5G Technology in Healthcare and Wearable Devices

Subjects: Telecommunications

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Wearable devices with 5G technology are currently more ingrained in our daily lives, and they will now be a part of our bodies too. The requirement for personal health monitoring and preventive disease is increasing due to the predictable dramatic increase in the number of aging people. Technologies with 5G in wearables and healthcare can intensely reduce the cost of diagnosing and preventing diseases and saving patient lives.

Keywords: 5G ; wearable devices ; healthcare ; chronic disease ; health monitoring ; telemedicine

1. Patient Health Monitoring Using 5G

Several articles have described remote patient monitoring using a wireless body area network. The concept is to screen multiple vibrant sign limitations documented by various sensors mounted on the body exterior, or even fixed sensors, and to collect all motions. Before sending the footage to the doctor, it must first pass through a wearable receiver or radio communication gateway. Clinicians need automatically recorded data in order to correctly diagnose the patient's actual condition. Wearable sensors are used to monitor patients remotely and with communication equipment, which is a critical component of the personalized healthcare concept [1][2][3].

5G network solutions may open up whole new options for action control, patient monitoring, and data analysis. For example, as a result of increased communication capacity in future 5G networks, the prevalence of cardiac sickness will skyrocket and Follow-up with patients and drug administration will be offered in unique ways. An enhanced solution for individually individualized medication modification could be another essential use. Dosages of medications are now given based on prior experience and possibly on periodic interval-based monitoring, such as insulin dosages for diabetic patients. Cardiac patients' quality of life will improve if implantable dose reservoirs can be managed remotely. 5G will enable high-bandwidth practitioners in the healthcare field to communicate with one another and a central server, as well as between patients and a personal trusted gateway (PTG). A number of researchers have looked into employing 5G technology to monitor patients. The following summary will provide a quick overview of current 5G research for patient health monitoring. Zhang [4] and colleagues submitted a study titled "Real-Time Remote Health Monitoring System Powered by 5G MEC (Multi-Access Edge Computing)-IoT." They built a telemedicine system based on MEC and AI for remote sickness diagnosis and healthiness monitoring. According to their findings, integrating various technologies such as computers, medicine, and telecommunication can considerably increase patient treatment efficiency while also lowering healthcare costs. Their suggested model displays greater accuracy of estimation over many categories in the ECG dataset in simulation results, allowing the entire system to deliver more efficient medical information.

2. Management of Preventing Infectious Diseases Using 5G

From a social and humanitarian standpoint, 5G communication and IoT are aimed at expanding communication systems in order to improve people's quality of life. Control measures based on technology could be a valuable instrument in the fight against infectious disease spread. This research looks at the possibilities of upcoming technology such as 5G for regulating infection transmission, managing infectious disease prevention, and assuring health safety. Using current wireless networking solutions such as 5G, the healthcare sector can deliver a uniform, quick, and continuous service to individuals during the spread of disease. It can assist reinforce the robust communication infrastructure of the smart healthcare system in terms of greater reliability, connection stability, ultramassive accessibility, network scalability, and quick response flexibility, enabling pandemic monitoring and prevention [5][6]. Wireless communication technology can aid in the monitoring of virus spread, as well as the improvement of health, treatment, and socioeconomic sectors. In catastrophe situations, hospitals are quickly overwhelmed by the large number of people seeking treatment. Due to a lack of medical professionals and equipment, as well as a limited patient capacity, maintaining control of the situation is challenging. In fact, in pandemic scenarios, things deteriorate due to the virus's rapid transmission capacity. Avoiding contact between two people, the person seeking treatment and the physician, is a good strategy to avoid this issue.

3. Robotic Surgery Using 5G

Over the past two decades, telesurgery has evolved as a medical specialty. The concept is pretty straightforward: a highly skilled surgeon operates on a patient outside of the operating theater. Two main pieces of equipment are used to carry out the surgery: a robot that is placed in the operating room, and a remote station from which the surgeon operates the robot. A dedicated internet connection is used to establish communication between the two parties. In the orthopedic field, the robot approach has only lately entered clinical practice. It enhances implant placement precision and repeatability and has a lot of potential in terms of enhancing and assuring a better and safer clinical outcome for orthopedic surgery. The interchange of medical data is at the heart of the remote surgery concept [7][8][9][10]. Medical data, including photos, audio, and video, is digitized and transmitted via cable or wireless telecommunication networks. Surgeons can utilize the networks to remotely control the surgical robot and perform operations.

Two main pieces of equipment are used to carry out the surgery: a robot that is placed in the operating room, and a remote station from which the surgeon operates the robot. A dedicated internet connection is used to establish communication between the two parties. The goal of this study was to see if utilizing a robot might help establish the efficacy and practicality of fifth-generation (5G) wireless technologies. Surgeons can use 5G connectivity to remote control a medical robot or other surgical instrument permitting them to function as if they were in the same room. For the first time, different specialists may work together utilizing 5G technology to accomplish groundbreaking surgical procedures from any place in the world. The first 5G remote brain surgery has been completed by doctors. The patient was suffering from Parkinson's disease and was located nearly 1500 km away. The patient acknowledged a deep brain stimulus implant through a three-hour operation. Dr. Zhipei accomplished the ground breach operation from his Sanya City place, using a computer powered by China Mobile and Huawei's 5G network to manipulate equipment in Beijing.

4. 5G and the Future of Wearables

The ultralow latency of 5G might expand wearables' capabilities beyond health and wellness in the coming years, bringing new levels of utility to applications that require a remote uplink. Ambient assisted living provided by 5G-powered wearables could provide an effective alternative to live-in care for the elderly. A 5G-enabled wearable that may alert family members or healthcare experts to a dip in blood pressure or an untaken dose of medication could benefit patients' quality of life and caregivers' general peace of mind [11][12][13][14][15][16]. In smart homes, wearables may also provide more tailored experiences. Beyond smart locks and learning thermostats, 5G promises to relieve developers from speed constraints and compatibility difficulties, allowing users to enjoy more ambient and intuitive connectivity. It might also pave the way for the next AI-powered virtual assistant—one that caters to every member of the family and gives what they require without prompting. Wearables have the potential to evolve from handy additions to indispensable tools that help people learn more about themselves and their surroundings thanks to 5G. However, for wearables, speed is not the most appealing aspect of 5G. For starters, 5G has significantly reduced latency than 4G. Data transfer time between two places decreases from roughly 20 milliseconds to around 1 millisecond. For most use scenarios, that is near-instant, which is critical for an autonomous car that has to know if its route needs to change right away [17][18][19][20]. The following important categories can be used to categorize major 5G disruptions:

- Device-centric architectures;
- Wearable antennas;
- Massive multiple input/multiple outputs (MIMO);
- Smart devices and the IoT;
- The mmW band.

5. Internet of Things in 5G Communications

The internet of things (IoT) and 5G technologies are more than fair a new group of wireless technology. This is owed to the fact that 5G networks will expand the performance and reliability of these linked devices suggestively. 5G will drive origination across many industries and offer a platform for developing technologies such as the internet of things to become embedded into our economy and way of life. The keystone for solving the full capacity of the internet of things is

5G. Today, connectivity accounts for the great majority of operator IoT income, but in the next five years, revenue will also come from apps, services, and service enablement platforms [21][22][23][24][25][26][27][28][29][30]. Thales provides a variety of 5G solutions, IoT gateways, modem cards, ranging from Cinterion IoT Modules to 5G SIMs, and IoT projects that connect and secure next-generation devices while facilitating simple migration to new networks and structures. Beyond an increase in speed, 5G networks will be more reliable, leading to more reliable connections. For any internet of things, the importance of having a reliable and stable network state is especially important for connected devices such as cameras, locks, and other monitoring systems that depend on real-time updates. IoT devices will be dependent on the next-generation network's extremely low latency, expanded coverage, and high-speed connectivity. In order for manufacturers to benefit from these developments, they must first participate in 5G-compatible products. 5G connects more devices at faster rates and practically eliminates lag, which is ideal for IoT-enabled devices. The term "mobile IoT" refers to cellular low-power wide-area systems that operate on licensed range bands. Both 3GPP narrowband IoT and long-term evolution machine-type communications are key components of the impending 5G era of smart communications. Today's 5G networks can support mobile IoT solutions for smart logistics, smart utilities, and smart cities [31][32][33][34][35][36]. The earliest 5G applications and customer premises equipment included fixed wireless access, mobile computing, video broadcasting,

- Facilities will be able to communicate crucial upgrades to whole networks using 5G IoT without having to interrupt operations, overload servers, or freeze functionality.
- Since personal applications drastically change how we work and live, 5G IoT will improve ordinary users' quality of life.
- Some of the recent industries that will stay to profit from 5G IoT developments include:
  - Smart utilities;
  - Agriculture;
  - Smart cities;
  - Security and surveillance;
  - Smart buildings;
  - Healthcare;
  - Smart factories;
  - Automotive and transportation.

5G and Business IoT

Not only is the internet of things expected to facilitate technological advancement, but it is also estimated to sustain 22 million employees globally. The digitization of transportation, manufacturing, agriculture, and other physical industries is likely to drive this job development. Consider mines, oil derricks, building sites, and freighter fleets. Because of the time-sensitive nature of their output, these productions would yield enormously from ultrafast data transfer. We are using the internet of things in all wearables. So, we included what is the use of the internet of things in 5G and how it can help to connect wearables for monitoring patients. When it comes to IoT and healthcare, several well-known companies are at the forefront. These firms are competing for a large slice of the pie by developing products for specific medical applications, expanding collaborative research and development, and acquiring new startups. For example, the Apple Watch continues to advance its health features with each iteration, such as its FDA-approved electrocardiogram (ECG) embedded in the Series 4, and both a menstrual health-tracking feature and a dedicated research app added to the Series 5.

6. Challenges Facing Wearable Technology

Similar to any new technology, wearable computing devices go through an introduction and exploration phase before becoming mainstream. The introduction of 5G, which will offer more bandwidth and open the door to alternative solutions such as real-time health monitoring and multiple apps running at once, is a new catalyst that will quicken the life cycle of wearable technology. You can envision what kinds of applications this combination of wearables and 5G will benefit from. Clients will occasionally question the device's purpose and utility, whereas some will flexibly discard them. Wearable technologies, on the other hand, have plentiful probability and offer far too numerous profits to be discounted. If the acceptance of smartphones is any warning, the future of wearable computing devices will be just as bright, with only our imaginings serving as a limit.

- Improvements in software architecture to make up for the challenges of using small screens for navigation.
- Wireless and local area network administration.
- Enough protection from hackers who might obtain access to the device's data.
- Augmented reality and autonomous processing have developed a technological dependency.

Wearable devices and electronics represent a novel interface of technology and humanity, resulting in novel challenges that must account for both the technological and human aspects of the problem. Human behavior may influence the operation of wearables as much as technological advancement. The following are some of the challenges that the wearables industry is facing:

- Wearable electronics applications that are groundbreaking. The evolution of wearables has been driven by the practicality, utility, and convenience they provide since the dawn of time. The modern wearable electronics challenge is in discovering ubiquitous applications, as its future growth is dependent on emerging applications in health, wellness, and other personal needs.
- User burden reduction and integration with everyday wearables. Wearable device illustrations frequently include images of people who have been instrumented in every possible location on the body, such as the arms, legs, torso, and so on. In practice, such a scenario represents an unrealistically high user burden and is therefore unfeasible. A related challenge is the seamless integration of wearable electronics into everyday wear items such as textiles.
- Data generated by wearable devices must be interpreted in an efficient and informative manner. Wearable devices may generate a large amount of data, such as health-related sensor signals. The difficulty lies in interpreting such data streams and connecting them to health outcomes, as well as using sensor data to guide behavioral interventions and health education.
- Privacy and security. By definition, a wearable is an electronic device that resides on or close to a person and is present in a variety of life situations. The challenges include the protection of personal information, preventing the unauthorized use of wearables for biometric identification, and ownership of the data produced by wearables.

7. Next Generation of Healthcare with the IoMT and 5G

The internet of medical things (IoMT) is an important subcategory that encompasses all things linked to health care. 5G, in particular, has the potential to expand the IoMT frontier significantly. Inventors of these devices can now take advantage of the 5G data transmission speeds mandatory for real-time solutions for surgeons, as well as for connecting IoMT devices to each other and to the succeeded servers and databases that keep track of them. Furthermore, these devices may decrease the length of time a patient occupies in the hospital while also keeping clinicians more related to their patients on a regular basis, theoretically resulting in fewer hospital visits and better total care. The implementation of IoMT technology has the possibility to bring important origination to two major areas of health care: hospital practices and costs, and home care. When we are admitted to the hospital, whether it is for a reserve or a routine treatment, we all receive a plastic bracelet. It covers personal information such as our name, blood type, birth date, and so on. Your next bracelet, on the other hand, will be more like a smartwatch. Its strength is linked to your health data, your actual location in the hospital, and even screens your vibrant signs. This bracelet might also be associated with a private 5G network within the hospital, giving you the assistance of 5G connectivity while securely transferring your data. An interconnected system of medical policies, software, and health schemes and services is known as the internet of medical things (IoMT). The IoT ecosystem is finally what sets it different, despite the fact that a growing pool and general acceptance of IoT technologies are beneficial to many industries. These include a wave of sensor-based apparatuses, such as wearables and standalone methods for remote patient monitoring.

The goal of IoMT is to connect people, data, and progressions using medical devices and mobile applications to monitor patients' health outcomes. Remote patient monitoring is the most common and useful IoMT-connected device for monitoring a patient's health, for example, vital tracking wearables. Most of the elderly population suffers from diseases such as diabetes, cardiac ailments, and hypertension. Hence, for cardiac patients, heart monitors are vital, as they monitor arrhythmia and alert health providers about the adverse events that may take place. Regular active monitoring and heart monitoring are achieved by some consumer wearable devices such as smartwatches. Additionally, if a patient is hospitalized, IoMT platforms help the off-campus physicians and nurses to monitor senior citizens' signs without disturbing them.

8. IoMT in the Hospital

Over time, the hospital's IoMT apparatus may develop gradually advance. Apart from basic vital indicators, the band could also road your oxygen stages, conduct an electrocardiogram routinely, and alert nurses if you have tumbled. Your wristband might act as a nurse's assistant, undertaking simple tests and care an eye on you [37][38][39][40]. The IoMT devices at the hospital could become more sophisticated over time, much as a smartwatch adds new abilities every year. With a combined device similar to this wristband, the amount of time saved by workers may skyrocket. Assumed that there is an approaching nursing deficiency. As a result, 5G's skill to minimize the claim for harbors and other healthcare laborers while keeping the same level of care would be a big benefit to hospitals. By replacing resource-intensive invasive measures with noninvasive technology, important cost decreases could be realized.

9. IoMT at Home

5G's brands are connectivity and fast data transmission, which might speed up the growth of remote care monitoring (RCM) apparatus, and being able to connect medical information in a timely and dependable way can mean the difference between life and death. Consider a patient with chronic renal disease who could profit from industrious blood monitoring to evade kidney failure. If a patient's blood pressure or glucose levels grow and emergency care is mandatory, a 5G-connected RCM device strength sends a cautionary to both the patient and their doctor. These RCMs are previously obtainable for diabetics who involve minute-by-minute glucose specialist care. This scenario is charming gradually possible thanks to the collective strength of IoMT and 5G, and it is composed to have a significant impact on our healthcare [41][42][43][44]. This sector's products and services advance healthcare, ease the burden on doctors and nurses, and enable patients to receive care outside of hospitals or at home [45]. IoMT comprises tracking patient prescription orders, patients' wearable devices, and the location of patients admitted to hospitals, which can provide information to caregivers. It also includes remote patient monitoring for persons with long-term or chronic diseases. Infusion pumps that connect to analytics consoles and hospital beds with sensors that track patients' vital signs are other medical devices that can be upgraded to or used with IoMT technology. IoMT and wearable technology are also the cornerstones of telemedicine, which has gained a lot of attention in recent years and allows patients to be monitored remotely from their homes.

A patient who receives this kind of care can avoid going to the hospital or doctor's office if they have a medical question or a change in their condition. By establishing a connection between patients and their doctors and enabling the interchange of medical data through a secure network, it can lessen unneeded hospital visits and the strain on healthcare systems [46]. Telehealth virtual visits, personal emergency response systems, and remote patient monitoring are all included in the in-home category. A PERS blends wearable device/relay units with a live medical contact center service for the elderly who are housebound or have limited mobility to promote independence. Users can communicate and swiftly access emergency medical treatment thanks to the package. RPM includes all sensors and home monitoring equipment used to manage chronic diseases. In order to assist long-term care in a patient's home and limit the progression of the disease, they regularly monitor physiological markers. They are also used for acute home monitoring and ongoing care of patients who have been released from the hospital to speed up recovery and avoid readmission. In order to increase adherence and outcomes, they offer customers dosing instructions and reminders for their medications. Telehealth virtual visits involve online consultations that help individuals manage their illnesses and acquire medications or recommended treatment plans. Online consultations and the assessment of symptoms or lesions under video observation and digital diagnostics are two examples [47][48][49][50]. A residential internet of things is depicted in **Figure 1**.

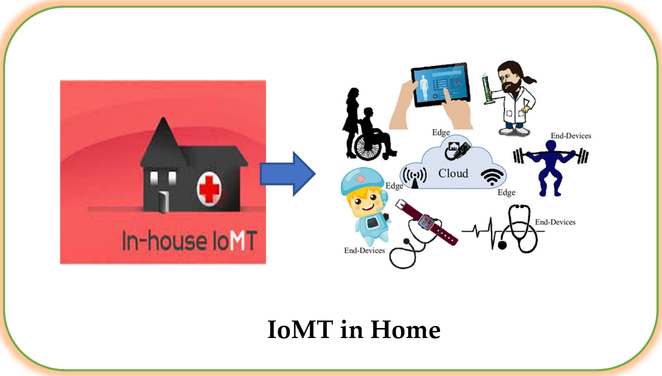

Figure 1. Internet of medical things at home.

10. IoMT and 5G Innovations

Before COVID-19 arrived, the IoMT was previously in overuse. Though, the coronavirus has carried even more devotion to the ways in which knowledge may recover and reorganize health care. This year's speculation in healthcare technology has set new highs. The mainstream is now drastically reconsidering how we deliver health care, not because it needs to, but because it has to. We are grateful to travel for substitutions when some cities in our country run out of clinic cots and there is not always sufficient staff to care for patients in need. Luckily, designers and academics are already seeing how technology may improve health care, and 5G could offer the network required to alter these ideas into authenticity [51][52][53][54][55][56]. **Figure 2** depicts the characteristics and benefits of 5G in business.

Figure 2. Features and benefits of 5G in business.

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