Journal of Positive School Psychology
2022, Vol.6, No.3, 7827-7834
http://journalppw.com

A Comprehensive Study of Energy Mechanisms in IoT System for Medical Domain

Prince Tehseen Ganai[1]; Dr. Pradnya Wankhade[2]

[1]Research Scholar, Department of Information Technology; Shri JJT University Jhunjhunu Rajasthan
[2]Assistance Professor, Dept. of Computer Science and Engineering, Shri JJT University Jhunjhunu Rajasthan

Abstract

Electronic medical records, for example, are a necessity for the health care system, which benefits from the use of information technology (EMR). An IoT with 5G network research model has been presented to examine how the technology might improve various healthcare services. Physicians in remote places may find it challenging to provide continuous monitoring for their patients via telemedicine, for example. Unreliable networks and weak signals, as well as incompatible equipment, increase the likelihood that conversations or video conferences will be disrupted and that patients will be unable to get treatment on time. The Internet of Things (IoT) and 5G networking are expected to revolutionise communication. IoT model advantages are measured by 5G and IoT characteristics, as well as a healthcare service demand, in the IoT model. Models employing the Internet of Things (IoT) and 5G technologies will be shown in this article to demonstrate how healthcare services may be enhanced in efficiency and effectiveness. Literature review and modelling are two of the primary methods we use to conduct our study. Information technology applications in healthcare may be used to improve the quality of healthcare services and help improve the overall health of the healthcare business.

Keywords: IoT, Health sector, IoMT, energy consumption, 5G

1. Introduction

IoT aims to connect everything with current technology to improve the overall health and well-being of the entire population. Smaller and smaller computer systems have been developed as a result of the development of integrated circuits. There are a number of obstacles in the way of realising this objective. The issue of powering all of these tiny gadgets is one that must be addressed in the near future. A battery is no longer a viable option for any of these gadgets. First and foremost, it is quite difficult to reduce the size of a battery while still providing the necessary amount of power. Secondly, the near proximity of multiple batteries to the user's skin might offer health and safety risks. Furthermore, customers will have negative experiences if they have to charge all of these batteries every one or two days. As a result, researchers are always looking for new ways to fuel their devices. For IoT devices that demand both small size and high power, energy harvesting is one of the most promising alternatives.

Direct energy conversion techniques are used to gather energy from the ambient environment and convert it directly into electric power. Kinetic, electromagnetic (including light and RF) and thermal energy are a few examples of power sources. To replenish a capacitor or to directly power the electronic components, the energy can be obtained. Harvested energy, on the other hand, has an inherent disadvantage. All of them are shaky. Emerging embedded systems are challenged by the volatility of their power supply, which is often weak and intermittent. Traditional CMOS-based technology loses all computing state when the power is turned off, and the computation must continue from scratch. Processor execution will be often interrupted if there are frequent power interruptions. A little power budget will be taxed more often if the system has to be shut down and restarted frequently.

Non-volatile memory has been used in energy harvesting embedded devices to overcome this difficulty. Emerging non-volatile memory technologies, such as FRAM, PCM, and STT-RAM, have advantages over traditional CMOS-based memory devices in that they can maintain data even if power is lost. Fast recovery from power outages means long-running calculations even with uncertain power sources are possible with non-volatile memory.

During a power outage, the processor's volatile state is saved in non-volatile memory, known as checkpointing. Power outages can be handled by copying the current state back to the next available checkpoint. Instead of starting over from the beginning every time a checkpoint occurs, a programme can simply resume execution from the last one.

2. General architecture and characteristics of IoT

It's important to note that the Internet of Things is very different from the regular Internet in terms of communication. Internet of Things has an extra dimension – "anything" – for us, which means that communication may be made at any time and from any location. There are various aspects that indicate the IoT concept's multidimensional comprehensiveness, information exchange and intelligent processing:

- Interconnected. Web of things works with individuals to gadgets and gadgets to other de-indecencies.
- Shrewd detecting. Most of gadgets and actuators have implanted or associated sen-sors to identify current circumstances.
- Knowledge. IoT gadgets make them compute units and programming utilized for savvy deci-sions, forecasts and computerization control.
- Energetical productivity. All IoT gadgets must be productive and ready to utilize recyclable energy, support own energy collecting, assuming the use of gadget requires and permits it.
- Communicating (or information sharing). IoT associated gadgets have the capacity to communicate and share their present status to any remaining associated gadgets. It permits better correspondence stream among client and machines.
- Wellbeing. Web of Things gadgets ought to assist with guaranteeing the security of individual life. All clinical shrewd gadgets are a genuine illustration of this trademark.

Moreover, Internet of Things has functional peculiarities:

- Capacity to get data from things
- Capacity to trade data
- Capacity to astutely process and control data
- Work at large scale

The architecture of the Internet of Things is what determines how well it works, since it is able to bring together all of its features and functions and make them work together seamlessly. 3-layer and 5-layer structures are the most often used. It depicts the building's layout and contains the layers listed below:

- Preception layer (here and there gadget layer or information gatherer and coordination and joint effort). This layer manages information gathered from things. For instance, detecting gadgets. Simple of the actual layer in OSI organizing model.
- Network layer (at times transmission layer). Moves data from the things to different things and data handling frameworks.
- Middleware layer. This layer is answerable for data handling and delivering choice in light of investigation performed.
- Application layer. Gives the applications in view of the article data handled in the middleware layer.
- Business layer. Liable for the administration of the entire IoT biological system.

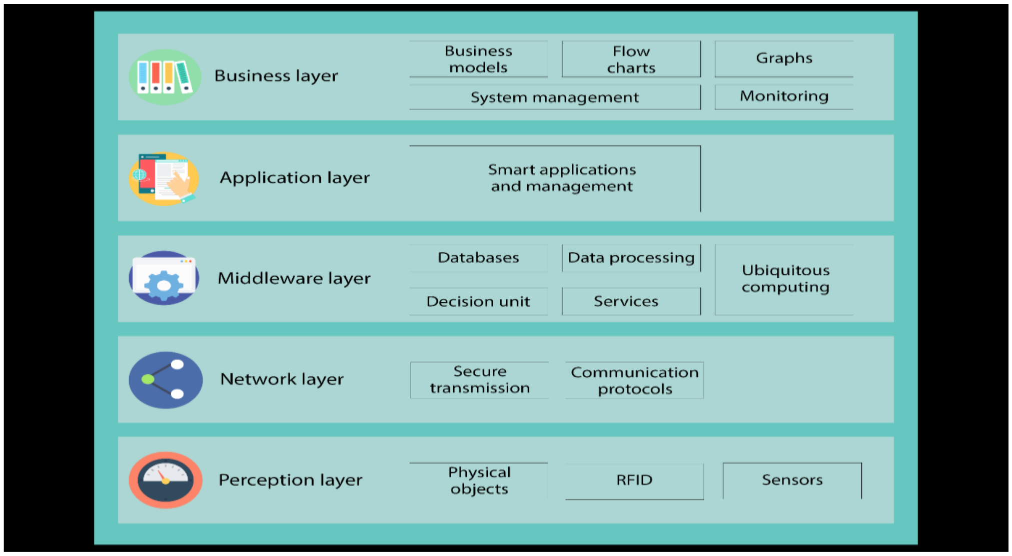

FIGURE 1. Internet of Things architecture

3. Telemedicine, healthcare and medical IoT

Misunderstanding of words can lead to misunderstanding in the telemedicine and healthcare/medical Internet of Things fields. In this section, I'll go over the many words I've used and how they relate to medicine and the Internet of Things.

Use of medical information from one location to another via electronic communications to enhance, maintain, or aid patient health is known as telemedicine. It's common to use the phrase "telehealth" to refer to a broader concept of remote health care that doesn't always include clinical services. Telemedicine and telehealth encompass a wide range of technologies, including video conferencing, image transmission, patient portals, remote vital sign monitoring, continuing medical education, and nurse call centres. For further information on this topic, see Higgs (2014) To put it another way, telemedicine is the use of the Internet of Things for medical reasons, making it a resumptive phrase for the use of information technology in modern medical treatment.

There are two types of telemedicine: medical and healthcare Internet of Things. An important part of health care is the use of preventative measures to keep people in good physical and mental health, as well as monitoring and treating any abnormal or chronic illnesses that may arise. In the Internet of Things, medicine refers to the fields of emergency care, illness research, and medical science. Medical Internet of Things refers to stationary solutions, medical databases, and linked professional equipment since that's what I perceive medicine to be for the sake of restoring health after an accident or disease. The term "Internet of Things" refers to a collection of devices and technology used to support a person's overall health. Because of this, the phrases "personal healthcare IoT" and "healthcare IoT" can be used interchangeably, as can "healthcare IoT" to refer to services tailored to a specific individual.

Personal healthcare Internet of Things technologies include a glucose monitor, pacemaker, cloud service with health information, and a monitoring gadget for youngsters. Medical IoT might be used to define all of the smart medical services, as healthcare is a part of medicine, and telemedicine is a new approach to medicine, later on in my article. It is impossible to study just one discipline because they are all concerned with the treatment of human health, and none of them can be regarded a stand-alone topic. Increasing process transparency and operational activity optimization are two ways the Internet of Things can enhance the health system and, as a result, patient care. Section 3, titled "Personal healthcare IoT research," will go into further detail on the advantages of eHealthcare.

4. Architecture of healthcare IoT

The end-to-end architecture for linked health apps has been announced by the Continua health alliance. The success of the partnership of more than 220 organisations is considered a significant milestone in its objective of creating an environment in which interoperable connected personal health systems are available. See Figure 8 for a high-level architectural overview of the ecosystem provided by the Continua end-to-end (E2E) reference architecture, which also contains three network interfaces and four reference device classes. Medical offices, hospitals, and patient information systems all benefit from the new end-to-end integrated solution.

With the Continua Design Guidelines (CDG), components used in apps that monitor a person's health and well-being will be able to communicate with one another. To further enhance interoperability, it also provides design recommendations that reduce the number of alternatives or add missing features to the standards or specifications. Continued Alliance, 2016).

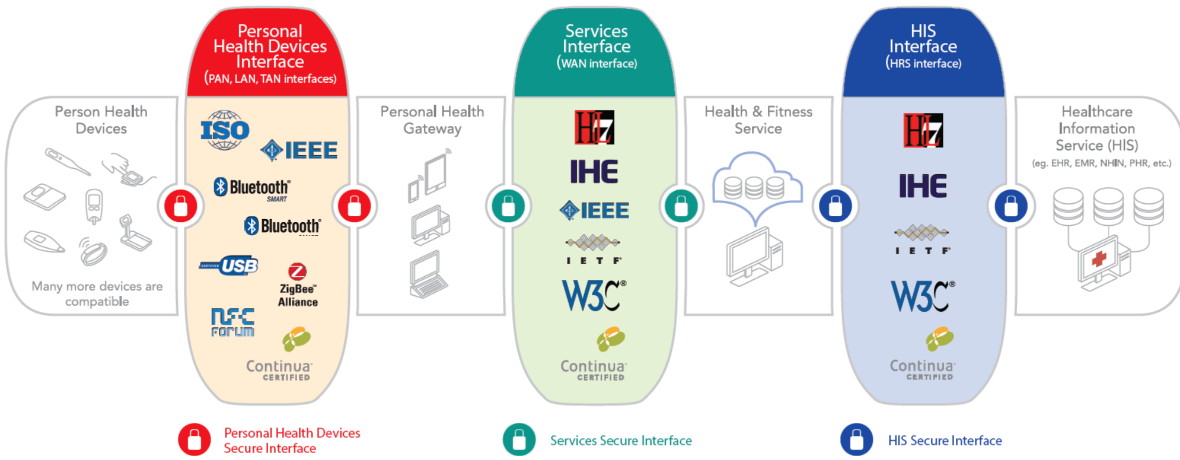

FIGURE 2. Healthcare IoT architecture

5. Related work

Using databases such as Embase, Google Scholar, the Web of Knowledge or MEDILINE, you may find publications about the real application of IOT in healthcare. In light of the limited resources and the nature of the work, the primary approach employed for this article was a review of medical, computer science, and engineering journals and publications. The study concentrated on the most current articles in the scientific community. MEDLINE was used to find the journal articles for this review of related literature (PubMed). For this investigation, keywords were searched for and identified. On the front page of PubMed, an advanced search option was selected, and articles were then searched using this option. Title and abstract were the only search options available. Adding keywords to the browser and doing a search were also done,

Healthcare, telemedicine, and the internet of things are just a few examples. The search results were recorded in a history with sequential numbers for each search. "or" and "and" were then added to the numbers to look for matches. As a result, the number of articles is increased as well as the number of results. In contrast, the addition of "and" narrows them down. Table 3 shows how it appears. It was then stored in a new folder and items of interest were collected from the UWM interlibrary lending system. As a result, the pdf file was saved and downloaded. As a last step, each article was vetted and the final results were determined. Specifically, the search is looking for English-language articles that provide evidence-based study findings on the extent to which IOT is being used in various aspects of healthcare delivery. Different methodologies are being searched for, such as random and non-randomised controlled trials, cross-sectional and longitudinal research studies, and retrospective research using key words such as "artificial intelligence," "Internet of Things," "machine learning," "telemedicine," "simulation," "robotics," and "robotics." Using IOT to access data from both online and offline networks, analyse the data, and give patterns that might aid in the response to various healthcare concerns is the common denominator for all of these words.

Other articles will offer examples of how IOT is being utilised to produce data for AI in medical processes, transformative innovation in healthcare delivery, and the deployment of AI systems across various healthcare or medical procedures may be found using the article search. For instance, a programme at Mount Sinai Hospital called the Deep Patient Initiative has 700,000 patients as participants. For example, the diagnostics layer for different diseases may be found in other publications that discuss IOT innovation content layers.

The article's content provides information on a wide range of subjects that search engines and databases are likely to be interested in. Patient-centered care, workflow optimization, computer assisted diagnosis and simulations for medical education are just some of the topics that should be considered when it comes to IOT in healthcare. IOT for predictive medicine, brain computer interfaces (BCI), system analysis, medical virtual assistants, electronic and online health monitoring, and digital consultations are also included. IoT and 5G RF health hazards have also been discussed in a number of papers.

6. Energy Consumption Model

Some valid assumptions were made while implementing the proposed algorithms. They are listed below:

a. All nodes boot only once i.e. they do not reboot. This assumption has almost no impact on the proposed algorithm. This assumption is only made to keep the counters for number of packets sent, total energy consumption.
b. All nodes are using the same hardware and flashed with the same firmware.
c. Only transmitting radio activities are considered to compute the energy consumption.
d. A fixed sized data frame is used.

A simple state-based linear software energy estimation model is used to compute the energy consumption, where the energy consumption of a node is calculated as the sum of the energy spent in the various states of the transceiver, basically, Transmission (TX), Reception (RX) and Sleep/Idle state (SLP). The amount of energy consumed in a particular state‘s’ of the transceiver (E_s) is formulated as:

$E_s = time\ spent\ (T_s) * current\ drawn\ (I_s) * Voltage\ (V)$

The total energy consumption of a node is then given by

$E_{con} = E_{TX} + E_{RX} + E_{SLP} = VI_{TX}T_{TX} + VI_{RX}T_{RX} + VI_{SLP}T_{SLP}$

In this research, the prime focus is on optimizing the transmission energy therefore the reception state (RX) and idle state (SLP) are ignored and only transmission energy is considered. Hence,

$E_{con} = E_{TX} = VI_{TX}T_{TX}$

ITX is given by the different power levels settings and depends on the type of the hardware

7. Conclusion

We all know that the Internet of things is here to stay and will be for a long time hence. The number of IoT devices that can be linked to the internet has been growing at an exponential rate. With so many uses, it's no surprise that batteries and IoT are often considered to be a single unit. The size, affordability, flexibility, mobility, and ease of installation that come with employing a battery over alternative power sources cannot be overstated. With that said, there are a number of drawbacks, such as a short lifespan. The long-term viability of IoT devices has emerged as a significant issue.

There are a variety of ways to save energy in this subject. This thesis aims to reduce radio transmission energy usage by bringing intelligence to the edge. This thesis focuses on maximising the transmission power and bit-rate, which are two radio characteristics that have a significant influence on energy usage. As a result, four primary research goals have been established, each of which ultimately points to the global goal of producing an energy-efficient approach by modifying transmission power and rate control. Each chapter has its own set of goals for the study project. The most significant effects of transmission power and bit rate are on energy consumption, interference, channel occupancy, and radio connection, to name just a few.

An efficient transmission power/rate management system relies on monitoring and analysing radio links, using the results to anticipate future link quality, and altering protocol or radio settings to meet communication requirements in an energy-saving manner.

References

[1]. Jacob Rodrigues, M., Postolache, O., & Cercas, F. (2020). Physiological and Behavior Monitoring Systems for Smart Healthcare Environments: A Review. Sensors (Basel, Switzerland), 20(8). https://doi.org/10.3390/s20082186

[2]. Ismail, L., Materwala, H., Karduck, A. P., & Adem, A. (2020). Requirements of Health Data Management Systems for Biomedical Care and Research: Scoping Review. Journal of Medical Internet Research, 22(7), e17508. https://doi.org/10.2196/17508

[3]. Godfrey, A., Hetherington, V., Shum, H., Bonato, P., Lovell, N. H., & Stuart, S. (2018). From A to Z: Wearable technology explained. Maturitas, 113, 40–47. https://doi.org/10.1016/j.maturitas.2018.04.012

[4]. Gupta, S., Johnson, E. M., Peacock, J. G., Jiang, L., McBee, M. P., Sneider, M. B., & Krupinski, E. A. (2020). Radiology, Mobile Devices, and Internet of Things (IoT). Journal of Digital Imaging, 33(3), 735–746. https://doi.org/10.1007/s10278-019-00311-2

[5]. Haghi, M., Thurow, K., & Stoll, R. (2017). Wearable Devices in Medical Internet of Things: Scientific Research and Commercially Available Devices. Healthcare Informatics Research, 23(1), 4–15. https://doi.org/10.4258/hir.2017.23.1.4

[6]. Dalal, S. & Athavale, V. (2012). Analysing Supply Chain Strategy Using Case-Based Reasoning. Journal of Supply Chain Management Systems, 1(3), 40-48.

[7]. Dalal S., Agrawal A., Dahiya N., Verma J. (2020) Software Process Improvement Assessment for Cloud Application Based on Fuzzy Analytical Hierarchy Process Method. In: Gervasi O. et al. (eds) Computational Science and Its Applications – ICCSA 2020. ICCSA 2020. Lecture Notes in Computer Science, vol. 12252. Springer, Cham. https://doi.org/10.1007/978-3-030-58811-3_70

[8]. Seth B., Dalal S., Kumar R. (2019) Hybrid Homomorphic Encryption Scheme for Secure Cloud Data Storage. In: Kumar R., Wiil U. (eds) Recent Advances in Computational Intelligence. Studies in Computational Intelligence, vol 823. Springer, Cham.

[9]. S. Pradeep and Y. K. Sharma, “A Pragmatic Evaluation of Stress and Performance Testing Technologies for Web Based Applications,” in 2019 Amity International Conference on Artificial Intelligence (AICAI), 2019, pp. 399–403.

[10]. Panthee, M., & Sharma, Y. K. (2019). Review of e-government implementation. International Journal of Recent Research Aspects, ISSN: 2349-7688, 6(1), 26–30.

[11]. Y. K. Sharma and M. D. Rokade, "Deep and Machine Learning Approaches for Anomaly-Based Intrusion Detection of Imbalanced Network Traffic.," IOSR Journal of Engineering, pp. 63-67, 2019.

[12]. Bijeta Seth, Surjeet Dalal, Dac-Nhuong Le, Vivek Jaglan, Neeraj Dahiya, Akshat Agrawal, Mayank Mohan Sharma, Deo Prakash, K. D. Verma, Secure Cloud Data Storage System Using Hybrid Paillier–Blowfish Algorithm, Computers, Materials & Continua, Vol.67, No.1, 2021, pp.779-798, doi:10.32604/cmc.2021.014466

[13]. Sunita Saini, Dr. Yogesh Kumar Sharma, “LI-Fi the Most Recent Innovation in Wireless Communication”, International Journal of Advanced research in Computer Science and Software Engineering, Volume 6, Issue 2, February 2016.

[14]. Loncar-Turukalo, T., Zdravevski, E., Machado da Silva, J., Chouvarda, I., & Trajkovik, V. (2019). Literature on Wearable Technology for Connected Health: Scoping Review of Research Trends, Advances, and Barriers. Journal of Medical Internet Research, 21(9), e14017. https://doi.org/10.2196/14017

[15]. Magsi, H., Sodhro, A. H., Chachar, F. A., Abro, S. A. K., Sodhro, G. H., & Pirbhulal, S. (2018). Evolution of 5G in

Internet of medical things. 2018 International Conference on Computing, Mathematics and Engineering Technologies (ICoMET), 1–7. https://doi.org/10.1109/ICOMET.2018.8346428

[16]. Mazzanti, M., Shirka, E., Gjergo, H., & Hasimi, E. (2018). Imaging, Health Record, and Artificial Intelligence: Hype or Hope? Current Cardiology Reports, 20(6), 48.

[17]. Malik Meenakshi, Nandal Rainu, Dalal Surjeet, Jalglan Vivek and Le Dac-Nhuong 2021 Driving Pattern Profiling and Classification Using Deep Learning Intelligent Automation & Soft Computing 28 887-906.

[18]. Qi, J., Yang, P., Waraich, A., Deng, Z., Zhao, Y., & Yang, Y. (2018). Examining sensor-based physical activity recognition and monitoring for healthcare using Internet of Things: A systematic review. Journal of Biomedical Informatics, 87, 138–153.

[19]. Radanliev, P., De Roure, D., Walton, R., Van Kleek, M., Montalvo, R. M., Santos, O., Maddox, L., & Cannady, S. (2020). COVID-19 what have we learned? The rise of social machines and connected devices in pandemic management following the concepts of predictive, preventive and personalized medicine. The EPMA Journal, 1–22.

[20]. Ranasinghe, N., Nakatsu, R., Nii, H., & Gopalakrishnakone, P. (2012). Tongue Mounted Interface for Digitally Actuating the Sense of Taste. 2012 16th International Symposium on Wearable Computers, 80–87. https://doi.org/10.1109/ISWC.2012.16

[21]. RAVPower, T. (2019, March 22). Will 5G Improve Battery Life? A Brief Overview. RAVPower. https://blog.ravpower.com/2019/03/will-5g-improve-battery-life-a-brief-overview/

[22]. Reddy, S. S. K. (2016). Evolving to Personalized Medicine for Type 2 Diabetes. Endocrinology and Metabolism Clinics of North America, 45(4), 1011–1020. https://doi.org/10.1016/j.ecl.2016.07.001

[23]. Rights (OCR), O. for C. (2009, November 20). Summary of the HIPAA Security Rule [Text]. HHS.Gov. https://www.hhs.gov/hipaa/for-professionals/security/lawsregulations/index.html

[24]. Roehrs, A., da Costa, C. A., Righi, R. da R., & de Oliveira, K. S. F. (2017). Personal Health Records: A Systematic Literature Review. Journal of Medical Internet Research, 19(1), e13. https://doi.org/10.2196/jmir.5876

[25]. Romeo, L., Petitti, A., Marani, R., & Milella, A. (2020). Internet of Robotic Things in Smart Domains: Applications and Challenges. Sensors (Basel, Switzerland), 20(12). https://doi.org/10.3390/s20123355

[26]. Meenakshi Malik, Rainu Nandal, Surjeet Dalal, Vivek Jaglan and Dac-Nhuong Le, Deriving Driver Behavioral Pattern Analysis and Performance Using Neural Network Approaches, Intelligent Automation & Soft Computing, vol.32, no.1, 87-99, 2022, DOI:10.32604/iasc.2022.020249

[27]. Dalal, S., Seth, B., Jaglan, V. et al. An adaptive traffic routing approach toward load balancing and congestion control in Cloud–MANET ad hoc networks. Soft Comput (2022). https://doi.org/10.1007/s00500-022-07099-4

[28]. Yogesh Kumar Sharma et al. "Designing enhanced Security Architecture for 5G Networks", International Journal of Management, IT & Engineering, ISSN: 2249-0558, Vol. 8, Issue 8(1), Pp. 73-83, Aug. 2018.

[29]. Yogesh Kumar Sharma et al. "Framework for Privacy Preserving Classification in Data Mining", Journal of Emerging Technologies and Innovative Research, ISSN: 2349-5162, Volume No. 5, Issue No. 9, pp. 178-183, Sept. 2018.

[30]. Yogesh Kumar Sharma et al. "Critical Study of Software Models Used Cloud Application Development",

International Journal of Engineering & Technology, E-ISSN: 2227-524X, Volume No. 7, Issue No. 3.29, pp. 514-518, 2018.

[31]. Yogesh Kumar Sharma et al. “Project Virtualization Task Scheduler: A New Contribution to Green Cloud Computing”, International Journal of Engineering Inventions (IJEI), ISSN (e): 2278-7461, ISSN (p): 2319-6491, Vol. 07, Issue 09, Pp. 43-46, Sept. 2018.

[32]. Yogesh Kumar Sharma et al. “Latest Review of Literature for Understanding Traditional Project Management Challenges and Need of Enterprise Cloud Project Management Practices”, International Organization of Scientific Research Journal of Engineering (IOSRJEN), ISSN (e): 2250-3021, ISSN (p): 2278-8719, Vol. 08, Issue 10, Pp. 1-5, Oct. 2018.

[33]. Yogesh Kumar Sharma et al. “Enhanced Technique for LSB Based Security in Digital Color Images Using Visual Cryptography”, Journal of Computational Information Systems, ISSN: 1553-9105, Vol. 14, Issue 6, Pp. 81-88, Nov. 2018. 39. Paper published in International Journal of Management, Technology and Engineering, “Mobile Banking - How secure it is”, ISSN: 2249-7455, Vol. 8, Issue XI, Pp. 24-28, November 2018.

[34]. Kukreja, S., Dalal, S. (2018). Performance Analysis of Cloud Resource Provisioning Algorithms. In: Saeed, K., Chaki, N., Pati, B., Bakshi, S., Mohapatra, D. (eds) Progress in Advanced Computing and Intelligent Engineering. Advances in Intelligent Systems and Computing, vol 563. Springer, Singapore. https://doi.org/10.1007/978-981-10-6872-0_57

[35]. Yogesh Kumar Sharma et al. “security-in-digital-images-using-visual-cryptography-scheme”, Journal of Computational Information Systems, ISSN: 1553-9105, Volume No. 14, Issue No. 6, pp. 49-57, Nov. 2018.

[36]. S. Dalal and U. Jindal, "Performance of integrated signature verification approach: Review," *2016 3rd International Conference on Computing for Sustainable Global Development (INDIACom)*, 2016, pp. 3369-3373.

[37]. Yogesh Kumar Sharma et al. “Web Page Classification on News Feeds Using Hybrid Technique for Extraction”, “Information& Communication Technology for intelligent system”, Series Print ISSN 2190-3018, Series Online ISSN 2190-3026, Print ISBN 978-981-13-1746-0, Online ISBN 978-981-13-1747-7, Vol.-107, Issue-6, Pp.-399-405, DOI: https://doi.org/10.1007/978-981-13-1747-7_38, Dec.

[38]. 2018.