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A Comparative Review of Emerging Wireless Technology

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ABSTRACT

Communication Systems can be Wired or Wireless and the medium used for communication can be Guided or Unguided. In wired technology, communication or transmission of information is done via a medium (also called guided medium) such as co-axial cables, twisted pair cables and optical fiber links; which guides the propagation from one point to another. In wireless technology, communication or transmission of information is done via free space (air) using electromagnetic waves such as radio frequencies, infrared, satellite, and so on, which guides the propagation from one point to another. Data transmission is an unavoidable part of every application or system. This is necessary for additional data processing and evaluation, and different wireless technologies fulfill this purpose. This paper is focused on elements of wireless technology, types, advantage and disadvantage, as well as literature review on various applications and improvements of wireless technology and systems. Additionally, a comparative analysis between the various types of wireless technology based on different aspects and their characteristics was discussed. This paper will serve as a benchmark in wireless technology and use of a particular wireless technology based on the requirement of the application.
Word Count: 189

Keywords : Wireless Technology, Wireless System, Data Transmission, Communication

I. INTRODUCTION

Though wireless communication has been around since 1876, the technology is now being broadly used to convey information from one node to another, using radio waves, microwaves, or infrared waves. A key benefit of wireless technology, information can send out data across long distances without any kind of hindrance; thus, more trustworthy and convenient compared to wired technology. Consequently, devices like sensors and actuators, can be monitored and controlled with ease, making the device more portable and flexible. In industry, various devices, sensors, and actuators are connected in diverse ways through various protocols, if done using wireless technology, can replace all the physical limits of wired technology (Deepan, Himanshu, & Hardik, 2016). A variety of IEEE standards and protocols, such as like Bluetooth, Zigbee, RF modules, infrared and many more, are used for wireless communication. It is used in many areas like industrial, commercial, home use, health care, Smartphone, laptops and

many others. Each wireless standard is being chosen as per the requirement and specification. For example, Bluetooth is used in Smartphone, laptops, home automations, music players, and so on. where several meters of range and data transfer in tens of MBs are required.

1.1 Characteristics of Wireless Technology

Here is some inherent characteristic of wireless communications that make the networks more efficient in usability to the users of networks nodes (Prashant, Varun, Raj, & Devendra, 2015):

1. **Mobility:** Users can access files, network resources, and the Internet without having to physically connect to the network with wires. The Wireless users are provided with access to the real time information even when they are away from their home/offices and even from their society.
2. **Rapid Installation:** The time required for installation is reduced as network connections can be made without moving or adding wires, or pulling them through walls or ceilings, or by making modifications to the infrastructure cable plant.
3. **Flexibility:** Enterprises can also enjoy the flexibility of installing and taking down wireless devices in locations for temporary needs such as a conference, trade show, or standards meeting. The Wireless users are provided with access to the real time information even when they are away from their nativity.
4. **Multihopping:** A multihop network is a network the spot that the path from source to destination traverses' other nodes.
5. **Scalability:** Wireless network topologies can easily be configured to meet specific application and installation needs and to scale from small peer-to-peer networks to very large enterprise networks that enable roaming in a broader area.
6. **Cost:** Networks can be extended at any level with limited cost or almost no cost, no wired system and hence setting up a wireless network is much easy and fast; it eliminates the need for pulling out the cable through walls and ceilings.
7. **Self-organization:** the ad hoc network must autonomously determine its very own configuration parameters including: addressing, routing, clustering, position identification, power control, and so on.
8. **Energy conservation:** most ad hoc nodes have limited power supply, no power to generate their particular power. High efficiency protocol design is important for longevity with the mission.

1.2 Types of Wireless Technology

1. RF Module

This is a band of frequency ranging from 3KHz to 300GHz known as Radio Frequency (RF). RF module is an electronic circuitry which is used to "broadcast" and "receive" real time data from one device to another. The data transfer rate is ranging from 1kbps to 10kbps. It transmits data in the range of 100 meters in open space. It contains a very low-level power consumption and ease of access. There are various signal modulation techniques that can be employed in RF module, such as Amplitude Shift Keying (ASK) (best suitable for digital data), Frequency Shift Keying (FSK), Direct Sequence Spread Spectrum (DSSS) and Frequency Hopping Spread Spectrum (FHSS). There are four categories of RF module: Transmitter, Receiver, Transceiver and System On Chip (SoC). It can work for long ranges with no hindrance by other radio modules unlike Infrared modules. It can be applied in various application areas such as vehicle monitoring, telemetry, Remote control, small range wireless network, wireless home security system, robotics, radio tag reading, wireless fire protection system and other countless number of applications (Deepan, Himanshu, & Hardik, 2016).

II. METHODS AND MATERIAL

1. Bluetooth

Bluetooth is standardized as IEEE 802.15.1 standard, generally used for short range communication. It works on 2.4 to 2.485 GHz frequency of the ISM band having 79 channels separated by 1 MHz. Data transmission is done in the form of packets, which are transmitted by Frequency Hopping Spread Spectrum (FHSS). It consumes very less power, available at very economical price, and it is a very simple yet effective technology (Rajeev & Brent, 2000). Bluetooth technology works on the principle of "Master-Slave". Communication can be established only after the Master device invoke the process. Every device containing its Global ID, which gets exchanged among them and the connection gets established after it. Bluetooth Low Energy (BLE) and Bluetooth 4.0 are the latest version of this technology which consumes much less power than the former version. It is being employed in new applications, such as Healthcare, security, fitness and many more. Sometimes, Bluetooth Technology encounters with pairing error, yet it still has a very wide range of application, such as wireless networking between devices and other wireless peripherals such as mouse, keyboard, headsets, media transfer, wireless control, Data logging equipment, and many more (Deepan, Himanshu, & Hardik, 2016).

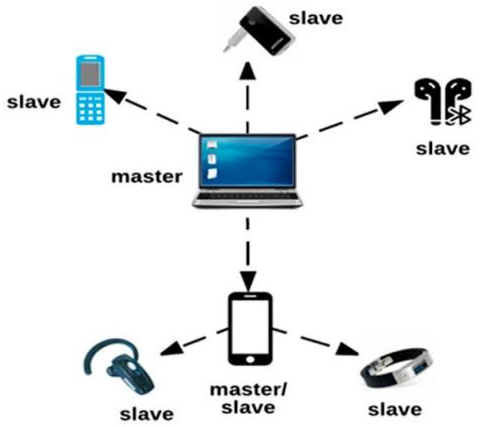

Figure 1 : Bluetooth Network Architecture

2. Wireless Fidelity

Wireless Fidelity (Wi-Fi), IEEE 802.11 standard, is also known as Wireless Local Area Network (WLAN). It is a protocol used to connect devices wirelessly, to provide internet access and also connect different devices to the wired network. Its range is always greater than 100 meters and works on either on 2.4 GHz or 5 GHz. These frequencies are the part of the ISM band and are free to use. Wi-Fi uses radio waves to transmit information for wireless communication between devices or internet access. To establish communication, there are two devices required, namely Wireless adapter and Wireless router. (Deepan, Himanshu, & Hardik, 2016) highlighted three major standards applied for the security purpose of Wi-Fi which are: **Wireless Equivalent Privacy (WEP)** uses 40- or 104-bit encryption and WPA provides authentication; **Wi-Fi Protected Access (WPA)**; **Wi-Fi Protected Access-2 (WPA-2)** uses 128-bit encryption methods. Wi-Fi uses 2.4 or 5GHz high frequency so that it can carry more data. Wi-Fi can be used to share internet, to share files, to share resources between devices and much more.

3. ZigBee

In the industrial and medical applications, there is need for low data transfer medium. So, Zigbee alliance presented IEEE 802.15.4 standard. While Bluetooth and Wi-Fi are used to transfer lager data file such as media files, Zigbee is suitable when communication is occasional, smaller packet sizes are used, and power consumption is an issue (Andreas, Kirsten, & Adam, 2005). Zigbee works on radio standards and 2.4 GHz, 900 MHz, 868 MHz unlicensed band frequency. Due to low power and low data rate its range is limited from 10 to 100m. Its having data rate of 250kbps. Due to energy efficiency, it provides long battery life (Fotouhi, Vahabi, Rasid, & Raja, 2008). Zigbee technology works on Direct Sequence Spread Spectrum (DSSS), due to its very low latency. One of the leading features of Zigbee is, it supports mesh networking. In this topology, each

and every node is capable of locating itself. With the help of routing table any node is able to select a best suitable path for communication. With the help of ad-hoc routing and mesh topology, better stability can be provided. Zigbee is it supports 65000 nodes in network topology. It provides various network topologies like point to point, point to multipoint, mesh network topology and "Personal Area Network" (PAN). It provides security and application services which can work on PHY layer and MAC layer (Hu, 2010). Zigbee technology is very much safe and secure, because it provides 128-bit encryption method to get security from data collision, interference, and trespassing. Zigbee is used in various applications such as automation, Automatic meter reading, sensor networking in industrial, Medical devices and applications, lighting control, building automation and many more thanks to a very low cost and long battery life.

4. Infrared

This is the technology through which communication is achieved via infrared radiation. In this technology, an infrared port is required to transmit and receive the data. This technology provides bi-directional communication. Its range is about 1 to 10 meters. It provides data rates about 4 Mbps. Infrared technology features include, very economical, very low power consuming, highly secure, portable, immune from noise yet contains simple circuitry. But it has some limitations too. It requires line of sight communication; any obstacle causes interference and failure in the communication. It is only available for short range communication, which is affected by light, climate and atmospheric conditions. It is usually used in TV remote control and cheap mobile handsets.

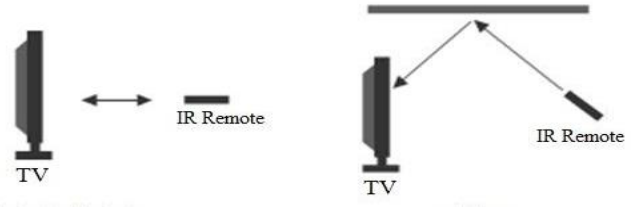

Figure 2: Example of Infrared Application

5. Near Field Communication

Near Field Communication (NFC) is the wireless technology that allows mobile devices to vigorously work together with additional mobile devices. NFC is a very short-range communication used to share data between two devices closer within 4 cm. It works at 13.56 MHz, which is an unlicensed ISM radio frequency band. The data transfer rate is ranging from 106 to 424 kbps. NFC makes available flawless medium for the recognition protocols that authenticate the protected transfer of data. Near Field Communication can take place in three modes: **Card emulation**: smartphone can act like smart card and make payments; **Reader/ writer**: smartphone can read or write NFC tags; **Peer to peer**: two NFC device can interact with each other and convey information (Agrawal & Sharad, 2016).

6. Ultra-Wideband

Ultra-Wideband (UWB) technology transmits information over a large spectrum with a high bandwidth and a low power spectral density. Due to low power spectral density it is secured from interference with other radio frequencies, and with the help of high bandwidth which is greater than 500 MHz it can carry large data. UWB uses the 3.1 to 10.6 GHz frequency band. In this technology, we can share spectrum with other users and be used as a high rate personal area network (PAN). It is generally known as pulse radio, transmission is made by increasing or decreasing the level of amplitude, frequency or phase, and transmission takes place by generating radio energy at specific time interval. It is mainly used in radar imaging technique, because it has a very efficient spatial capacity around 1013 bits/m2. It can also be used in short range indoor application (Aiello & Gerald, 2003) (Porcino & Walter, 2003).

7. Wireless Body Area Network

Wireless Body Area Network (WBAN), IEEE 802.15.6 standard, is mainly created for low power, short range and highly reliable medical and healthcare application. It uses ISM band and other

frequency band which is allowed for medical purpose. It provides data transfer rate about 10 Mbps. It can work on a range of about 2-5 meter and allows 256 nodes. It uses star network topology for the communication process. A key layer which is used for data communication is MAC layer (Mohammad, Harneet, Sherratt, & William, 2015). With the help of this technology, notification can be sent before the heart attack occurs from the observations of change in vital signs. Also, it can inject insulin in the diabetic patient's body. The WBAN technology contains three levels of security, such as unsecured communication (level 0), authentication but no encryption (level 1), authentication and encryption (level 2). For the communication, the host and node must be at same security level. Consequently, a temporary key is generated which is used for communication and can only be used once.

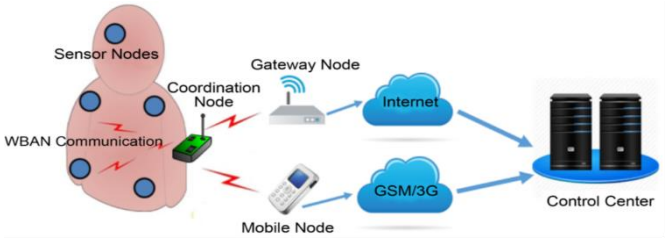

Figure 3 : Wireless Body Area Network Architecture

8. Long Range

Long Range (LoRa) is a long-range wireless communications system, promoted by the LoRa Alliance. It aims at being usable in long-lived battery-powered devices, where the energy consumption is of paramount importance. LoRa can commonly refer to two distinct layers: a physical layer using the Chirp Spread Spectrum (CSS) radio modulation technique; and a MAC layer protocol (LoRaWAN). The LoRa physical layer, allows for long-range, low-power and low-throughput communications. It operates on the 433-, 868- or 915-MHz ISM bands, depending on the region in which it is deployed. The payload of each transmission can range from 2–255 octets, and the data rate can reach up to 50 Kbps when channel aggregation is employed. The modulation technique is a proprietary technology from Semtech. LoRaWAN provides a medium access control mechanism, enabling many end-devices to communicate with a gateway using the LoRa modulation. While the LoRa modulation is proprietary, the LoRaWAN is an open standard being developed by the LoRa Alliance (Aloÿs, Jiazi, Thomas, & William, 2016).

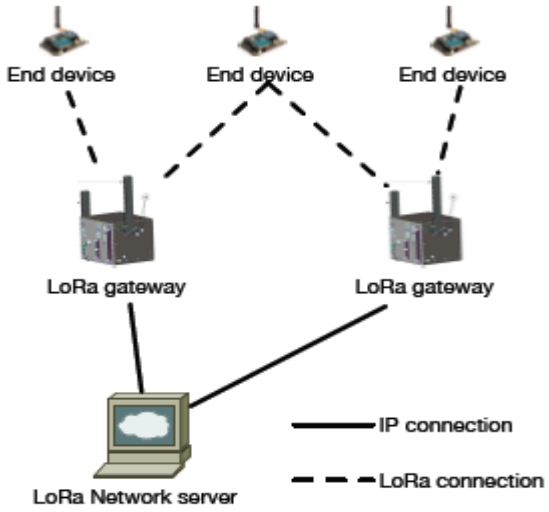

Figure 4 : Long Range Network Architecture

9. Dedicated Short-Range Communication

The Dedicated Short-Range Communication (DSRC), based on IEEE 802.11a standard, is a multi-channel wireless standard that operates in 75MHz licensed spectrum at 5.850 to 5.925 GHz band range. It is designed for indoor low-mobility WLAN. The 802.11p based DSRC is being considered as a promising wireless technology for enhancing transport safety and highway efficiency. It operates in a strict environment which requires fast communications to maintain the connection with speeding vehicles in real-time, thus maintaining a strict quality of service threshold. Minimal use of transmission power and maintain privacy and anonymity. Relevant application areas include vehicle-infrastructure integration (IntelliDrive), cooperative intersection collision avoidance system (CICAS), automatic vehicle safety inspection, electronic toll collection, transit or emergency

vehicle signal priority, amongst others (Habib, et al., 2013).

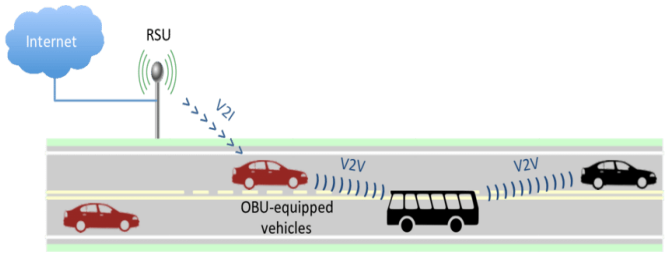

Figure 5 : DSRC-Based Communication

10. Long Term Evolution

The long-term evolution (LTE) as defined by the 3rd Generation Partnership Project (3GPP) is a highly flexible radio interface. The first release of LTE provides peak rates of 300 Mbps, a radio-network delay of less than 5 ms, a significant increase in spectrum efficiency compared to previous cellular systems, and a new flat radio-network architecture designed to simplify operation and to reduce cost. LTE supports both frequency-division duplex (FDD) and time-division duplex (TDD), as well as a wide range of system bandwidths in order to operate in a large number of different spectrum allocations. The radio link control (RLC) and medium access control (MAC) layers, among other tasks, are responsible for retransmission handling and multiplexing of data flows. In the physical layer, the data that is to be transmitted is turbo coded and modulated using one of the following: quadrature-phase shift keying (QPSK), 16-QAM, or 64-QAM, followed by OFDM modulation. The subcarrier spacing is 15 kHz and two cyclic-prefix lengths are supported in both uplink and downlink, a normal cyclic prefix of 4.7 μs, suitable for most deployments and an extended cyclic prefix of 16.7 μs for highly dispersive environments (David, et al., 2009).

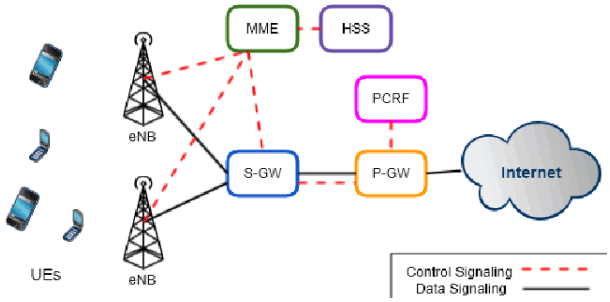

Figure 6 : Main Components of LTE Network

11. Light Fidelity

Light Fidelity (Li-Fi) is a Visible Light Communication (VLC) technology in which data is transferred through a LED light bulb whose intensity keep on varying at a very high speed. The VLC uses visible light between 400 THz (780 nm) and 800 THz (375 nm) as the optical carrier for data transmission and for illumination. Data rates of greater than 100 Mbps can be achieved by using high speed LEDs with adequate multiplexing. Parallel data transmission using arrays of LEDs where each LED transmits a separate stream of data can be used to increase the VLC data rate. Though the lights have to be kept on in order to transmit data, they can be dimmed to the point that they are not visible to humans but still be capable of transmitting data. This technology offers a large bandwidth which is unlicensed, so it can be used for many application such as streaming of video and music, connection of internet with moving or stationary devices and so on (Anurag, Shalabh, & Asoke, 2015).

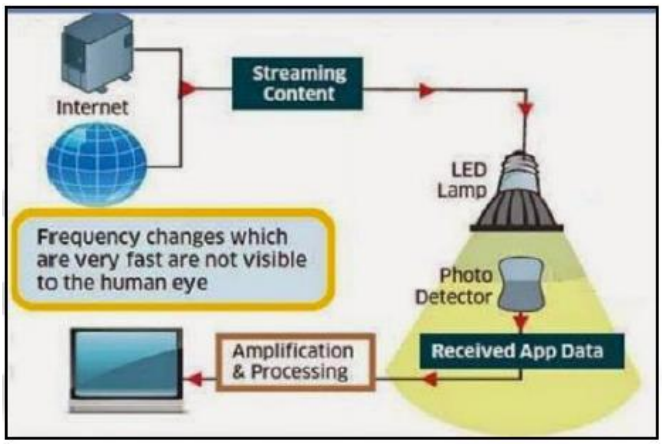

Figure 7 : Block Diagram of Li-Fi Sub System

1.3 Advantages of Wireless Technology

There are numerous advantages of Wireless Communication Technology, Wireless Networking and Wireless Systems over Wired Communication such as (Mohaiminul & Shangzhu, 2019):

1. **Cost:** The cost of installing wires, cables and other infrastructure is eliminated in wireless communication and hence lowering the overall cost of the system compared to wired communication system. Installing wired network in building, digging up the Earth to lay the cables and running those wires across the streets is extremely difficult, costly and time-consuming job. Thus, wireless communication such as Wi-Fi or Wireless LAN is the only option.
2. **Mobility:** This is the main advantage of wireless technology system. It offers the freedom to move around while still connected to network.
3. **Ease of Installation:** The setup and installation of wireless technology network's equipment and infrastructure is very easy compared to wired technology. Also, the time required to setup a wireless system like a Wi-Fi network for example, is very less when compared to setting up a full cabled network.
4. **Reliability:** Since no cables and wires involved, no chance of communication failure due to damage of these cables which may be caused by environmental conditions, cable splice and natural diminution of metallic conductors.
5. **Disaster Recovery:** In case of accidents due to fire, floods or other disasters, the loss of communication infrastructure in wireless communication system can be minimal.

1.4 Disadvantages of Wireless Technology

Even though wireless communication has a number of advantages over wired communication, there are a few disadvantages such as (Mohaiminul & Shangzhu, 2019):

1. **Interference:** Wireless technology systems use open space as the medium for transmitting signals. Therefore, there is a huge chance that radio signals from one wireless technology system might interfere with other signals. For example, Bluetooth and Wi-Fi (WLAN) uses the 2.4GHz frequency for communication, when both are active simultaneously, there is a chance of interference.
2. **Security:** Since the signals are transmitted in open space, it is possible that an intruder can intercept the signals and copy sensitive information. This is a major concern in wireless technology.
3. **Health Concerns:** Continuous exposure to any type of radiation can be hazardous. Even though the levels of Radio Frequency energy that can cause the damage are not accurately established, it is advised to avoid Radio Frequency radiation to the maximum.

III. LITERATURE REVIEW

This review of literature focuses on the applications and improvement of wireless technology. Highlighting some of the possible ways via which wireless technology has been employed in our daily lives. (Tan-Hsu, et al., 2017) presented a new ubiquitous emergency medical service system (UEMS) that consists of a ubiquitous tele-diagnosis interface and a traffic guiding subsystem. The UEMS manages the sensor wires for eliminating inconvenience for both patients and paramedics in an ambulance, providing ubiquitous accessibility of patients' biosignals in remote inaccessible areas using wireless biosensors, and offering availability of real-time traffic information using webcam; can be simultaneously transmitted to an emergency room for pre-hospital treatment via WiMAX/3.5 G networks. Results validates the feasibility of the proposed system for application in real-life scenarios. (Danda, Bassma, & Vijay, 2019) investigated wireless virtualization (WiVi) where wireless resources for

virtual wireless networks are adapted based on availability of leasable RF slices as well as the demands from the users of virtual wireless networks. With the help of software defined network controller, wireless infrastructure providers (WIPs) slice their RF bands to sublease those slices to mobile virtual network operators (MVNOs). In wireless virtualization, MVNOs work as independent service provides, and thus, the end users negotiate directly to MVNOs regardless of WIPs used behind the scene. WiVi through MVNOs can provide better service to wireless users (higher data rates and with lower outage probability) when MVNOs receive enough RF slices from WIPs to serve their users. (Natasa, et al., 2019) presented and evaluated a mobile monitoring system using various non-intrusive wireless sensors that continuously measure vital parameters of the patient. Results shows high acceptance of the developed system by Electronic Medical professionals. And concluded that the proposed system can be used as a complementary system in Electronic Medical System, allowing continuous real-time monitoring of patients' vital signs and on-scene triage. (Estefania, Adrián, Aarón, Alfonso, & Matilde, 2019) proposed a network and physical layer solution based on LTE-A and future 5G capabilities to improve public safety communications, which are currently conveyed through narrowband private mobile radio (PMR) systems and mainly focused on offering limited voice services. Performance was analyzed in terms of capacity of an amplify-and-forward relay network when massive multiple-input multiple-output (MIMO) textile technology is deployed at the user side. Additionally, the optimal relay location was evaluated, with the purpose of maximizing the achieved capacity in the two-hop network. Results illustrated the viability of the proposed design, specifically for low SNR scenarios where the relay node will allow us to extend the coverage and the MIMO textile technology to improve the capacity. (Bradley, Salil, Yvonne, & Keat, 2020) reviewed and briefly describes some common wireless technologies and modern advancements, as well as their strengths and suitability for use in implantable medical devices. The applications of these wireless technologies in treatments of orthopedic and cardiovascular injuries and disorders are described. Such that, with remote data collection and control of implantable devices, these wireless technologies help researchers and clinicians to better understand diseases and to improve medical treatments. And then concludes with a discussion on the technical challenges and potential solutions of implementing wireless technologies in implantable devices. (Bahaa, Alyani, & Aduwati, 2020) reviewed electro-textile wearable tags involved in the body-centric area particularly examining microstrip patch antennas; since they radiate perpendicularly to the planar structure, of which their ground plane shields the human body efficiently. The crucial features of conductive and non-conductive textile materials used in designing wearable antennas were reviewed. This review can be the benchmark used to choose the materials and techniques to design a textile wearable tag in the Body Area Network. The embroidery textile slotted patch design antenna with specific materials proved in this study to have high performance. (Gordana, Konstantinos, Dragana, & Lazar, 2020) provided an extensive survey on emerging IoT communication standards and technologies suitable for smart healthcare applications. With emphasis on low-power wireless technologies as a key enabler for energy-efficient IoT-based healthcare systems; with challenges in privacy and security. A particular attention is devoted to crowdsourcing/crowdsensing, envisaged as tools for the rapid collection of massive quantities of medical data. (Emanuele & Salvatore, 2020) designed a technology which can reduce the effects of exposure to electromagnetic fields as much as possible is needed. By applying resonance theory to search non-resonant frequencies in the mechanism of ions flux across cellular membrane channels, that minimize harmful effects of high-frequency electromagnetic radiation, using spectroscopic and

biochemical techniques. The development of new emerging 5G technology at non-resonant frequency should induce a decreasing of harmful effects on human health, without giving up advantages of this advanced technology. (Lova Raju & Vijayaraghavan, 2020) analyzed of the idea of IoT in the field of agriculture. In the near future, sensors, actuators, and devices will rule the agricultural world by connecting to the internet alongside the basic aim of intercommunication and decision making. By providing innumerable profits to the end user with a variety of services such as supervise pests, build intelligent seeds, monitor crop yield, weed detection, water management and so on, for improving the result of production in agriculture. By using wireless technologies such as Wi-Fi, Zigbee, Z-Wave, GSM and automation, helps to improve the crop yield by perfect monitoring and detection of disease affected crops. Hence better usage of automation in agriculture helps to improve the yield of the crops.

IV. Discussion

Table 1 : Comparative Analysis of Wireless Technologies

Attributes	Network Standard	Operating Frequency	Range	Transfer Rate	Modulation Technique	Cost	Power
RF Module	802.15.4	433.92 MHz	100 m	1 – 10 kbps	ASK, OOK, FSK	Low	Low
Bluetooth	802.15.1	2.4 – 2.485 GHz	10 m	1 Mbps	GFSK	Low	Low
Wi-Fi	802.11.x	2.4 GHz, 5GHz	100 m	11 Mbps	BPSK, QPSK, CCK	High	High
Zigbee	802.15.4	2.4 GHz	100 m	250 kbps	BPSK	Low	Low
Infrared	802.11	875 nm	1 - 10 m	1.152 Mbps	Pulse	Low	Low
Near Field Communication	ISO 13157	13.56 MHz	4-20 cm	106 – 424 kbps	ASK	Low	Low
Ultra-Wideband	802.15.4a	3.1 – 10.6 GHz	500 ft	50 – 100 Mbps	PPM	Low	Low
WBAN	802.15.6	2.4 GHz, 800, 900, 400 MHz	2 – 5 m	10 Mbps	BPSK, QPSK	Low	Low
LoRa		Sub – 1 GHz	10 km	~38.4 kbps	CSS	Low	Low
DSRC	802.11p	5.86 – 5.92 GHz	~1000 m	~27 Mbps	BPSK to 64 QAM		Low
LTE	GSM/UMTS	7 – 900 MHz (Licensed)	~11 km	~1 Mbps	QPSK, 16-QAM, 64-QAM, OFDM	Low	Low
Li-Fi	802.11bb	800 THz and 400 THz	~10 m	1 - 3.5 GHz	Visible Light	Low	Low

In this developing world, wireless technology has become very cost-effective, very much effective, and easy to implement compared to conventional wired technology. Each wireless technology is best suited for an assortment of applications, with their pros and cons coming into action based on the requirement of the application. Table 1 presents a comparative analysis of a variety of wireless technologies for communication. Wi-Fi is best for internet sharing and large media file transfer. On the other hand, Infrared, Near Field Communication and Light Fidelity are best for extremely short-range communication, yet they are highly secure. Additionally, Ultra-Wideband technology can be used in radar application and Wireless Body Area Network has been specifically designed for healthcare and medical application to make Wearable Sensor Network. Bluetooth and Long-Term Evolution are used by laptops and smartphones for communication purpose. If an application needs low data rate, low power consumption and very small sized data transfer, then Zigbee comes into the picture. Also, it is the most reliable technology in industrial application and for sensor networking.

Table 2 : Applications and Improvement of Wireless Technologies and Systems

Author(s)/Year	Applications/Improvement	Wireless Technologies	Wireless Systems
(Tan-Hsu, et al., 2017)	A new ubiquitous emergency medical service system (UEMS) that consists of a ubiquitous tele-diagnosis interface and a traffic guiding subsystem	WiMAX/3.5 G	Wireless biosensors, Webcam
(Danda, Bassma, & Vijay, 2019)	Wireless Virtualization (WiVi)	Radio Frequency	
(Natasa, et al., 2019)	Mobile monitoring system		Non-intrusive wireless sensors
(Estefania, Adrián, Aarón, Alfonso, & Matilde, 2019)	A network and physical layer solution improve public safety communications	LTE-A and future 5G	
(Bradley, Salil, Yvonne, & Keat, 2020)	Implantable medical devices	Bluetooth Low Energy, Zigbee, Wi-Fi	
(Bahaa, Alyani, & Aduwati, 2020)	An electro-textile wearable tag	Microstrip patch antennas	Wireless Body Area Network
(Gordana, Konstantinos, Dragana, & Lazar, 2020)	Smart healthcare applications		IoT communication standards and technologies
(Emanuele & Salvatore, 2020)	A technology which can reduce the effects of exposure to electromagnetic fields	New emerging 5G technology at non-resonant frequency	
(Lova Raju & Vijayaraghavan, 2020)	IoT in Agriculture	Wi-Fi, Zigbee, Z-Wave, GSM	Sensors, Actuators, and Automation devices

In recent times, the use and reliance on wireless technology in our daily lives is increasing erratically. The research community is working round the clock to make sure that these wireless technologies are up to standard and meets their functional requirements. Various industries have adopted wireless technology as a key component in delivering mark results. Table 2 presents various applications and improvement of wireless technologies and systems. And the various application areas include Healthcare (Tan-Hsu, et al., 2017) (Natasa, et al., 2019) (Bradley, Salil, Yvonne, & Keat, 2020) (Gordana, Konstantinos, Dragana, & Lazar, 2020); Agriculture (Lova Raju & Vijayaraghavan, 2020); Communication (Estefania, Adrián, Aarón, Alfonso, & Matilde, 2019) (Emanuele & Salvatore, 2020); and Emerging paradigms (Danda, Bassma, & Vijay, 2019) (Bahaa, Alyani, & Aduwati, 2020).

V. CONCLUSION

Wireless technology is the fastest growing and most vibrant technological areas in the communication field. This is a method of transmitting information from one point to other, without using any connection like wires, cables or any physical medium. Generally, in a communication system, information is transmitted from transmitter to receiver that are placed over a limited distance. With the advent of Wireless technology, the transmitter and receiver can be placed anywhere between few meters to few thousand kilometers. In the world we live in today, communication and Wireless technology are a key part of our daily lives. Some of the commonly used Wireless technology systems in our daily life are: Mobile Phones, GPS Receivers, Remote Controls, Bluetooth Audio and Wi-Fi and so on. This paper is focused on elements of wireless technology, types, advantage and disadvantage, as well as literature review on various applications and improvements of wireless technology and systems. Additionally, a comparative analysis between the various types of wireless technology based on different aspects and their characteristics was discussed. Although wireless technology is not void of challenges, issues with security regarding access to a person's personal information or the negative impact on society are a few things that are holding back the progress that wireless technology could be making. But with more research and experimentation, the challenges faced by wireless technology can be reduced. Wireless technology will be very important in the near future where the need for wires connecting individual devices seems to be coming to an end.

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