Lee, D. Lee, W.-G. Bae, T.-I. Kim, D. S. Hwang, H. E. Jeong & H. Ko. (2019). Ultra-adaptable and wearable photonic skin based on a shape-memory, responsive cellulose derivative.' *Responsive Cellulose Derivative, 29*(34), Art. no. 1902720.

[2] B. V. Vishakh & M. K. Khwaja. (2015). Wearable device for hearing impaired individuals using ZigBee protocol. In: *Proc. 9th Asia Modelling Symp. (AMS)*, pp. 181-184.

[3] A. I. Hussein. (2015). Wearable computing: Challenges of implementation and its future. In: *Proc. 12th Learn. Technol. Conf.*, pp. 14-19.

[4] Y. Jin. (2019). Low-cost and active control of radiation of wearable medical health device for wireless body area network. *J. Med. Syst.*, *43*(5), 137.

[5] Z. Ning, P. Dong & X. Wang. Mobile edge computing enabled 5G health monitoring for Internet of medical things: A decentralized game theoretic approach. *IEEE J. Sel. Areas Commun.*, to be published.

[6] H. A. Khattak, Z. Ameer, I. U. Din & M. K. Khan. (2019). Cross-layer design and optimization techniques in wireless multimedia sensor networks for smart cities. *Comput. Sci. Inf. Syst.*, *16*(1), 1-17.

[7] I. U. Din, H. Asmat & M. Guizani. (2018). A review of information centric network-based Internet of Things: communication architectures, design issues, and research opportunities. *Multimedia Tools Appl.*, *4*, 1-16.

[8] D. V. Dimitrov. (2016). Medical Internet of Things and big data in healthcare. *Healthcare Inform. Res.*, *22*(3), 156-163.

[9] *Covid Data repository*. Available at: https://ourworldindata.org/coronavirus

[10] Y. Yin, F. Hu, L. Cen, Y. Du & L. Wang. (2015). Balancing long lifetime and satisfying fairness in WBAN using a constrained Markov decision process. *Int. J. Antennas Propag.*, Art. no. 657854.

[11] P. T. Hiep & N. Huy Hoang. (2015). Payload and power consumption analysis of IEEE802.15.6 based WBAN with CSMA/CA. In: *Proc. ATC*, Ho Chi Minh City, Vietnam, pp. 500-505.

[12] A. Awang & U. F. Abbasi. (2015). Performance evaluation of cross-layer opportunistic mac/routing with node's mobility for wireless body area networks. In: *Proc. MICC, Kuching, Malaysia*, pp. 30-35.

[13] S. Misra, N. Islam, J. Mahapatro & M. Mahadevappa. (2015). Random room mobility model and extra-wireless body area network communication in hospital buildings. *IET Netw.*, *4*(1), 54-64.
[14] Y. Liao, Y. Han, Q. Yu, Q. Ai, Q. Liu & M. S. Leeson. (2018). Wireless body area network mobility-aware task of_oading scheme. *IEEE Access*, *6*, 61366-61376.
[15] V. Chamola *et al.* (2020). A comprehensive review of the covid-19 pandemic and the role of IoT, drones, AI, blockchain, and 5G in managing its impact. *IEEE Access*, *8*, 90, 225–65. DOI: 10.1109/ACCESS.2020.2992341.
[16] M. Otoom *et al.* (2020). An IoT-based framework for early identifi cation and monitoring of covid-19 cases. *Biomedical Signal Processing and Control*, *62*, 102, 149. DOI: 10.1016/j.bspc.2020.102149.
[17] John Martin R, Swapna S.L & Sujatha S. (2018). Adopting machine learning models for data analytics-a technical note. *International Journal of Computer Sciences and Engineering*, *6*(10), 360-365.
[18] M. N. Mohammed *et al.* (2020). Novel covid-19 detection and diagnosis system using IOT based smart helmet. *Int'l. J. Psychosocial Rehabilitation*, *24*(7).
[19] John Martin, R. & Sujatha, S. (2018) Symbolic-connectionist representational model for optimizing decision making behavior in intelligent systems. *International Journal of Electrical and Computer Engineering*, *8*(1). 326-332.
[20] S. Tuli *et al.* (2020). Predicting the growth and trend of covid-19 pandemic using machine learning and cloud computing. *Internet of Things J.*, *11*, 10, 022, 210. DOI: 1016/j.iot.2020.100222. Accessed on: 30-08-2020.
[21] V. Kramar. (2020). UAS (Drone) in response to coronavirus. *27th Conf. Open Innovations Association, Trento, Italy*, pp. 90–100. DOI: 10.23919/FRUCT49677.2020.9211075.
[22] P. Manikanta *et al.* (2019). Iot ambulance with automatic traffic light control. *Int'l. Conf. Vision Towards Emerging Trends in Communication and Networking, Vellore*, pp. 1-3. DOI: 10.1109/ViTECoN.2019.8899469.
[23] D. Fischinger *et al.* (2016). Hobbit, A care robot supporting independent living at home: First prototype and lessons learned. *Robotics and Autonomous Systems*, *75*, 60–78.
[24] A. Samanta & Y. Li. Distributed pricing policy for cloud-assisted body-to-body networks with optimal QoS and energy considerations. *IEEE Trans. Services Comput.*, to be published.
[25] X. Wang, Z. Ning & L. Wang. (2018). Of_oading in internet of vehicles: A fog-enabled real-time traf_c management system. *IEEE Trans. Ind. Informat.*, *14*(10), 4568-4578.
[26] Z. Ning, X. Kong, F. Xia, W. Hou & X. Wang. (2019). Green and sustainable cloud of things: Enabling collaborative edge computing. *IEEE Commun. Mag.*, *57*(1), 72-78.
[27] L. Guo, Z. Ning, Q. Song, F. Huang & A. Jamalipour. (2017). Joint encoding and grouping multiple node pairs for physical-layer network coding with low-complexity algorithm. *IEEE Trans. Veh. Technol.*, *66*(10), 9275-9286.
[28] S. Huang, W. Lian, X. Zhang, B. Guo, P. Luo, J. Zhang & W. Gu. (2012). A novel method to evaluate clustering algorithms for hierarchical optical networks. *Photonic Netw. Commun.*, *23*(2), 183-190. DOI: 10.1007/s11107-011-0349-4.
[29] Z. Ning, Y. Li, P. Dong, X. Wang, M. S. Obaidat, X. Hu, L. Guo, Y. Guo, J. Huang & B. Hu. (2020). When deep reinforcement learning meets 5G-enabled vehicular networks: A distributed offloading framework for traffic big data. *IEEE Trans. Ind. Informat.*, *16*(2), 1352-1361. DOI: 10.1109/tii.2019.2937079.
[30] M. Jia, X. Gu, Q. Guo, W. Xiang & N. Zhang. (2016). Broadband hybrid satellite-terrestrial communication systems based on cognitive radio toward 5G. *IEEE Wireless Commun.*, *23*(6), 96-106.