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Modelling of Internet of Things (IoT) for Healthcare

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MODELLING OF INTERNET OF THINGS (IOT) FOR HEALTHCARE

by

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ABSTRACT

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Purpose: Information technology benefits the world, and it's required for health care system, such as electronic medical records (EMR). We have proposed systematic model to study hoe IoT with 5g network has potential to benefit various healthcare services. For example, telemedicine may have some usage restrictions in rural areas and physicians may find it difficult to provide continuous monitoring to patients from such area. There are higher chances that the calls or video conferences getting significantly affected by poor networks and signals as well as non-compatible devices and patient may not get the treatment on time. 5G networking with IoT devices are believed to be the game changer for communication technology. The IoT model assists in attaining information by measuring its benefits through criteria which include 5G and IoT features along with a healthcare service requirement. Purpose of this paper is to present a model using Internet of Things (IoT) and 5G technology which will help to understand improved efficiency and efficacy of healthcare services. Our main research methodologies are literature review and modeling. The obtained results can be used for information technology applications in healthcare for various healthcare services and assist in increasing health quality in the healthcare industry.

Method: Created a model to set the standard for incorporating 5G IoT devices health related technology and services. Reviewed through several models that serve as potential model to involve key factors that are unique certain healthcare services. We picked one model that can be easily incorporated in the system and can be revised to fit within the requirements using 5G IoT devices. Gathering of related literature served as a foundation in understanding the benefits of 5G IoT in the healthcare systems and parameters were pooled from it to revise the IoT model.

Results: Incorporating 5G IoT features into a chosen model gave an overview of various determinants that can help understanding how IoT can influence any healthcare service and improve the quality of health. There are no rules and restrictions for use and utilization of this technology for health management yet in developing stage however, healthcare systems can rely on the 5G IoT devices for quality betterment.

Conclusion: IoT with 5G has potential to improve healthcare management. The 5G world with an IoT will allow us to enter an era where real-time health services will become the part of the daily routine rather than the exception. However, further research needs to be done about its usage within any kind of specific health technology. Future research directions can utilize our model for other lesser known healthcare services.

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1.Introduction

Internet was here for been a while. The internet we know is created by people for people and about people. All games, videos, everything was created by people. As we all see that an internet has changed our life and so the world. In the pre-internet era, fixed and mobile telephony was the major mode of human to human communication. With the origin of Internet, the world changed and made the information available for us from miles away, at just the click of a button. As the internet grown the invention of blogging, social media began to explode in popularity. Social media sites gained prominence and introduced entirely new way for the people to communicate and share information with each other across great distances. Nearly all the data available on the Internet today is created by human for humans. But human has limited time, attention, and accuracy, which limits their ability to capture the data about things in the real world, so, if we had things or devices that knew everything about things, using data they gathered without a human help, we would be able to track and count everything and greatly reduce waste, loss and cost and this concept has given birth to “Internet of Things”.

IoT has been emerging as a new technology that is used to express a modern wireless telecommunication network. It would be expected to be an intelligent interoperability node which would be interconnected in a dynamic global infrastructure network. IoT can also be referred as Internet of Everything (IoE) which consists of all the web-enabled devices that collect, send and act on data they acquire from their surrounding environments using embedded sensors, processors and communication hardware. The devices, often called "connected" or "smart" devices as it can talk through machine-to-machine (M2M) communication other related devices and can act on the information they get from one another. Humans can interact with the gadgets to set them up, give them instructions or access the data, but the devices do most of the work on their own without human intervention. The Internet of Things (IoT) is expanding at a rapid rate, and it is becoming increasingly important for professionals to understand what it is, how it works, and how to harness its power to improve business. The next generation internet 5G, can unlock the power of the IoT and give life to the physical world which will transform our lives in the next 25 years. The IoT has the potential to reach every human being on the planet at one time or another in their lifetimes. It's gone from the modern factory floor to tech-driven hospitals and medical facilities in a very short amount of time, and it's a development that is already transforming the industry of healthcare IT.

1.1 What is Internet of Things (IoT)?

The new internet emerging is not only about connecting the people but connecting the things where things can share their experience with other. Internet of things was born when there were more things on internet than people. The IoT is influencing our lifestyles from the way we react to the way we behave. The air conditioner can be operated with a smart phone, the smart cars provide the shortest route. Furthermore, the smart watch we use track our daily activities. IoT is a giant network with connected devices. These devices gather and share data about how they are used and the environment in which they are operated. It is all done using sensors which are embedded in every physical device. It can be our mobile phone, electrical appliances and vehicles, barcode sensors, traffic lights and almost everything that we come across in day to day life. These sensors continuously emit data and the working state of the devices, but the important question is how they share this huge amount of data, and how do we put this data to our benefit. IoT provides a common platform for all these devices to dump their data and a common language for all the devices to communicate with each other. Data is emitted from various sensors and sent to IoT platform's security. IoT platform integrates the collected data from various sources and further analysis is performed on the data for extraction of the valuable information as per requirement. Finally, the result is shared with other devices for better user experience, automation and improving efficiencies. Let us look at a scenario where IoT is doing wonders. A light bulb can be switched on/off from miles away using a mobile device is an example of an IoT device. A motion sensor inside an office combined with a thermostat and a display which provides temperature, ambient lighting and presence inside a conference room at regular intervals is another example of an IoT device. We have smart appliances, Smart Cars, Smart Homes, smart Cities where IoT is redefining our lifestyle and transforming the way interact with Technologies. The future of IoT industry is huge.

Definitions

Definition 1: Internet of Things (IoT) is a network of devices which can sense, accumulate and transfer data over the internet without any human intervention.

Definition 2: The Internet of Things (IoT) is a concept of connecting interrelated computing devices over the internet. In simple words IoT is an internet, through which device to device communication and data transfer is possible. These devices do not need human help.

In other words, it is a platform that comprises hardware and software interacting seamlessly with each other to connect everyday things to the internet thus enabling us to collect and exchange information (*Accelerating Digital Transformation in Healthcare with IoT - IoT Agenda*, n.d.) (Banafa , 2016).

Key Features (components) of IoT

By now we have understood that IoT is not just Internet-connected consumer devices. In fact, IoT is the technology that builds systems capable of autonomously sensing and responding to stimuli from the real world without human intervention. We therefore need to develop a process flow for a definite framework over which an IoT solution is built. The IoT data undergoes a long and fascinating journey. There is a data up-stream from the sensors in the field, via the wireless connectivity, into the IoT platforms. Then, there are data mash-up opportunities within the platforms allowing us to leverage Big Data opportunities. Finally, there is a data down-stream from the platforms back to the actuators in the field or some beautiful frontends on our computer screen or smart phone.

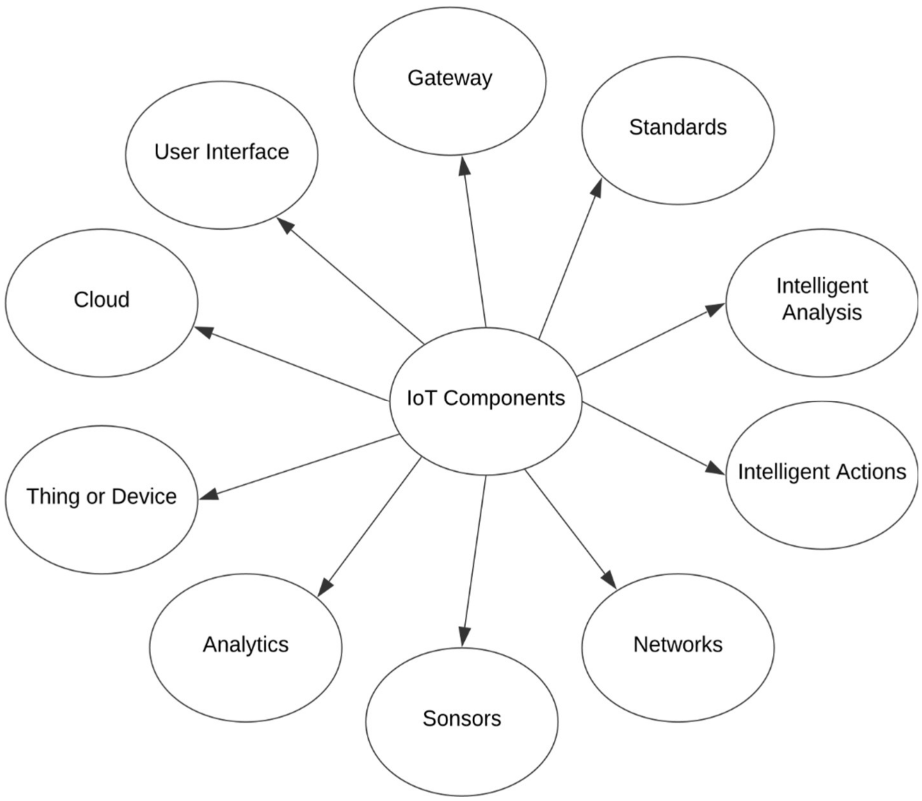

Figure 1.Model of IoT

Let's look at the different technology components that make up an Internet of Things product. (IOT NEWS PORTAL)

IoT Components	
Component	Description
Gateway or Connectivity	A communication channel through which devices can communicate and share information.
Standards	Use of various standards depending on the IoT application in use for example, technology and regulatory standards.
Intelligent Analysis	IoT use cases are intended to derive business insights or actionable recommendations.
Intelligent actions	M2M (Machine to Machine) interfaces actions perform automatically. Automation and artificial intelligence provide better control over the system and help us achieve the real potential of technology.
Networks	Data collected is sent to a cloud infrastructure, but it needs a medium for transport.
Sensors	Help in collecting very minute data from the surrounding environment. A device can have multiple sensors that can bundle together to do more than just sense things.
Analytics	Data coming from devices and sensors is converted into a format that is easy to read and

	process. Cloud infrastructure will then identify the particular user who has requested the data and will then push the requested data to the app.
Thing or Device	An entity or physical object with an unique identifier, an embedded system and the ability to transfer data over a network.
Cloud	IoT generates a lot of data and cloud platform allows us to store and process the IoT data received.
User Interface	IoT provides a visible interface that can be easily accessed and controlled by the user.

Table 1. IoT Components

1.2 Human and Machine Senses

What makes living things alive? They can sense and communicate with each other, can't they? Humans have five basic senses: touch, sight, hearing, smell and taste. The sensing organs associated with each sense send information to the brain to help us understand and perceive the world around us. In this coming era of computing, the era of cognitive systems, we can imagine a world where computers with the help of 5G, would be able to use human senses, smell, taste, see, hear and touch. Over the last decades, "electronic sensing" or "e-sensing" technologies have undergone important developments from a technical and commercial point of view. The expression "electronic sensing" refers to the capability of reproducing human senses using sensor arrays and pattern recognition systems. Now imagine if inanimate objects could sense and interact with each other without any human intervention. Sounds amazing isn’t it? This is pretty much the underlying concept of Internet of Things.

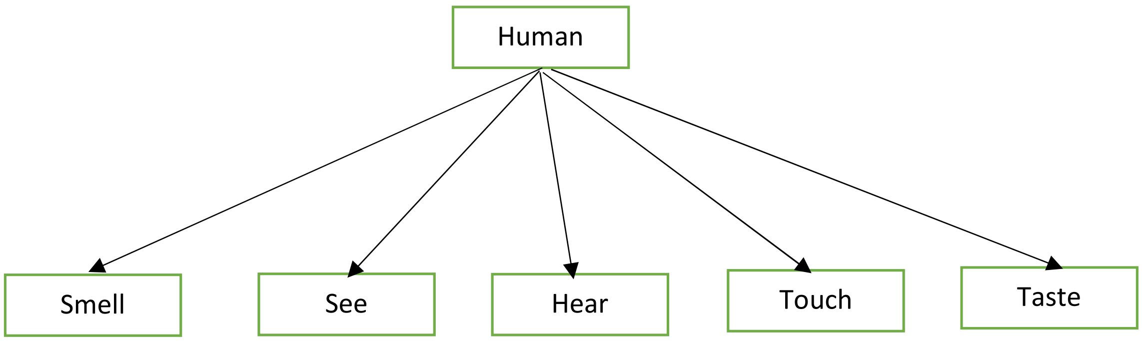

Figure 2 Human Senses

With advances in cognitive technologies' ability to process varied forms of information, vision and voice have also become usable, and open the doors for in-depth understanding of the non-stop streams of real-time data. The hardware and software will gain amazing new human brain-like capabilities to learn, adapt and sense that can help in improving the way people live, work and interact with each other. We can imagine a computer that not only can understand but also emulate human senses and respond to humans. It might be as difficult to believe as people, a decade ago would not have believed the smartphone and tablets.

If computers could see, it would be able to extract minute data from medical MRIs, CT and X-ray images, or even assess photo images of sunspots on skin. A computer’s assessment, analysis and recommendation based on human sense “see/vision” could be one of the tools to a doctor to prescribe timely and effective treatment. A hand-gesture recognition system has been developed by researchers at Ben Gurion University, that enables doctors to manipulate digital images during medical procedures using hand gestures instead of touch screens or computer keyboards. This human- machine interface would help to maintain sterile environment without contamination in the operating room (*Hand Gesture Recognition System Targets Medical Applications*, 2008).

If we consider the human sense "hear", computers would detect the voice and act on the command producing the desired results. Voice interface could act as a good digital assistant for physician in examination room, operating room. It can update the electronic medical record (EMR) with relevant information just from the back and forth conversation between patient and doctor. It may also be able to provide decision support and propose and prepare scripts silently in the background for review and signature by the physician. Using a digital assistant in this manner has the potential to free up physicians to focus on their patients rather than their EMRs. Simulation of the human sense "touch" will undoubtedly provide new tools for interactive experience design. The touch screen technologies ranges from the simplest segment displays found in handheld thermometers, to high resolution, color displays used on ultrasound and medical imaging equipment. Which knocks the possibility to consider this technology as the active and passive modes of touch and its integration with the other senses.

Human Sense	Device using the human sense
Touch (FOCUS LCDs ,2016)	Mobile phone, iPad, computer screens, all the touch screen devices. Thermometers, USG machines.
Hear	Voice detection by mobile phones, Siri, Amazon Alexa, Dragon Naturally Speaking (DNS)

See	Medical devices: imaging machines (x-ray, CT, MRI), face detection and adaptive brightness technology.
Smell	Neuro Device Scent.
Taste (Ranasinghe et al., 2012)	Digital Taste Stimulator, Digital Sour Lollipop

Table 2 Machine (Medical Devices) Senses

The sense of smell has a tremendous potential for AR and VR applications, as it addresses our emotions so directly, hence researchers are trying to develop a digital smell. The company NeuroDevice, has developed a medical device named Neuro Device Scent™, which is an advanced olfactometer, a system for measuring reactions of human neuronal system to fragrance during sensory analysis and examination of the nervous system. It measures the response of the human neural system to fragrance. This device is said to be compatible with most EEGs, psychophysiological systems and MR scanners. Moreover, it also can eliminate the appearance of artifacts in MR imaging. Thus, this device can play a vital role as a source of additional information for the physician in the course of diagnostics of degenerative diseases (e.g. Alzheimer's disease) (*Neuro Device Scent* *TM*).

The scientists are also working on a digital taste stimulator which has a base of the human sense "taste". The Digital Sour Lollipop has been developed on the base of the Tongue Mounted Digital Taste Interface, which effectively control the sour taste digitally. Even more, people with diabetes could use the device with digital taste interface to stimulate sweet sensations (Honor Whiteman, 2013) keeping their blood sugar levels in normal range. Furthermore, this device can help improve or regenerate the sense of taste of cancer patients (Svechtarova et al, 2016).

The research has been conducted to develop technologies, commonly referred to as electronic noses, that could detect and recognize odors and flavors. The stages of the recognition process are similar to human olfaction and are performed for identification, comparison, quantification and other applications, including data storage and retrieval.

1.3 Why IoT now?

With the development of technologies like M2M (machine-to-machine communication) and widespread of Internet, communication over long distance became possible. Technology is reshaping the relationship between patients, healthcare providers, and the health system. Mobile will play a crucial role, as it has become the patient's constant companion. The humongous data is generating with the devices which are connected to internet. Today there are more devices on the internet than people. It has been easier to build smaller, cheaper computers and sensors that has wireless networking and that are so cheap that we can put them on everyday objects. There is a network available to connect to everywhere which enables exchange of information with other devices. Most people always have a device that will allow them to interact with other devices regardless of location and without any sort of user interface on the other device. This useful exchange of information across the globe is being done with just a click with minimal human intervention. This ultimately turned into the urge of the Internet of Things (IoT) so that objects can represent themselves as a digitally forming large network of connected devices that can communicate over the internet. The benefits of an IoT solution are essentially immediate and are tangible, improving the company's bottom line and adding business value. Further, the benefits grow as time elapses. The data that is collected, the deeper and more comprehensive the analytics will be. This will enable the transition from a reactive mode to a predictive mode of business operations.

1.4 5G

Mobile communication is an important aspect in communication technology and mobile phone has become the most common tool of communication over the recent years. In the past few decades, mobile wireless technology has experienced tremendous revolution. Generation 4, i.e. 4G was introduced which was loaded with the features like mobile multimedia, anywhere global mobility solutions over, integrated wireless and customized services with high network capacity and huge data rate. Now everybody is talking about next generation 5G which is currently under development, that's intended to improve on 4G. 5G is said to be the latest and greatest next generation internet that going to transform our lives. 5G uses wide range of radio frequency which are extremely high frequency like security on airport. This can be considered as one of the most exciting breakthroughs of the century, this technology offers a lot of promise. It is currently under development now and it promises to improve on the 4G. The aim is to facilitate machine-to-machine communication, reduce the energy consumption, the available wireless coverage, and ultimately aiming the speed as fast as 35.46 Gbps, which is over 35 times faster than 4G. 5G promises significantly faster data rates, higher connection density, much lower latency, among other improvements. Some of the plans for 5G include device-to-device communication, better battery consumption, and improved overall wireless coverage. Fifth-generation wireless (5G) is the latest iteration of cellular technology, engineered to greatly increase the speed and responsiveness of wireless networks. It also enables a sharp increase in the amount of data transmitted over wireless systems network which will empower wireless network connections to support specific uses or business. Some service providers are already providing the service in some part of USA and loT of devices are expected to be equipped with the capacity to use the 5G technology in 2020 (Kaur, 2012).

1.5 Organization of the thesis

Unfortunately, the healthcare and pharmaceutical industries have lagged behind when it comes to implementing digital strategies. In fact, in a recent survey, only seven percent of healthcare and pharmaceutical companies said they had gone digital, compared to 15 percent of companies in other industries. By connecting patients and healthcare providers, treatments can be improved due to non-stop real-time gathered data. By providing access to such accurate information, healthcare providers can take immediate action if necessary. This will prevent conditions from worsening and therefore improve quality of life. The transformational change in the healthcare industry is thus only taking place because patients are empowered by using digital tools on every step of their journey. IoT in Healthcare has opened new doors of opportunity for medical specialists and patients. The technology enables doctors to get a real-time access to patient medical data, store them on cloud, and share with others. It also cut down the waiting time, helps to check for the availability of hardware and equipment, and simplifies the process to identify chronic diseases and take the right actions to mitigate the risk. Thanks to technology, patients get better treatment with virtual reality tools, wearable medical devices, telehealth, and 5G mobile technology. Doctors, on the other hand, can streamline their workflows using artificial intelligence-powered systems.

This dissertation shows how a realistic model can help healthcare industry to understand how IoT/5G devices help improve the functionality performance. The organization of this thesis is as follows. Section 1 introduces what is Internet of things and how it works. our communication model in detail. We first describe the architectural model that our communication model is built on, as well as provide a breakdown view on how data flow through this architecture. Then we list out all the components of IoT model together with their associated cost formulae. In the section 2 is we will be focusing on reviewing how related models and show how our work is distinguished from other works. Section 1 introduction to IoT and its definition and development till date. What is IoT and how it influences on daily life. Which would help improving daily life. Key component of IoT and how they work and their importance and features. Connection between human senses and machine senses. Elaborated machines that use human senses and how it works and help in healthcare. Why do we need IoT and how it can improve healthcare? What is 5g. 5g and IoT go hand in hand and create magic. How the 5g power initiate the change in the world of healthcare with IoT devices. Section 2 talks about the method literature review that we used to support our view. In section 3 we proposed a model comparing individual features and matching it with a specific healthcare service and how it will be benefited with IoT and 5G. Further in section 5, 6 and 7, we continued to discussion on our review, conclusion and bibliography.

2.Methods

2.1 Literature Review

One of the ways to identify the actual use of IOT in healthcare is conduct an electronic search of articles in health sciences databases such as Embase, Google Scholar, Web of Knowledge of databases, or MEDILINE. Due to resource constraints and the nature of the paper itself, the main methodology used for this paper was through the survey of journals and publications in the fields of medicine, computer science and engineering. The research focused on more recent publications. The research articles for this literature review were selected from MEDLINE (PubMed). The keywords required for this study were first searched and identified. Then the articles were searched on the home page of PubMed by selecting the advanced search option. The search field was limited by choosing "title and abstract". Further, the keywords were added into the browser and searched. For example, 1. Internet of Things, 5G, Low latency-à OR 2. Healthcare, telemedicine, health à OR 1 **AND** 2. The results obtained were saved in the search history which had assigned numbers for each search. Then the numbers were searched by adding "or" and "and" between them. Adding "or" combines both the results and increase the number of articles. Whereas, "and" narrow downs them. It looks as shown in table 3. Then the obtained file was saved in a new folder and the full text of articles of interest were retrieved from UWM interlibrary loan. Finally, the pdf was downloaded and saved. Each article was then reviewed, and the results were computed. The search targets English-language publications that have evidence-based research findings on the extent to which IOT is being applied in different spheres of healthcare delivery across the board. The search focuses on different methodologies such as the randomized and nonrandomized controlled trials, cross-sectional studies, longitudinal studies, and retrospective studies using a list of key words such as artificial intelligence, the internet of things, machine learning, telemedicine, simulation, and robotics. All these terms are related because they all relate to the manner that IOT can be used to tap data from online and offline networks, get the data analyzed and provide patterns that would facilitate response to various healthcare challenges.

The article search will provide data on various aspects of IOT in use, and other articles will also provide illustrations where IOT is used to create data where AI is applied in medical processes, transformational innovation in healthcare delivery, and applications of AI systems in various healthcare or medical processes. For example, one article focuses on a program referred to as the Deep Patient Initiative carried out at the Mount Sinai Hospital with 700, 000 patients as participants. In other articles, it is noted IOT offers innovation content layers that integrates a multiplicity of data forms such as the diagnostics layer for different diseases.

History and Search Details — Download — Delete

Search	Actions	Details	Query	Results	Time
#16	•••	>	Search: **#10 and #11** Filters: **Review, Systematic Review, in the last 5 years**	129	16:55:13
#14	•••	>	Search: **#10 and #11** Filters: **in the last 5 years**	630	16:54:21
#12	•••	>	Search: **#10 and #11**	723	16:53:49
#11	•••	>	Search: **#7 or #8 or #9**	2,096,347	16:52:52
#10	•••	>	Search: **#1 or #2 or #4**	6,244	16:52:24
#9	•••	>	Search: **telemedicine[Title/Abstract]**	13,979	16:51:46
#8	•••	>	Search: **healthcare[Title/Abstract]**	247,723	16:51:14
#7	•••	>	Search: **health[Title/Abstract]**	1,966,857	16:50:44
#4	•••	>	Search: **Low latency[Title/Abstract]**	361	16:47:44
#2	•••	>	Search: **5G[Title/Abstract]**	3,596	16:46:57
#1	•••	>	Search: **Internet of Things[Title/Abstract]**	2,399	16:46:16

Table 3 Manual selection of articles

The content of the article offers data on various topics that the search engine and database searches will focus on. Some of the topics to be considered include patient-centric care that arises from using IOT, using IOT for workflow optimization, computer-aided diagnosis, simulations for medical education, using IOT in decision analysis, scanning of electronic patient records, IOT for predictive medicine, using brain computer interfaces (BCI), using system analysis in healthcare, creating medical virtual assistants, electronic and online health monitoring and digital consultations. As well some articles focus on potential possibility of 5G radiofrequency health hazard and data security while IoT use.

Authors	Year	Focus of an Article	Conclusion
Adly et al.	2020	The article discusses the applicability of reported ideas for using AI to prevent and control COVID-19.	AI can potentially provide novel and reliable paradigms for health care services.
Aliverti	2017	The article discusses about the Apps that capture and interpreted data, IoT.	This article concludes that if developers, researchers and healthcare providers work together using an approach that consider the requirements of the user, health and wellness services, smart wearable technologies will provide unique opportunities for the future.
Arora	2020	Article focus on artificial intelligence as a digital healthcare innovation and highlight potential risks and opportunities.	AI has the potential to improve healthcare delivery through altering clinical practice as well as optimizing workflows.
Basatneh et al.	2018	Potential applications of IoMT to the diabetic foot ulcer DFU patient population.	The IoMT has opened new opportunities in health care from remote monitoring to smart sensors and medical device integration.
Bayram et al.	2020	Article describes new and critically informed approaches to democratize COVID-19 digital health innovation policy, especially when the	Article suggests that if epistemic competence, and attention to scientific knowledge and its framing are broadly appreciated, they can help reduce the disparity

		facts are uncertain, the stakes are high, and decisions are urgent, as they often are during a pandemic. It also introduces a potential remedy to democratize pandemic innovation policy, the concept of ‘‘epistemic competence,’’ to check the frames and framings of the pandemic innovation policy juggernaut and the attendant power asymmetries.	between the enormous technical progress and investments made in digital health versus our currently inadequate understanding of the societal dimensions of emerging technologies such as AI, IoT, and extreme digital connectivity on the planet.
Cabrera et al.	2020	Applying precision farming, big data analytics, and the Internet of Things successfully implementing a real-time, data-integrated, data-driven, continuous decision-making engine: The Dairy Brain.	The article demonstrates that the concept with 3 practical dairy farm applications, which show the potential to support advanced data analytics using data integration and real-time predictive tools to improve farm management decision making.
Cogollor et al.,	2018	This study puts together traditional methods and the most recent personalized platforms based on information and communication technology ICT technologies and Internet of Things to provide an identification of the effective assessment of rehabilitation practices for cognitive disorders.	The design and use of personalized and eHealth rehabilitation systems, which could be used for the assessment of a wide range of neurological disorders will reduce hospitalization rates as well as the frequency of home visits by health professionals, which means a reduction in costs for the national health care services.
Contreras et al.,	2020	Article summarizes the current telemedicine environment in order to highlight the important changes triggered by the novel coronavirus pandemic, as well as highlight how the current crisis may inform the future of telemedicine.	The coming decade is likely to usher in a proliferation of health-related connected devices and smartphone applications, along with the maturation of telesurgery due to improvements in 5G data transmission.
da Costa et al.	2018	This work introduces the concept of the Internet of Health Things (IoHT), focusing on surveying the different approaches that could be applied to gather and combine data on vital signs in hospitals.	It is concluded that a patient-centered approach is critical, and that the IoHT paradigm will continue to provide more optimal solutions for patient management in hospital wards.
Di Ciaula,	2018	Aim of the present review is to explore the more recent peer-reviewed studies on biological and health effects of radiofrequency electromagnetic fields RF-EMF, and to check the available evidences on the effects of millimeter waves, which will be employed worldwide, in the medium-long term, in 5G communication systems.	Evidences about the biological properties of RF-EMF are progressively accumulating and, although they are in some case still preliminary or controversial, clearly point to the existence of multi-level interactions between high-frequency EMF and biological systems, and to the possibility of oncologic and non-oncologic (mainly reproductive, metabolic, neurologic, microbiologic) effects.
de la Torre Díez et al.	2018	Authors provide an overview of state of the art in research on IoT services, applications and architectures in Mental Health diseases	The study shows the benefits of IoT in Mental Health as well as applications and architectures developed to improve the patient’s quality of life with this type of disorder.
Dimitrov	2016	The study reviews mIoT and big data in healthcare fields.	Digital Health Advisors will help their clients avoid chronic and diet-related illness, improve cognitive function, achieve improved mental health and achieve improved lifestyles overall.
Faust et al.	2020	The study proposes a smart Heart Health Monitoring Service Platform and address the need for a cost-effective monitoring and diagnostic process that can be used for a wide range of non-communicable disease.	The proposed HHMSP architecture balances the commonality and distinctiveness, such that it is possible to address a wide range of customer needs, and at the same time harvest the economies of scale.
GHOLAMHOSSEINI et al.	2019	The study proposes Hospital Real-Time Location Systems based on the novel technologies in Iran.	A real-time location system enables hospitals to achieve their goals such as improving efficiency, increasing patient satisfaction and reducing time and cost. Novel technologies such as IoT and cloud computing or a combination of these two technologies can be used to design the real-time location system.
Godfrey et al.	2018	The study provides an overview of the common challenges facing Wearable Technology, if it is to transition from novel gadget to an efficient, valid and reliable clinical tool for modern medicine.	The power of Wearable Technology WT as a pragmatic and clinically useful technology to aid patient diagnosis, treatment and care is becoming evident.

Gupta et al.	2020	The paper discusses the commonly used mobile applications at various levels in radiology and talks about the existing IoT-based applications.	Without tolls like the Internet and various mobile applications, it would be impossible to build the future of healthcare which is based on precision medicine intricately linked with radiomics and genomics, with radiology forming an important pillar.
Haghi et al.	2017	The study addresses the most important wearable devices, which measure effective parameters in health status directly.	They believe that, motion trackers, gas detectors, and vital signs are the most important elements in health monitoring; therefore, to achieve the full range of health monitoring.
Harris et al.	2018	Article reviews current evidence, practice and developments on the role of digital health in supporting cancer patients and horizon scans emerging issues and opportunities.	Digital health innovations have the potential to have a positive impact on cancer survivors' clinical outcomes and on-going experience, by supporting a less disrupted life.
Ismail et al.	2020	Paper analyzes the requirements for better patient care and predictive analysis that must be considered when implementing a health data management system.	IoT- and big data–based health data management system ensures the requirements of smart health care: real-time access to data by physicians and patients.
Jalal et al.	2018	The article provides an overview of sensing approaches like optical, and electrochemical techniques for point-of-care diagnosis.	The integration of e-noses in a multimodal sensing platform through sensor-fusion have helped to do away with certain issues of selective in specific diagnosis of a physiological condition of an individual.
Jovanov	2019	The study proposes the use and present several examples of synergistic personal area networks (SPANs) with support for personalized health monitoring and interventions.	Seamless monitoring and annotation of vital signs, without the attachment of new sensors or initiation of the measurement procedure is possible.
Lanzola et al.	2016	The study emphasizes the advantages of remote monitoring, illustrating the technological components required to implement it.	The rapid development of a large variety of affordable portable medical devices, like insulin pumps and CGM sensors, and the ubiquitous availability of networking Sensors 2016, 16, 1983 13 of 17 resources, are enabling new paradigms of care in which remote monitoring becomes a key feature for enforcing safety during outpatient studies.
Lapão	2016	This study aims at addressing the potential effects of digitalization of healthcare services on the reorganization of healthcare and on healthcare workforce.	The "remote monitoring" that enables health professionals to monitor a patient remotely using various technological devices, is opening a new channel of services.
Li	2019	The article looks at cases focusing on the application of 5G wireless transmission technology in healthcare and highlight the potential pitfalls to availability of 5G technologies.	Despite the limitations and challenges, such as data confidentiality, security risks, 5G will reconstruct the healthcare system by intelligently improving the quality of medical service, balancing the distribution of medical resources between urban and rural areas, and reducing the burden of healthcare costs.
Li et al.	2020	This study reviews how countries across the world have utilized AI,5G and IoT to tackle diabetic retinopathy, retinopathy of prematurity, age-related 117 macular degeneration, glaucoma, refractive error correction, cataract and other 118 anterior segment disorders.	AI,5G and IoT may be able to make key contributions towards the provision of quality, sustainable eye care to all patients. However, challenges associated with implementation of these technologies remain, including validation, patient acceptance, and education and training of end-users on these technologies.
Loncar-Turukalo et al.	2019	This study aimed to identify and scope the scientific literature related to wearables in health monitoring, as measured by trends in the research evidence available in 3 large digital libraries: Institute of Electrical and Electronics Engineers (IEEE), PubMed, and Springer.	This study confirms that applications of the wearable technology in the Connected Health domain are becoming mature and established as a scientific domain. However, further research and development are required to improve their reliability, comfortability, and dependability levels.
Mazzanti et al.	2018	The study is focused on "digital health", which means advanced analytics based on multi-modal data.	Digital health will deliver highly accurate and individual personalized risk assessments and facilitate tailored management plans.
Mieronkoski et al.	2017	Article introduces the concept of Internet of Things to nursing audience by exploring the state of the art of Internet of Things based	Internet of Things technology is providing innovations for the use of basic nursing care although the innovations are emerging and still in early stages.

		technology for basic nursing care in the hospital environment.	
Mrabet et al.	2020	This study proposes a new classification of security threats and attacks based on new IoT architecture. The IoT architecture involves a physical perception layer, a network and protocol layer, a transport layer, an application layer, and a data and cloud services layer.	IoT trends include securing the most relevant communication protocols, mitigating the security issues of the most important IoT platforms, and applications of the most important machine-learning trends to mitigate and predict security threats and risks.
Ndiaye et al.	2017	The article is a general overview of the WSN management architecture based on SDN is presented and we review several contributions in the management entities of the architecture.	The SDN paradigm has introduced flexibility and simplicity in managing wireless sensor networks, despite having different vendor specific hardware in the network.
Nguyen et al.	2018	This study aims to systematically evaluate the use of IoT technology, especially in terms of sensing techniques and data processing techniques in performing falls management for supporting older adults to live independently and safely.	Applications using motion technique in falls detection had been used effectively achieving high sensitivity, specificity and accuracy and helped prevent individuals from having a fall.
Özdemir	2018	This article poses a question that has so far been neglected in the Industry 4.0 innovation echo chamber. Is it always good to have pervasive connectivity and extreme integration to the point that ‘‘everything is connected to everything else’’?	IoT, AI, and Industry 4.0 are the value-loaded decisions made by individuals, organizations, and other social actors that shape sociotechnical change.
Olatinwo et al.	2019	This paper focuses on the state-of-the-art wireless communication systems that can be explored in the next-generation wireless body area networks solutions for health-care monitoring.	Based on the unique features of the LPWAN solutions discussed in this study, such as low energy consumption, low latency, wide-area communication coverage, and health data transmission reliability, the LPWAN solutions can be considered suitable candidates for remote HCM in WBAN systems, to achieve efficient data communications.
Qi et al.	2018	Study categorizes classic PAMA technologies into an IoT architecture systematically and reviews the current research on IoT, key enabling technologies, major PARM applications in healthcare, and identifies research trends and current challenges.	Internet of Things (IoT) sequentially covers the sensing layer, network layer, processing layer and application layer, distinctively and systematically summarizing existing primary PARM devices, methods, and environments.
Radanliev et al.	2020	This review paper investigates the integration of predictive, preventive and personalized interoperable digital healthcare systems.	Emerging mass population surveillance systems should be built in a predictive, preventive and personalized interoperable system, to promote advancement of non-contact digital healthcare concepts (e.g. mHealth), that could help controlling and preventing future pandemics.
Roehrs et al.	2017	This work aimed to explore the recent literature related to PHRs by defining the taxonomy and identifying challenges and open questions. In addition, this study specifically sought to identify data types, standards, profiles, goals, methods, functions, and architecture about PHRs.	The physician-patient relationship traditionally consists of total dependence of the patient on the physician. The PHR can be a solution to this problem, including support for reaching this paradigm, where the ownership of the data belongs to the patient.
Jacob Rodrigues et al.	2020	This study discusses current Ambient Assisted Living solutions presented in the literature, characterized by vital signs monitoring systems, and identifies the most relevant physiological parameters that need to be considered in order to provide viable health diagnostics.	AAL systems are based on the architecture of an IoT-based healthcare system and have a special focus on providing personalized and assistive services for their inhabitants.
Romeo et al.,	2020	This study outlines IoRT applications, aiming to mark their impact on several research fields, and focusing on the main open challenges of the integration of robotic technologies into smart spaces.	They observed that the development of IoRT systems can be the answer to properly deal with the necessity of remote working, where the new requirements of remote interactions between humans and robots could be the answer for more satisfaction and productivity.

Rovini et al.	2019	This article provides a review of the typologies of smart systems that were investigated and implemented for PD management in the last decade and focuses both on the kind of technology used and the system performance.	Smart systems have the potentiality to enhance the PD management and treatment, supporting clinicians in remote monitoring and promoting the active engagement of the patients and their caregivers in the healthcare path.
Sadoughi et al.	2020	The purpose of this study was to identify and map the current IoT developments in medicine through providing graphical/ tabular classifications of some major information in medical IoT literature.	The findings of this study show that IoT in medicine is still in its infancy. It has been applied in several sub-fields which seem to have put a heavy burden on the healthcare system.
Saheb & Saheb	2019	This paper aims to map scientific networks; to uncover the explicit and hidden patterns, knowledge structures, and sub-structures in scientific networks; to track the flow and burst of scientific topics; and to discover what effects they have on the scientific growth of health informatics.	This study found that the future strands of research may be patient-generated health data, deep learning algorithms, quantified self and self-tracking tools, and Internet of Things based decision support systems.
Simkó & Mattsson	2019	This review analyzed if 5G higher frequencies can have a health impact.	There does not seem to be a consistent relationship between intensity (power density), exposure time, or frequency, and the effects of exposure.
Singh et al.	2020	This review has aimed to provide awareness of innovative IoT technology and its significant applications for COVID-19 pandemic.	In healthcare, IoT technology is helpful to maintain quality supervision with real-time information. By using a statistical-based method, IoT gets helpful to predict an upcoming situation of this disease.
Talal et al.	2019	This study aims to establish IoT-based smart home security solutions for real-time health monitoring technologies in telemedicine architecture.	The IoT is still in its development stage, thereby affecting the development and security of smart homes. IoT has several issues in its layers that should be enhanced to improve the security of health monitoring in IoT-based smart homes
Vaishya et al.	2020	Study aims to identify possible application the and support of new technologies like Artificial Intelligence (AI), Internet of Things (IoT), Big Data and Machine Learning to fight and look ahead against the new diseases.	AI works in a proficient way to mimic like human intelligence. This result-driven technology is used for proper screening, analyzing, prediction and tracking of current patients and likely future patients.
Wang & Facchetti	2019	Study summarizes recent examples of and advances in developing flexible and stretchable conducting elements for e-skin and e-textile device applications, mostly based on conducting nanomaterials.	It is important to keep in mind that meeting biocompatibility and human safety for any wearable and skin-laminated object, require for technology readiness and commercialization at both material and device levels.
Zhang et al.	2020	This review aims to synthesize the user-centered evaluative research of prehospital communication technologies.	There is a need to adopt a user-centered design approach to address the identified challenges and implement easy-to-use technologies in a time-critical medical environment.

Table 4 Bibliographic review study related to IoT/5G services and applications in Healthcare

Including the IOT in healthcare continues to be the potent tool to avert health crises such as the currently ravaging Covid19 pandemic. For example, Adly and Adly (2020) documents that IOT has helped reduce the rapid spread of Covid19 through internet solutions such as detecting suspected positive cases by contact tracing, large-scale screening, monitoring and experimental therapies. They also cite the use of IOT to gather data and information on Covid19, determine resource allocation, and using the data to model and simulate ideal response measures in communities. IOT in healthcare will constitute wearable devices and body area networks. The future of IOT and healthcare lies in using apps to capture data, interpret it, have it in integrated enterprise, and store it in cloud repositories. In particular four major areas analyzed by Alverti as integral to IOT's role in healthcare include pulmonary ventilation, pulse oximetry, activity tracking, and air quality assessment. IOT will thus enhance personalized respiratory medicine in future through smart wearable technology. Respiratory diseases are not the only medical area where IOT continues to be integral. In respect to using IoT to detect suspected Covid19 cases and other medical problems, the online database article search reveals that the health crisis caused a strain on the service delivery of healthcare workers. Studies also have found IOT as an integral to the performance of image analysis within radiology and dermatology. Arora posits that IOT is part of AI systems that learn from genomic information, patient records, and real-time patient data. In this case, IOT is the source of data for any health care system's AI applications. The future as predicted by Arora will be shaped by the extensive use of machine-learning and robotics without compromising the essential autonomy of clinicians in the course of the diagnostic process. All the authors agree a single fact: IOT will shape the provision of healthcare across the board, and it has been evident during the Covid19 pandemic.

2.2 Personal Observations:

Some personal observations help lends some credence to the related literature review showing correlation between the studies done about IoT/5G devices and the outcome of those studies. When we talk about the technology, internet was observed to be a vital source of information regarding any health issues as well as different health conditions, together with healthcare provider. 5G with an IoT devices has ability to transmit data to healthcare provider can cut down the hospital visits and help improve remote patient monitoring. The requirement for live transmission of high-definition surgery videos can be achieved using 5G, which can not only be remotely monitored but can also significantly enhance a doctor's ability to provide advanced and less complex treatments. By enabling the IoT technologies through 5G networks, no wonder that healthcare systems can improve the quality of care and patient experience as well as reduce the cost of care. Moreover, it can help predict the patients likely having post-operative complications where the system is by itself ca take decision to provide early interventions when necessary. The other aspect we would like to focus on that, the large amounts of data is needed and gets generated for real-time rapid learning require ultra-reliable and high-bandwidth networks. By moving to 5G networks, healthcare organizations can provide the best care possible from their location in the hospital or clinic. 5G networks can give providers the ability to provide more personalized and preventive care rather than only reacting to patients' conditions, which is the reason many healthcare employees became providers in the first place. Thus, IoT with 5G applications in healthcare can help address various situation where access to the patient care is restricted. So, we can surely say that, next generation mobile network with an IoT devices can boost the development of healthcare applications.

3.Results

3.1 Previous work on IoT/5G

According to Kodali et al. (2015) IoT enables devices in healthcare can enhance the quality of care in respect with regular monitoring and the care cost reduction as well as can actively engage in data collection and analysis. The data produced by IoT medical devices would hold the promise to increase the devices efficiency besides the patient health (Yeole, Anjali S., 2016). Ludovico Fassati, June 2020, highlights that 5G plays a pivotal role in digitization of healthcare industry which can open the opportunities in the future. He also further emphasizes how hospitals and clinicians, especially for remote diagnostics, would be benefitted for rapid decision making by the high speed and reliability of 5G in high resolution image transmission. The findings in the study was mostly done through literature review to identify key factors unique to the IoT/5G devices in healthcare. In analyzing their key values and how those values can match the requirements of various healthcare services, provides contextual insight into how IoT/5G devices can benefit various sectors in healthcare and improve its functions. How well they respond to western medicine and the healthcare system affect their view on health technology usage. Key features of IoT/5G and benefit perception in healthcare sectors become key factors that are incorporated into the IoT/5G devices model when refitting it to be more specific to individual services in healthcare in Case study: Systematic matching. Certain key factors are placed or grouped together under corresponding key principles of the revised model, traditional medicine falling under outcome expectations in using traditional method to manage health comes with the expectation of seeing visible improvement for instance.

3.2 Model study:

3.2.1 Generalize Summary

IoT as a component of AI can help address the health service challenges associated with a health care system and infrastructures being overwhelmed. For example, one of the articles cites the use of smartphone technologies such as apps to collect signs, previous locations, and symptoms associated with a pandemic such as Covid19. Other data that could be collected using mobile apps include the patients travel history, recent contacts, and updated areas of the outbreak. The information is filtered using algorithms so that the cases are diagnosed by physicians to determine the next measures to curb any further spread of the disease. In another example illustrated in one of the articles, the John Hopkins University created a publicly shared web-based interactive dashboard that helped citizens collect data and provide accurate visualizations and provide reported cases such as real-time diagnosed cases. The information on the dashboard is updated twice in a day so that AI and quarantine are predicted effectively. If patients report travelling so certain areas, the system, the information also forms the basis for early diagnosis. IoT has also been used in remote monitoring where home-quarantined patients' data and wellbeing is gathered and used to provide optimal response measures.

The IoT/5G has potential not only to improve healthcare system but also it can help to individualize and manage healthcare for patients. Here we propose the systematic model of IoT and 5G implementation in telemedicine and try to put forward the thoughts on how IoT and 5G can benefit telemedicine. We have identified the key features of IoT/ 5G in table 5 and Telemedicine in table 6 and matched them in section 3.2.2 to identify the potential benefits.

A. Systematic identification of key features of IoT/5G:

IoT Model For Healthcare	
Key Principles	Description
Connectivity	5G has potential to download a Full HD movie within few seconds.
Intelligent action	The output from the sensors/cameras, plots a pathway and sends instructions to the devices which ultimately take appropriate needed actions to avoid potential hazards. This way Intelligent health solutions can solve any number of issues in minimal time.

Intelligent analysis	Data is aggregated which needs further analysis done through various standardized analytic procedures.
Increased bandwidth	Bandwidth is the volume of information that can be sent over a connection in a measured amount of time, often mistaken as internet speed. This aids the network in latency, speed and capacity so that higher number of devices can operate on high-band frequency spectrum. The fastest 5G networks are expected to be at least 10 times faster than 4G LTE and eventually could be 100 times faster (Duffy,2020).
Low latency	Latency is the time that takes for data to be transferred between its original source and its destination, measured in milliseconds. 5G latency is expected to someday reach below 10 milliseconds.
Ultra reliable	Ultra-reliable low-latency communication, or URLLC, can deliver faster, more reliable mobile services, and a much smoother user experience. High-reliability service involves components like integrated frame structure,

	incredibly fast turnaround, efficient control and data resource sharing. (Allen, Libby, 2019.)
Low cost	Intelligent analysis using new methods can provide substantial financial savings
Better battery consumption	Automating daily tasks can help in extending battery life. (RAVPower,T., 2019)

Table 5. IoT/5G Model

B. Systematic identification of requirements of telemedicine:

Key Features:	Description
Generation of an extraordinary amount of data	To identify early warning signs of complications (remote monitoring)
Patient disease management	Includes technology use such as appointment setting, reminder texts etc.
web portal	Interfaces with patient cell phones and digital accelerometer devices.
Manage individualized care	To effect behavior, change such as with medication adherence, lifestyle modification, education, or peer mentoring.
Remote diagnosis and e prescriptions	Remote diagnosis and e prescriptions
Integration with other medical software	Integration with other medical software such as HER and Billing

Video conferencing	Enables face to face interaction, screen sharing and multiway video for third party participation.
Clinical documentation:	Clinical documentation: digital imaging, digital notes
Instant message chat	Instant message chat
Billing:	Billing: insurance information and payments
Virtual waiting room.	Virtual waiting room.

Table 6. Telemedicine Model

3.2.2 Model: Apply IoT to Telemedicine

After finding the key features of IoT/5G and Telemedicine in table 5 and 6, we have done systematic matching of table 5 and table 6 to find the probable benefits of IoT/5G for telemedicine. From literature review studies and identified key features, we can state that 5G fast speed which is enough to download a two-hour movie in fewer than 10 seconds can enable high quality audio and video conferencing as well as transmitting data and digital images to physicians and thereby allowing doctors to monitor vital signs in real time. High bandwidth internet access for wireless connectivity can help large-scale video streaming, virtual reality and automatic data transfer to health care provider. Ultra-reliability can allow for real-time data processing at the device level which enables some actions to be executed by the device if necessary, and then send back data to the patient and their clinical teams. This can be useful in emergency situations where IoT devices with 5G network can take the decision like informing caregiver and emergency services and patient relatives. Remote surgeries can be conducted via video conferencing. Ultra-reliability can allow for real-time data processing at the device level which enables some actions to be executed by the device if necessary, and then send back data to the patient and their clinical teams. This can be useful in emergency situations.

Some design applications for this model is to have its usability of health information technologies such as EMR, wearable technology, and monitoring devices targeting healthcare industry. In attracting their attention, the model can be used to determine their preferred sources when seeking health information for inserting technologies related to those searches. Health providers being a main source of health information can educate on the uses of health information technologies to get management involved in opting IoT technology in the system. Internet is another main source of health information seeking. Telehealth allows long distance contact between health care providers and patients. A new project proposal is teaching benefits and usage of telehealth to healthcare industry using the model.

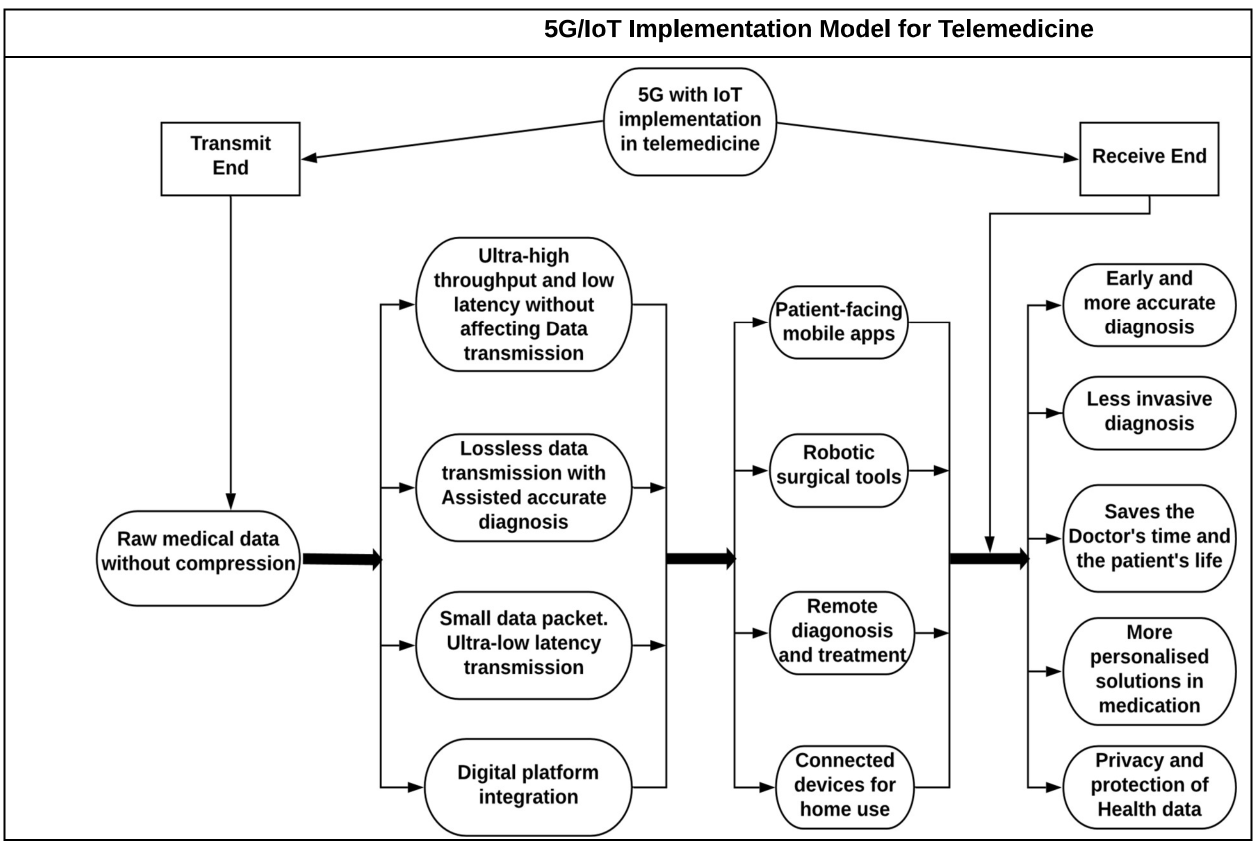

Figure 3 IoT and 5G implementation model for telemedicine

3.3 Security issues of IoT/5G

IoT devices can pose a threat to users' security and privacy. Unauthorized access of IoT devices could create a serious risk to patients' health as well as to their private information (Zeadally *et al.*, 2016). The fast detection of potential security threats remains a challenge because of the number and complexity of emerging software and hardware vulnerabilities. This issue is getting worse as increasing number of devices are being connected to the Internet and need further study for rules and regulations.

3.3.1 HIPAA for IoT

While it may seem daunting when it comes to developing IoT technology in healthcare, HIPAA is an important facet of keeping patient data secure in the industry. The complexity of data in the health-care industry makes integrating big data challenging. Data integrity should be maintained while updating information. Inappropriate document control may pose a risk to data integrity. Maintaining these databases is challenging because of the costs of maintenance as well as HIPAA regulations rules. The key elements of the Security Rule include who is covered, what information is protected, and what safeguards must be in place to ensure appropriate protection of electronic protected health information. (Rights (OCR), 2009).

3.3.2 Potential Hazards to Human Health and Ecosystem

The deployment of the fifth generation, 5G, of RF radiation is a major concern in numerous countries. 5G mobile technology promises a drastic increase in data transmission rates compared to current 4G networks, which will be achieved by using a higher transmission frequency. In addition evidences about the biological properties of radio frequency electro- magnetic field (RF-EMF) are progressively accumulating and, although they are in some case still preliminary or controversial, clearly point to the possibility of multi-level interactions between high-frequency

EMF and biological systems, and to the possibility of oncologic and non-oncologic (mainly reproductive, metabolic, neurologic, microbiologic) effects. (*5G Radiation Dangers - 11 Reasons to Be Concerned - ElectricSense*, n.d.)

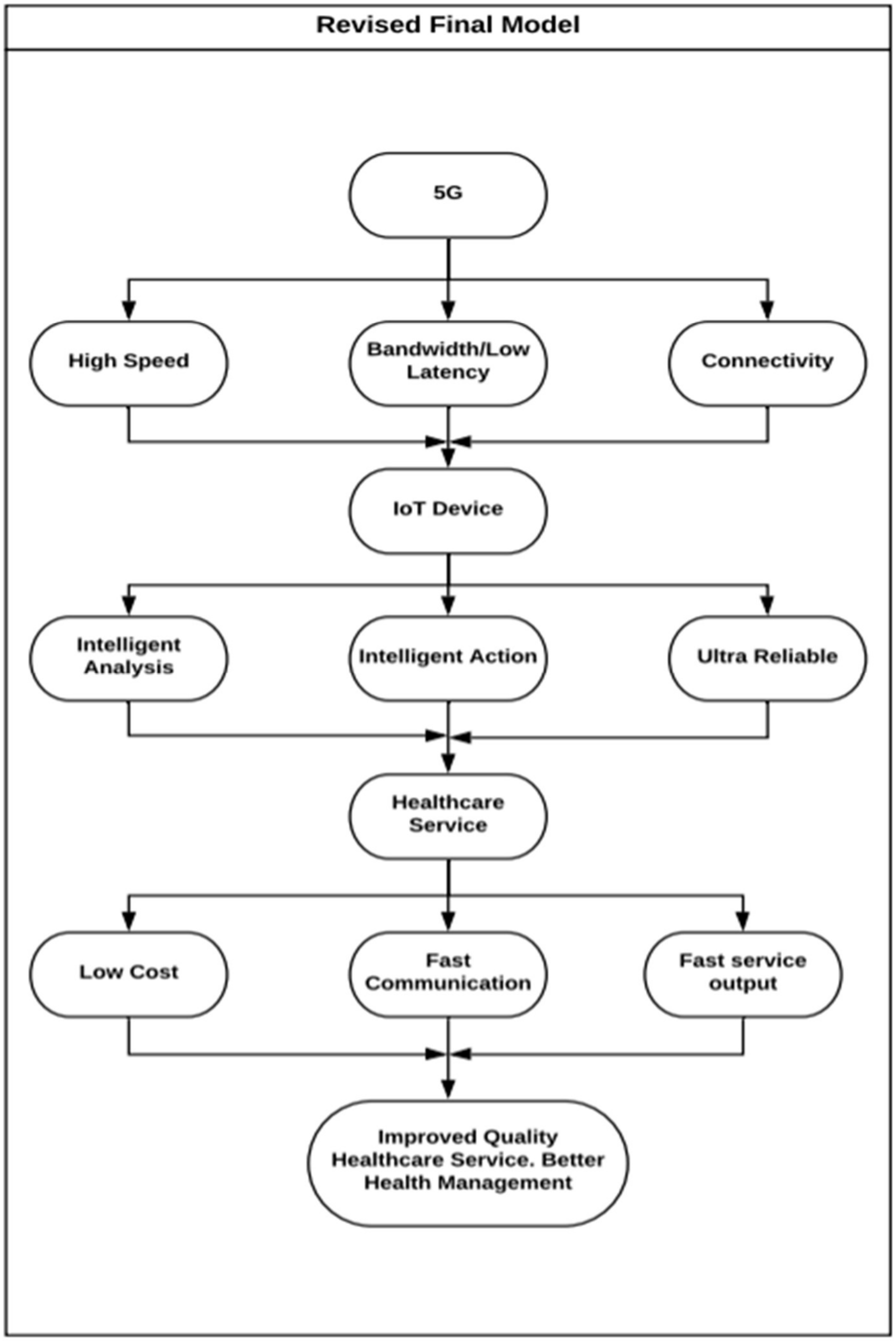

Figure 4. Revised IoT Model

4. Discussion

IoT with 5G network as a component of AI offers reliable and novel paradigms to improve the quality of health care services. Due to the unlimited abilities of AI, IoT is the reason that a lot of data can be gathered and stored, and then analyzed using numerous options of algorithms and approaches as well with the high speed 5G network the transmission of the huge data within no time is possible. In the article search, the recent example of IoT at work is cited in the use of data collected using online tools to curb the spread of the SARS-CoV-2 virus all over the world. The proper application of IoT/5G systems has been pivotal in dealing with the systemic and social challenges related to dealing with different health care problems. Another integral aspect is the infusion of wearable devices to research and track physical activity among patients and within healthcare settings. The devices collect data on behavioral change and response to healthcare interventions in different clinical settings. The data analysis reveals that AI and IoT are inseparable because the former relies on machine learning to identify feasible patterns of disease transmission. These systems are representative datasets to determine and map out accurate outcomes for patients. However, the notable threat to using IoT in providing healthcare systems is the possibility of yielding biased decisions when datasets turn out to be unrepresentative of health care realities or when the algorithms used to analyze data are biased. Thus, it is vital that training datasets are meet the features of the target population with healthcare systems. In conducting research on determinants that can influence the healthcare industry's perception of health technologies can help with understanding of how to increase its usage. It is possible for IoT technology to fit under more than one key principle. The recruit factor under outcome expectation can also fall under observational learning in that the 5G IoT model is being observed as an example. A potential application of the model presented in this paper can be used to conduct other studies on healthcare projects in remote area. Gauging real time usage among healthcare industry can be challenging as not much research has been done on this target technology's usage in healthcare. In this paper, we showed how 5G differs from previous generations of advancement (3G and 4G), discussed emerging applications in health care, and demonstrated how these developments will enable new systems of care delivery. We showed that connected medicine will help people get quality care through improvements in imaging, diagnostics, and treatment. Consumers and businesses will have a more immersive relationship with their digital devices in near future which will allow them to achieve high-quality affordable medical care in real time. The 5G world with an IoT will allow us to enter an era where real-time health services will become the part of the daily routine rather than the exception. Rather than having disparate and separate computing equipment, we will have all connected devices with a decision-making ability, independent of human interference. That will bring patients closer to a science fiction concept of digital integration than ever before.

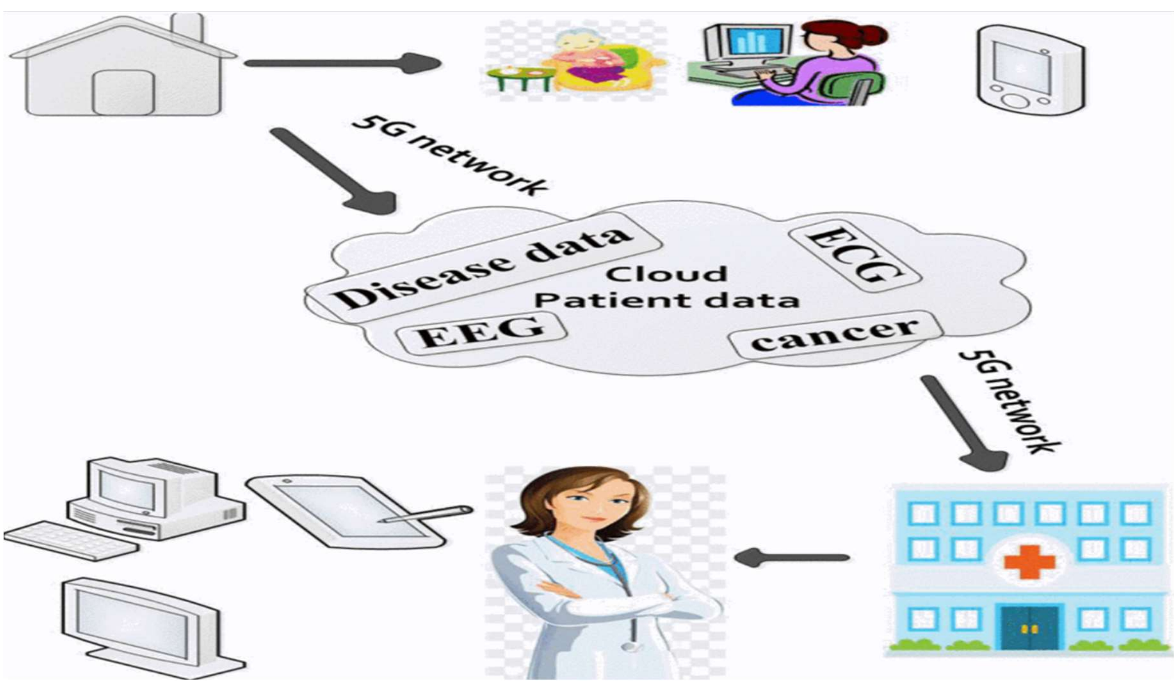

Figure 5 Future Healthcare sector with IoT connected 5G network

Figure 5 is taken from (Magsi et al., 2018).

5. Conclusion

This study highlights a few key issues, including the IoT with 5G network for healthcare telemedicine service, for future use. The goal of this study is to provide a healthcare service model that will be benefitted with an implementation of IoT with 5G network. It focused on the directions that handle this subject, mainly the research literature on the IoT and 5G of real-time health monitoring in various healthcare applications. We analyzed and discussed issues related to IoT and 5G implementation including the security limitation and possibility of health hazards. The connection between IoT/5G adaptability, the home security and privacy of users/patients still need the further investigation in regards with the protection of smart home patients. In addition, issues, like data/identity management, network protocols, patient privacy, self-management and resilient architectures, remained open in several approaches. Since the IoT is still in developmental phase, which might alter the development and security of smart homes. There are certain layers in IoT/5G implementation and development which need the boost to improve the security of health monitoring in IoT-based health services.

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