IJSSP

المجلة الدولية لنشر الدراسات العلمية
المجلد العاشر – العدد الثالث – البحث الأول (ص: 1 - 18)
15 – أيلول – 2021 م

www.ijssp.com ISSN: 2707-5184 International Journal of Scientific Studies Publishing

[The Modern Technologies in Managing Smart Homes and Healthcare Remotely Based on Io: Survey]

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[التقنيات الحديثة في إدارة المنازل الذكية والراعية الصحية عن بعد استناداً إلى إنترنت الأشياء]

الملخص:

منذ صياغة مفهوم "المدينة الذكية" ، تم اعتبار إنترنت الأشياء بمثابة بنية تحتية حيوية للمدن الذكية. يعد نظام مراقبة الرفاهية عن بُعد القائم على تقنية إنترنت الأشياء أحد محاور البحث المهمة. إنترنت الأشياء هو إنترنت الأشياء المادية المدمجة مع البرامج أو أجهزة الاستشعار لجمع المعلومات وإرسالها بين الكائنات والخوادم المركزية. ستساعد هذه الكلمة في تقليل قيود نظام الطب والرعاية الصحية ، وتقليل تكاليف التأمين وتحسين الرعاية الصحية. تُستخدم إنترنت الأشياء في العديد من المجالات الطبية في بيئة الرعاية الصحية المعاصرة ، بما في ذلك التتبع في الوقت الفعلي ومعالجة بيانات المرضى والإدارة الطبية الطارئة وإدارة بيانات الدم. على مر السنين ، تم اقتراح العديد من التطبيقات الحديثة القائمة على إنترنت الأشياء للمرضى والأطباء والمتخصصين في الرعاية الصحية في القطاع الطبي. لذلك ، يشرح هذا البحث التطبيقات الحديثة للطب وتقنيات إنترنت الأشياء للرعاية الصحية. كما أنه يؤكد على الإمكانية الهائلة لمزيد من الدراسة في هذه العملية والمستقبل.

مصطلحات الدراسة: المنزل الذكي ، إنترنت الأشياء ، المدينة الذكية ، التكنولوجيا الحديثة في إنترنت الأشياء ، الرعاية الصحية ، التطبيقات القائمة على إنترنت الأشياء.

Abstract:

Since the concept "smart city" was coined, the Internet of Things (IoT) has been regarded as critical infrastructure for smart cities. A remote well-being monitoring system based on IoT technique is an important focus of research. IoT is the Internet of physical objects integrated with software or sensors for the collection and sending of information between the objects and the central servers. This word will help reduce medicine and healthcare system constraints, reduce insurance costs and improve health care. IoT is used in many medical fields in the contemporary health care environment, including real-time tracking, patient data processing, emergency medical management, and blood data management. Over the years, several modern IoT-based applications for patients, physicians, and healthcare professionals have been proposed in the medical sector. So, this research explains the modern applications of medicine and healthcare IoT technologies. Also, it stresses the enormous possibility for further study in this process and future.

Keywords: Smart Home, Internet of things, Smart City, Modern Technology in IoT, Healthcare, IoT-based applications.

1. Introduction

The population of the world increases exponentially in the 21st century. Cities with more inhabitants face enormous urban pressure [1]. Although there are daily expansions of medical resources and facilities in the city, the level of adequacy is still not achieved. Massive pressure on the management of health services in cities has led to advances in technology to deliver solutions that can quickly grow the issues. Post-accident rehabilitation services for the elderly, for example, are novel obstacles that necessitate long-term medical and human resource involvement [2].

Therapy rehabilitation is a comparatively new concept that plays an important role in maintaining health services for individuals, especially the elderly and those who are afflicted with recurrent infections, to enhance their standard of living. However, there are several roadblocks in the way of expanding the scope of medical rehabilitation. To begin with, most rehabilitation therapies need deep and intensive treatment. Second, more aid facilities are required to make rehabilitation services more accessible to patients. Third, due to the rising population in the community, rehabilitation resources are limited, especially among the elderly [3].

The IoT is a term that refers to a fully connected world that provides improved technology to advance health care [4]. “Objects” in the IoT can range from vehicles with built-in sensing to people with heart rate monitors, as long as they are given an IP address and can gather and transmit files without human involvement [5, 6]. Previous IoT efforts in healthcare began with wireless sensor networks (WSNs)-based research and development projects [7]. This process guarantees that devices are accessible, low-cost, dependable, and easy to transport or assemble with patients, allowing for a clear network among doctors, patients, and medical equipment [2].

This paper aims to illustrate the use of the IoT technique in the healthcare and medical fields, as well as to demonstrate a variety of activities and things in the environment that can be linked to collaborate and undertake in future command for additional study "anytime, anywhere, with everything and everyone.

2. Concepts of smart healthcare

Smart healthcare is a healthcare administration framework that makes use of cutting-edge innovation such as wearable devices, the internet of things, and the mobile web to gather data, connect people, components, and foundations associated with the healthcare field, and then efficiently monitor and respond to treatment environment requests promptly. Smart healthcare should improve communication among all stakeholders in the healthcare industry, ensuring that members receive the managements and service they require, assisting stakeholders in making informed decisions, and encouraging the prudent allocation of resources. To put it another way, intelligent healthcare is the next step of the clinical data growth process [8]. Individuals in remote locations must be included in a smart healthcare services environment, as well as a tracking system that can contain a constant stream of data for better decisions, depending on the requirements [9]. A services system of Smart healthcare will be used in the homes, within a network, or even around the globe [3].

2.1 Personal healthcare requirements

The specifics requirements for the architectural component are as follows: Integrated subsystem for data generation from which physical parameters are extracted, a complete architecture system involves storage and distribution subsystems, the storage and distribution subsystem, irrespective of communications technology, must be able to access the data collection sub-system [10]. The architecture includes a consumer sub-system, and the consumer sub-system must support the detection of resources to find machine-to-machine (M2M) devices presented on the data collection sub-system. The current digital revolution is a communication from M2M and mobile technology. This is the first phase of the IoT process [11].

2.2 Internet of Things layer in healthcare

The middleware layer is critical for processing information in IoT apps. Smart medicine, smart city, smart agriculture, smart house, smart transportation, and other IoT apps are examples. Below is a diagram of the basic Internet of Things layer in figure (1), [5, 12].

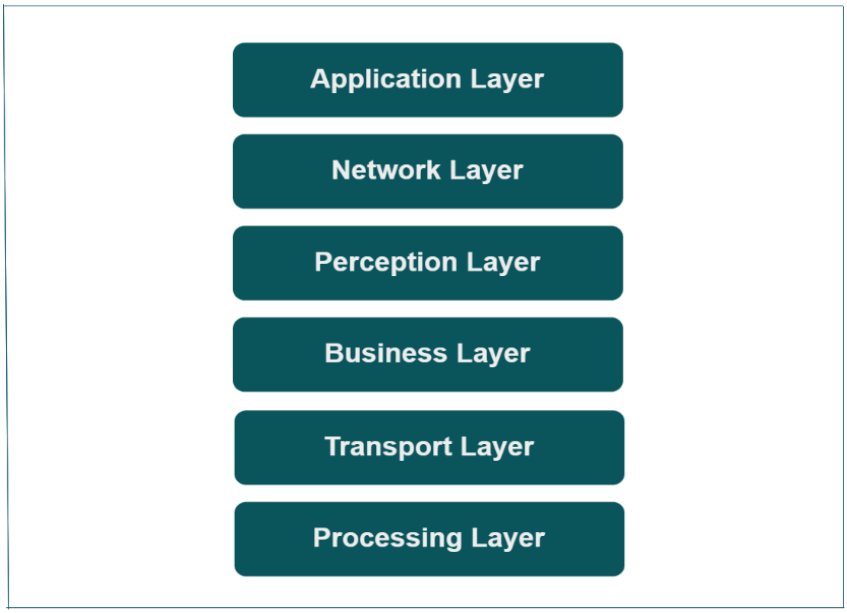

Fig. 1. The architecture of healthcare IoT.

Perception, network, and application layers are the three layers that make up the early stages of IoT architecture. A perception layer identifies sensors and physical things to recognize other intelligent things in the environment and senses physical factors such as temperature, orientation, motion, humidity, accelerating, location, and so on. As a first step toward intelligent and customized healthcare, this layer is made up of the subsystems for the generation and actuation. Actuators and sensors are used in smart homes to gain a better understanding of a person's environment and enable home automation [10].

Perception layer innovations are classified as active, passive, and semi-passive in [13]. The connection to other smart things, network equipment, and the server is the responsibility of the network layer. It's

most commonly used for sending and process sensor data. The app layer plays an important role in delivering app-oriented services to end-users. It recognizes several IoT apps, including smart houses, smart health, and smart city [12], [14].
The transport layer, which transferring sensor data from the perception layer to the processing layer and conversely by the networks like wireless, infrared, Radio Frequency Identification (RFID), LAN, Zig-Bee, WiFi, Bluetooth, and 3G, is the outline function of the other layers. The processing layer, also known as the middleware layer, can store and analyze massive amounts of data. It can handle and deliver a varied set of services to the lowest layers, as well as communicate to cloud computing, big data, and databases for data processing. The business layer is in charge of all aspects of IoT systems, including apps, enterprise models, privacy concerns, and profit models [12].

2.3 Problems in the health care system

In recent decades, the growing trend of the elderly population in society has resulted in complex health issues, including an increase in the number of recurrent diseases and the cost of clinical and hospital care. Health monitoring is important in maintaining people's health, especially for the elderly with chronic diseases, because it reduces the need for hospitalization and improves life quality [15], [16]. Below is a list of some topics and limits that trauma clinic-based interventions [17] are looking at:

- Availability and limited time: as the population of people with illnesses and disabilities grows, doctors are unable to plan for their patients' daily routines, such as physical activity, rest, diet, and general activity; these characteristics are equally important when diagnosis, operating, and therapy.
- Adherence-monitoring physicians are less equipped to verify whether their patients are adhering to recommended therapy, which may include medications, recovery activities, and certain prevention exercises, such as abstaining from some eating regimens.
- An aging population: As the population ages, more offices will be sought for therapeutic purposes.
- Urbanization: big urban populations are likely to request more healthcare foundations to meet the needs of an ever-increasing population.
- A shortage of medical healthcare workers fuels interest in healthcare workers such as surgeons, clinicians, dental professionals, nursing teams, nurture colleagues, skilled guardians, and lab teams who could improve the biological systems of healthcare in both urban and rural areas.
- Rising medical costs: the costs of medicine are rising, as is the cost of health insurance.

3. IoT Infrastructure in healthcare

Cloud, gadget (also known as a "base station"), therapeutic or healthcare vendors, and channels of communication are the constituents sections of the healthcare IoT foundations (between gadget and cloud). Customer objects for health monitoring, wearable, inside embedded medicinal equipment, and stationary medicinal equipment are all examples of healthcare and therapy gadgets [18]. These devices detect electrical, thermal, chemical, and other signals from the client's body. They simply discover and collect biomedical signals, which are data about a person's physical and mental well-being. The framework for the proposed Parkinson's disease detection system includes

various components, including a smart house with sensors, the cloud, a smart city, physicians, and customers. We're interested in sensors that can collect voice signals, such as mobiles, tablets, and voice recorders because the client lives in a smart home with many of them. The client first completed a web application to register with the service provider. Second, following successful registration, the customer records an audio signal and uploads it to the cloud for processing. Following processing, the results are forwarded to the doctors, who use the cloud to prescribe drugs to the client. Smart cities manage traffic and cars to ensure that the client receives service as quickly and seamlessly as possible [19]. External gadgets, referred to as peruses, are often used by gadgets to communicate with the Cloud (for example mobile phones, computers, etc.). In this manner, data can be sent directly to the Cloud or indirectly to the Cloud (through the peruse). Wi-Fi, Zig Bee, Bluetooth, and 2-G/3-G/4-G cellular are all well-known and used by it. Figure (2) shows the IoT infrastructure for components of healthcare [6].

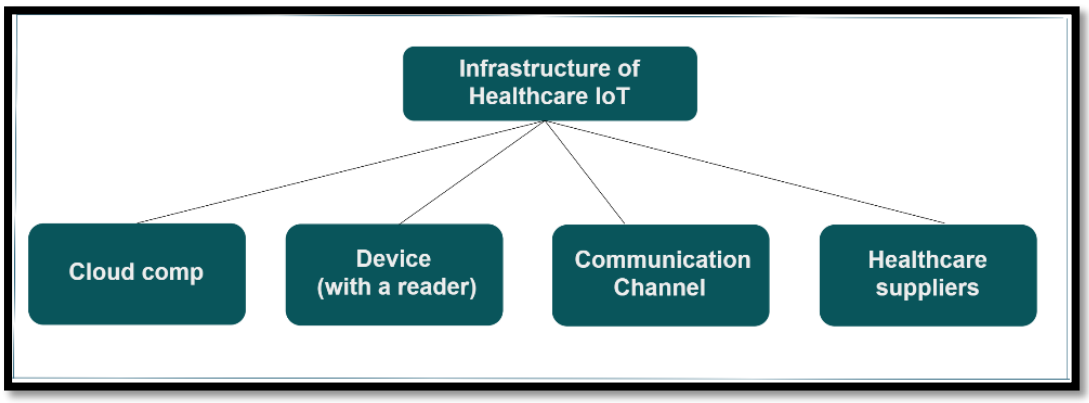

Fig. 2. The IoT infrastructure for components of healthcare.

4. Internet of things components in healthcare

The IoT in healthcare services is made up of five sections that work together to get smart medicinal utilities to make up around the system. Then the sensor collects data at the start of the device. The collected data is sent to the next level, witch's the intelligent network that allows this system to interact. The third aspect of the healthcare system is cloud computing, which stores the data sent on this network.

In the 4th part of big data analysis, after the data has been kept, it must be examined and analyzed to make the best decision. Following the selection of the most suitable knowledge decision, refined data would be transmitted to a smart medical clinic to advise medical services experts about the outcome.

The smart clinic records events to provide accurate diagnoses and care. Spite this reality that even the intelligent clinic will be a final component of its IoT health services structure; it continues to gather data and ensure that the analysis and treatment are consistent. The system returns to the 1st component [9] to maintain the circularity of the system illustrated in figure (3).

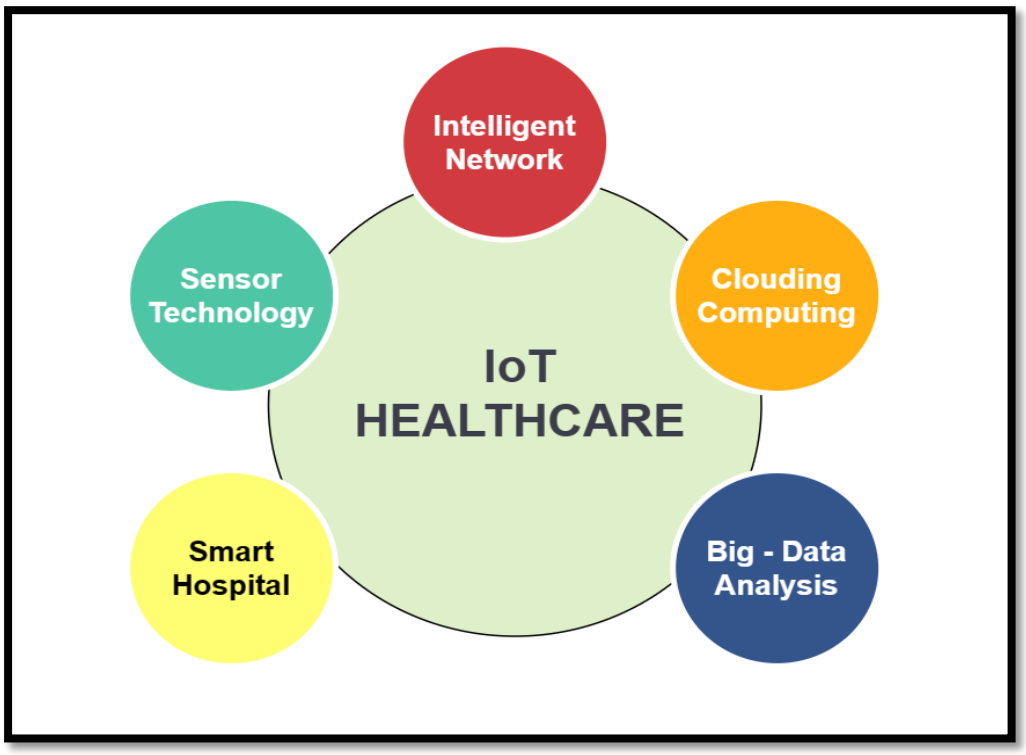

Fig. 3. IoT healthcare component [9].

The IoT is a modern healthcare model in which equipment and clinical data are transmitted to even the most remote locations. IoT technologies include sensor systems to control washing hands and RFID to track habits and interactions, as well as monitoring of patients, tracking health monitoring and remote health care. It allows for more accurate assessment, diagnosis, and treatment of patients. Kumar [20] uses IoT to collect data for a health monitoring system that contains customized warnings for patients and health service providers.

Smart Healthcare increases consciousness and medical education about one's state of health by disseminating information regularly. IoT-enabled healthcare techniques are more important for processing healthcare data for providers, medical research & innovation, government, service population, and targeted groups. With the use of wearable and other technologies at home and in the hospital, in hospitals and, nursing houses IoT ensures surveillance, participation, and behaviors of older people, as well as monitoring wandering patients to control chronic problems and predictive analysis of patients.

According to [21], other techniques which may be implemented to IoT-based healthcare systems include cloud computing, which provides facility with universal accessibility to the a sharing resource base, offers services on demand across the internet, as well as executes processes to achieve diverse requirements; grid-computing, which includes Sensing for non-invasive and less power wireless communication techniques, such as Small Area Networks, and grid computing, which includes non-invasive sensing and Wireless communication technologies low-power, such as Small Area Networks, Low-power wireless communication systems include wearable apparatuses that can continuously track

vitals such as blood pressure, temperatures, electrocardiograms electromyogram, and saturation oxygen; Big data must be detected by healthcare medical sensors for Short Term communications, such as W-PANs, W-BANs, W - LANs, 6LeWPANs, and W - SNs, as a critical component of the effectiveness of healthcare diagnostics and monitoring methods; and for long-term communication and surroundings intelligence and knowledge, such as WPANs, WBANs, WLANs, 6LeWPANs, and WSNs. Physical infrastructure networks based on the Internet of Things.

5. Health-care system Management

The systematic and effective application of resources such as individuals, materials and equipment, and financial resources to accomplish a particular goal is referred to as good management. It contains deciding what to do, preparing how to do things, inspiring people to do the work, and ensuring that the work progresses successfully [22]. Figure (4) illustrates the healthcare services management process.

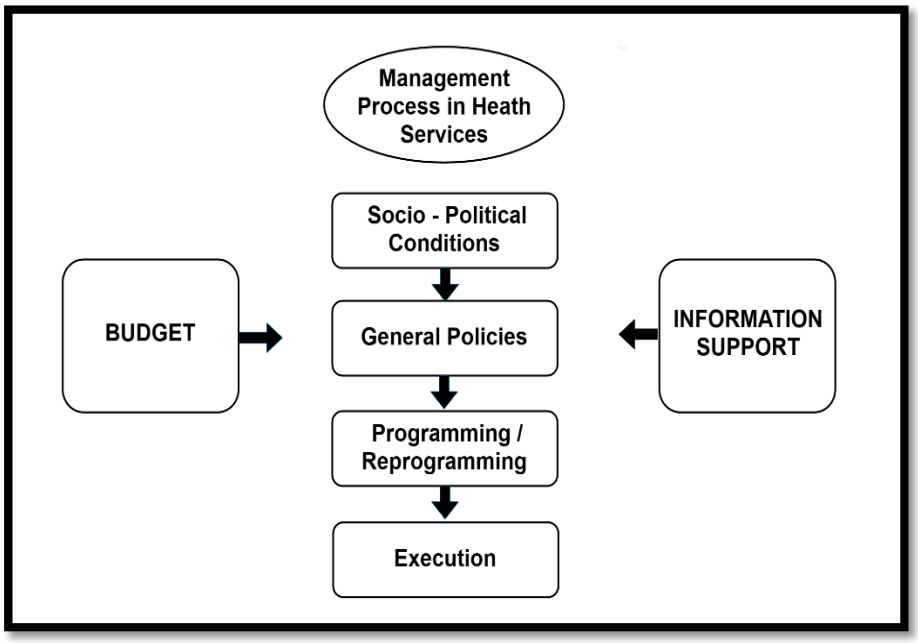

Fig. 4. Healthcare Service Management Process [22].

Different economic sectors have used performance improvement [23]. The definition is based on three primary goals: improved health increased population responsiveness and equitable financial sharing. The broad heading of performance management, proper communication action on progress made, and performing management tools may all be viewed as a way to measure progress toward predefined goals. [23, 24].

6. Collection and transmission of data

Table (1) shows the basic function for collecting information from smart sensors [9].

Table (1): The function basic

The Function	The Description
The Accepting device sensor (device)	Accept the new sensor device into the Internet of Things (IoT) healthcare system.
The Device that senses drops (device)	IoT Healthcare cancels the device's use.
The Device Reset (device)	To clear any Stocked data, Re-Set a device.
The Device Enabled (device)	Enable a device after it has been accepted.
The Device disabled (device)	To terminate using, disable the device.
The Obtain Information (device)	Get the device's signals
The Data is put (device, Net ID)	Send signal data for network ID from the device.
The signal is Check (device, Net ID)	Investigate the signal coming from the device that is linked to the network ID
Signal skipping (device, Net ID)	The signal from the devices going on network ID is skipped/ignored.

An environment in which a health care system already benefits from IoT-based medical services [25] would have been the perfect case for study. In [9], the data collection includes IoT driver sensors gather continuous tracking through smart sensing invention, such as Dynamic optical sensors, Sensors biometric, heart bit rate sensor for Monitor blood pressure, Monitor for virus infection, tracking glucose, and health care monitoring. Then the E.G.C servicing links nodes in the network (that the

patients can access directly), other medical instruments [26], as well as the internet (to which necessary servers and customers have direct access).

An IoT-based Electrocardiogram tracking system consists of a wireless transmitter portable and a wireless reception processor. As an invention by [27], the device uses the searching automated approach to detect irregular information, allowing real-time cardiac activity to be detected. Patients will be given a wearable sensor that can monitor muscle function, electromyography, Temperature, Respiration rate, sweating, and glucose levels in the blood. The sensor may be placed in many different body parts as well to obtain accurate measures and diagnose diseases like an irregular heartbeat (arrhythmia), febrile disease, disorders neuromuscular, (BP) the level of blood pressure, the fatness, as well as dialysis. Compact sensors embedded in the body of the patient collect physiological data, which includes several required physiological variables. Small parts of the hardware then reprocess the data, and communication tools are used to transmit it. There the sensor must be small, light, and unobtrusive to the patient's- mobility. Thin, energy-efficient batteries are required to power the sensors. The battery can last for a long time without having to be recharged or replaced [2]. Figure 5 illustrates the component systems.

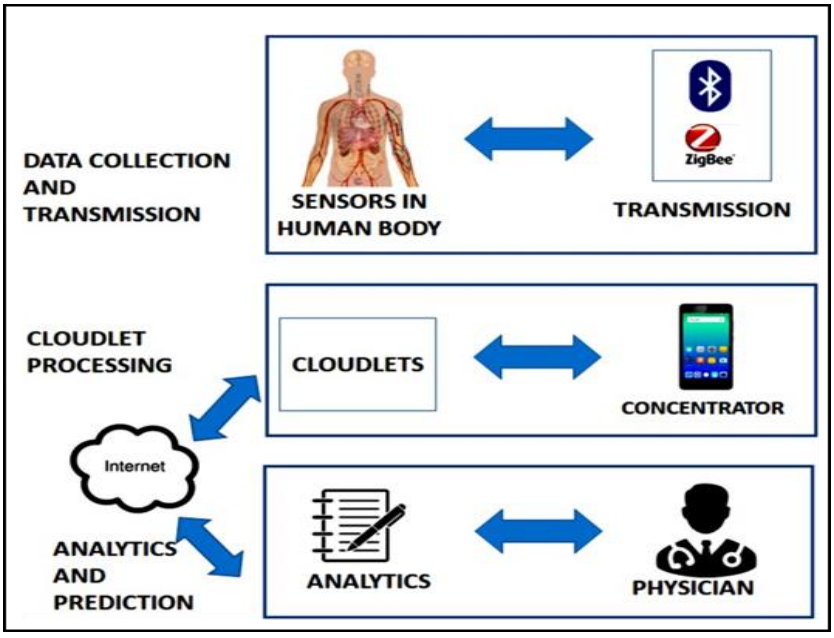

Fig. 5. The component Systems [2].

The components of the data transmission system must be capable of converting patient records from any location to the health center reliably and safely. Transmission can be accomplished using ZigBee or Bluetooth short-range low-power digital radios. Additionally, the data collected may be sent to a health center for storage via the Internet. The condenser, which can also be a smartphone, will use the Internet to monitor the sensors in the IoT device.

7. Application in the area of medicine and healthcare

Major applications of the IoT within the field of medicine and health care include the following [28]:

7.1. Controlling medical equipment and medications

To ensure the safety of public medical, monitor the entire process of medical equipment and prescription manufacture, distribution, anti-counterfeiting, and tracing. The following are some of the features:

- The use of RFID tags attached to therapeutic equipment and medicine to prevent counterfeiting is unique and impossible to replicate. Patients or emergency clinics should compare labels to database records to effectively identify fake drugs if medicine data is stored in an open database.
- Real-time monitoring ensures that drugs are delivered and stored safely.
- Medical refuse data management can track medical waste from hospitals to waste treatment plants, eliminating illegal medical waste disposal.

7.2. Medical information management

The following are a few points to consider when it comes to medical information management:

According to Patient data Management and Status Monitor [29], Electronic Patient Health Profile contains treatment history, corrective evaluations, treatment records, and medications.

Due to sensitivities, some consultants and nurses may be required to monitor the patient's vital signs, perform testing, and prescribe therapies to prevent using inappropriate drugs or injecting the patient. Various parts of information about the patient's condition may be needed depending on the pathology. It must be regularly accessible on medical or nursing teams (movement features, breath, heartbeat, proximity to other patients, and so on.) [30].

• Patient tracking and location is a valuable asset because it allows for quick response if immediate help is needed. Pathologies such as perceptual disorders, epilepsy, Down's syndrome, and neurodegenerative diseases such as Parkinson's and Alzheimer's disease are all addressed [30].

• Patients' Long-Term Care Patients' vital signs are constantly monitored, which aids in preventing Re-treatment in the hospital by detecting abnormalities early and allowing for timely and appropriate interventions [31]. The IoT is critical for linking medical equipment with video-oculography to study the organizational structures and activity of the brain. Thanks to an integrated process involving an intelligent machine, the presence of oculomotor changes in the disease of Parkinson's is well understood [32].

• Management of Medical Emergency can help with RFID innovation by storing and reviewing data reliably and efficiently [33].

• Management of Medication Storage, RFID can be used in the storage, use, and medicine review, making drug review more useful and avoiding the confusion of similar prescription names and dosage forms, as well as strengthening drug management and protecting convenient medicine supplies [34].

• Blood data management can effectively avoid the small limit disadvantage of bar tags and recognizable proof of acknowledging non-contact to reduce blood pollution, achieve multi-target ID, and increase data collection effectiveness [35].

• Mechanisms for preventing errors in pharmaceutical preparations[36], by developing error prevention mechanisms for buying and prescribing medications, as well as pharmaceutical data management for prescriptions, doses, medication distribution.

• Information Sharing: Using this system, authorized specialists can access patients' medical records [37].

• The Neonatal Anti-theft System: providing newborn babies with workable and robust protection [38].

• An alarm system: that continuously tracks and monitors clinic therapeutic equipment and patients [39].

7.3. Telemedicine and ambulatory medical care

Telemedicine is a form of advanced medical aid that integrates computers, multimedia, communication, and medical technologies [40]. The aim is to enhance the level of analysis and therapy, reduce the cost of medical services, and meet people's health needs [41], advances in remote communication systems for effective communication within a patient's Body Sensor Network [42]. Furthermore, telemedicine is gradually supplying life-saving information and facilitating the exchange of medical programs. Figure (6) illustrates the telemedicine architecture [43, 44].

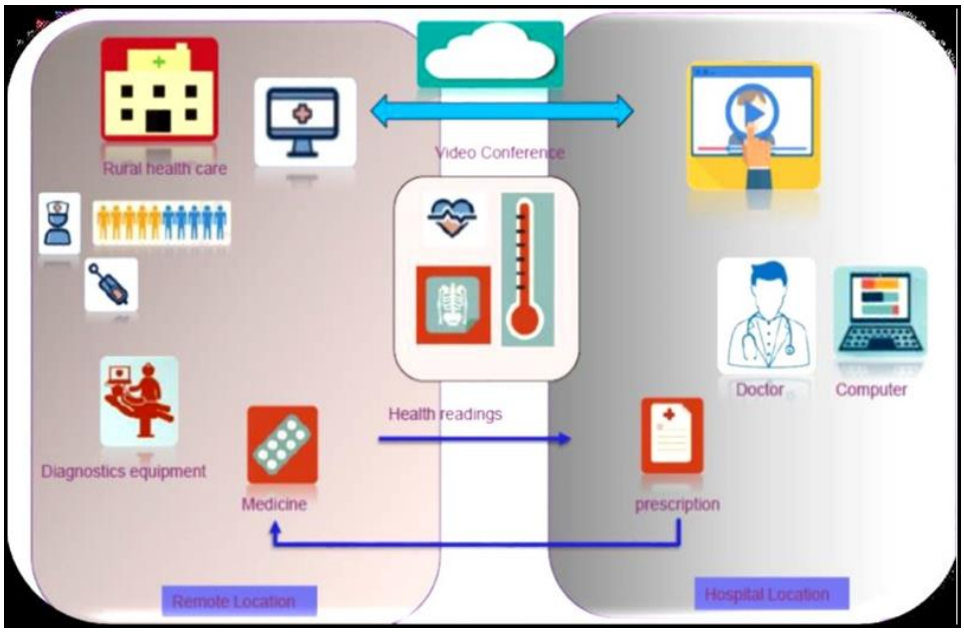

Fig. 6. Telemedicine architecture.

8. Strategies and methodologies for implementing IoT healthcare

WiFi and RFID-based short-range radio communication techniques, G.P.S-based location technique, unique identifier (UID)-based identification technique, and service-oriented architecture (S.O.A)-based architecture technique all help to enable IoT of rehabilitation systems [45, 46]. In an IoT-based healthcare services system, viable approaches and methods play a key role in improving the system's capability and viability. The center concerns include the ability to respond quickly and the risk of retaining a strategic distance from insight, which is strongly linked to recovery quality [3]. Figure 7 illustrates the semantic relationships between the main techniques of I.o. T-based rehabilitation systems [47].

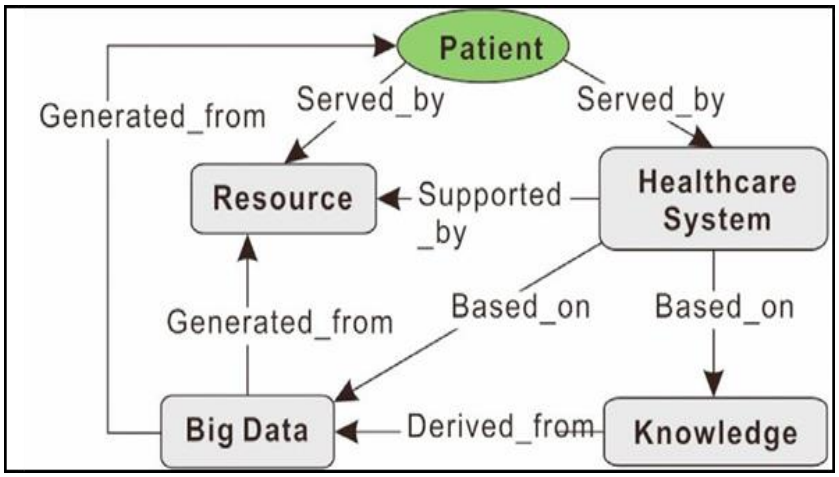

Fig. 7. The semantic relationships between the main techniques of IoT-based rehabilitation system

Conclusions

Medical recovery may be a moderately new field that plays an important role in maintaining people's health, especially for the elderly with chronic diseases who want to enhance their life quality. The IoT is expanding at a breakneck speed, resulting in cultural and technical shifts for institutions, enterprises, and industries as they transform a smarter model that prioritizes environmental stewardship and social responsibility. Implementing IoT in clinical safety systems such as medical devices and opioid surveillance, telemedicine, medical records management, and virtual patient treatment, and delivery processes and methodologies, like the recovery system, has important and beneficial benefits.

References:

TUN, S. Y. Y., MADANIAN, S., & MIRZA, F., INTERNET OF THINGS (IOT) APPLICATIONS FOR ELDERLY CARE: A REFLECTIVE REVIEW. AGING CLINICAL AND EXPERIMENTAL RESEARCH, 1-13, 2020.

DE SOUSA, T. B., ROCHA, I. F., LOIOLA, F. S., DA CONCEIÇÃO, G. R., DE SOUZA, C. G. L., & RUWER, S. G., APPLICATION OF THE INTERNET OF THINGS IN THE HEALTHCARE FIELD. IN 2ND INTERNATIONAL SYMPOSIUM ON SUPPLY CHAIN 4.0 (P. 16), 2018.

YUEHONG, Y. I. N., ZENG, Y., CHEN, X., & FAN, Y., THE INTERNET OF THINGS IN HEALTHCARE: AN OVERVIEW. JOURNAL OF INDUSTRIAL INFORMATION INTEGRATION, 1, 3-13, 2016.

QADRI, Y. A., NAUMAN, A., ZIKRIA, Y. B., VASILAKOS, A. V., & KIM, S. W. THE FUTURE OF HEALTHCARE INTERNET OF THINGS: A SURVEY OF EMERGING TECHNOLOGIES. IEEE COMMUNICATIONS SURVEYS & TUTORIALS, 22(2), 1121-1167, (2020).

MOHAMMED, M. N., DESYANSAH, S. F., AL-ZUBAIDI, S., & YUSUF, E., AN INTERNET OF THINGS-BASED SMART HOMES AND HEALTHCARE MONITORING AND MANAGEMENT SYSTEM. IN JOURNAL OF PHYSICS: CONFERENCE SERIES (VOL. 1450, NO. 1, P. 012079). IOP PUBLISHING, 2020.

STRIELKINA, A., UZUN, D., & KHARCHENKO, V., MODELLING OF HEALTHCARE IOT USING THE QUEUEING THEORY. IN 9TH IEEE INTERNATIONAL CONFERENCE ON INTELLIGENT DATA ACQUISITION

AND ADVANCED COMPUTING SYSTEMS: TECHNOLOGY AND APPLICATIONS (IDAACS) (VOL. 2, PP. 849-852). IEEE, 2017.

ALBESHER, A. A., IOT IN HEALTH-CARE: RECENT ADVANCES IN THE DEVELOPMENT OF SMART CYBER-PHYSICAL UBIQUITOUS ENVIRONMENTS. IN IJCSNS (VOL. 19, NO. 2, P. 181), 2019.

TIAN, S., YANG, W., LE GRANGE, J. M., WANG, P., HUANG, W., & YE, Z., SMART HEALTHCARE: MAKING MEDICAL CARE MORE INTELLIGENT. GLOBAL HEALTH JOURNAL, 3(3), 62-65, 2019.

JEONG, J. S., HAN, O., & YOU, Y. Y., A DESIGN CHARACTERISTICS OF THE SMART HEALTHCARE SYSTEM AS THE IOT APPLICATION. INDIAN JOURNAL OF SCIENCE AND TECHNOLOGY, 9(37), 52, 2016.

DAUWED, M., & MERI, A., IOT SERVICE UTILIZATION IN HEALTHCARE. INTERNET OF THINGS (IOT) FOR AUTOMATED AND SMART APPLICATIONS, 2019.

KHAN, S. A., FARHAD, A., IBRAR, M., & ARIF, M., REAL-TIME ALGORITHM FOR THE SMART HOME AUTOMATION BASED ON THE INTERNET OF THINGS. INTERNATIONAL JOURNAL OF COMPUTER SCIENCE AND INFORMATION SECURITY (IJCSIS), 14(7), 94-99, 2016.

SETHI, P., & SARANGI, S. R., INTERNET OF THINGS: ARCHITECTURES, PROTOCOLS, AND APPLICATIONS. JOURNAL OF ELECTRICAL AND COMPUTER ENGINEERING, 2017.

PERWEJ, Y., ABOUGHALY, M. A., KERIM, B., & HARB, H. A. M., AN EXTENDED REVIEW ON INTERNET OF THINGS (IOT) AND ITS PROMISING APPLICATIONS. COMMUNICATIONS ON APPLIED ELECTRONICS (CAE), ISSN, 2394-4714, 2019.

PRABHA, R., VENKATESH, V., ALEKYA, R., BODDETI, N. D., & MONICA, K. S., IOT-BASED SMART HEALTHCARE MONITORING SYSTEMS: A LITERATURE REVIEW. EUROPEAN JOURNAL OF MOLECULAR & CLINICAL MEDICINE, 7(11), 2761-2769, 2021.

NING, H., & WANG, Z. FUTURE INTERNET OF THINGS ARCHITECTURE: LIKE MANKIND NEURAL SYSTEM OR SOCIAL ORGANIZATION FRAMEWORK, IEEE COMMUNICATIONS LETTERS, 15(4), 461-463, 2011.

KARTHIKEYAN, S., DEVI, K. V., & VALARMATHI, K., INTERNET OF THINGS: HOSPICE APPLIANCES MONITORING AND CONTROL SYSTEM. IN 2015 ONLINE INTERNATIONAL CONFERENCE ON GREEN ENGINEERING AND TECHNOLOGIES (IC-GET) (PP. 1-6). IEEE, 2015.

FARAHANI, B., FIROUZI, F., CHANG, V., BADAROGLU, M., CONSTANT, N., & MANKODIYA, K., TOWARDS FOG-DRIVEN IOT EHEALTH: PROMISES AND CHALLENGES OF IOT IN MEDICINE AND HEALTHCARE. FUTURE GENERATION COMPUTER SYSTEMS, 78, 659-676, 2018.

SUNITHA, C., ASHA PRIYA, B., & LAVANYA, S., NEED OF INTERNET OF THINGS FOR SMART CITIES. INT. J. TREND SCI. RES. DEV. (IJTSRD), 3, 218-222, 2019.

ALHUSSEIN, M., MONITORING PARKINSON'S DISEASE IN SMART CITIES. IEEE ACCESS, 5, 19835-19841, 2017.

KUMAR, S. M., MAHALAKSHMI, K., & XAVIER, P., A PERVASIVE STUDY ON APPLICATIONS AND TECHNOLOGIES OF INTERNET OF THINGS (IOT), 2019.

TYAGI, H., & KUMAR, R., CLOUD COMPUTING FOR IOT. IN INTERNET OF THINGS (IOT) (PP. 25-41). SPRINGER, CHAM, 2020.

NASEF, A., & TAGURI, A. E., HEALTH RESEARCH PRODUCTION IN DEVELOPPING COUNTRIES/AFRICA. ANN BONE MARROW RES, 5(1), 006-0010, 2020.

MATTHIAS, O., BROWN, S., & HALSALL, D,. DELIVERING HEALTHCARE EFFICIENCY–CAN AI HELP IDENTIFY PERFORMANCE ISSUES, 2020.

STIEFEL, M. C., UTILITY OF HEALTH EXPECTANCY WHEN EVALUATING HEALTH CARE SYSTEMS. IN INTERNATIONAL HANDBOOK OF HEALTH EXPECTANCIES (PP. 201-216). SPRINGER, CHAM, 2020.

MARTÍNEZ-CARO, E., CEGARRA-NAVARRO, J. G., GARCÍA-PÉREZ, A., & FAIT, M., HEALTHCARE SERVICE EVOLUTION TOWARDS THE INTERNET OF THINGS: AN END-USER PERSPECTIVE. TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE, 136, 268-276, 2018.

ISLAM, S. R., KWAK, D., KABIR, M. H., HOSSAIN, M., & KWAK, K. S., THE INTERNET OF THINGS FOR HEALTH CARE: A COMPREHENSIVE SURVEY. IEEE ACCESS, 3, 678-708, 2015.

THEOHARIDES, T. C., ALYSANDRATOS, K. D., ANGELIDOU, A., DELIVANIS, D. A., SISMANOPOULOS, N., ZHANG, B., ... & KALOGEROMITROS, D., MAST CELLS AND INFLAMMATION. BIOCHIMICA ET BIOPHYSICA ACTA (BBA)-MOLECULAR BASIS OF DISEASE, 1822(1), 21-33, 2012.

HU, F., XIE, D., & SHEN, S., ON THE APPLICATION OF THE INTERNET OF THINGS IN THE FIELD OF MEDICAL AND HEALTH CARE. IN 2013 IEEE INTERNATIONAL CONFERENCE ON GREEN COMPUTING AND

COMMUNICATIONS AND IEEE INTERNET OF THINGS AND IEEE CYBER, PHYSICAL AND SOCIAL COMPUTING (PP. 2053-2058). IEEE, 2013.

ERICSSON, A., & POOL, R., PEAK: SECRETS FROM THE NEW SCIENCE OF EXPERTISE. HOUGHTON MIFFLIN HARCOURT, 2016.

REDONDI, A., CHIRICO, M., BORSANI, L., CESANA, M., & TAGLIASACCHI, M. (2013). AN INTEGRATED SYSTEM BASED ON WIRELESS SENSOR NETWORKS FOR PATIENT MONITORING, LOCALIZATION, AND TRACKING. AD HOC NETWORKS, 11(1), 39-53, 2013.

BABU, G. C., & SHANTHARAJAH, S. P., REMOTE HEALTH PATIENT MONITORING SYSTEM FOR EARLY DETECTION OF HEART DISEASE. INTERNATIONAL JOURNAL OF GRID AND HIGH-PERFORMANCE COMPUTING (IJGHPC), 13(2), 118-130, 2021.

FARZANEHFAR, P., WOODROW, H., BRAYBROOK, M., MCGREGOR, S., EVANS, A., NICKLASON, F., & HORNE, M., OBJECTIVE MEASUREMENT IN ROUTINE CARE OF PEOPLE WITH PARKINSON'S DISEASE IMPROVES OUTCOMES. NPJ PARKINSON'S DISEASE, 4(1), 1-8, 2018.

ROMERO, L. E., CHATTERJEE, P., & ARMENTANO, R. L., AN IOT APPROACH FOR INTEGRATION OF COMPUTATIONAL INTELLIGENCE AND WEARABLE SENSORS FOR PARKINSON'S DISEASE DIAGNOSIS AND MONITORING. HEALTH AND TECHNOLOGY, 6(3), 167-172, 2016.

LIU, J., & LOCKHART, T. E., DEVELOPMENT AND EVALUATION OF A PRIOR-TO-IMPACT FALL EVENT DETECTION ALGORITHM. IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING, 61(7), 2135-2140, 2014.

CHENG, Y., JIANG, C., & SHI, J., A FALL DETECTION SYSTEM BASED ON SENSORTAG AND WINDOWS 10 IOT CORE. IN 2015 INTERNATIONAL CONFERENCE ON MECHANICAL SCIENCE AND ENGINEERING (PP. 238-244). ATLANTIS PRESS, 2016.

JARA, A. J., BELCHI, F. J., ALCOLEA, A. F., SANTA, J., ZAMORA-IZQUIERDO, M. A., & GÓMEZ-SKARMETA, A. F., A PHARMACEUTICAL INTELLIGENT INFORMATION SYSTEM TO DETECT ALLERGIES AND ADVERSE DRUGS REACTIONS BASED ON INTERNET OF THINGS. IN 2010 8TH IEEE INTERNATIONAL

CONFERENCE ON PERVASIVE COMPUTING AND COMMUNICATIONS WORKSHOPS (PERCOM WORKSHOPS) (PP. 809-812). IEEE, 2010.

PANG, Z., TIAN, J., & CHEN, Q., INTELLIGENT PACKAGING AND INTELLIGENT MEDICINE BOX FOR MEDICATION MANAGEMENT TOWARDS THE INTERNET-OF-THINGS. IN 16TH INTERNATIONAL CONFERENCE ON ADVANCED COMMUNICATION TECHNOLOGY (PP. 352-360). IEEE, 2014.

LEE, Y. J., TREVATHAN, J., ATKINSON, I., & READ, W., AN INTELLIGENT AGENT SYSTEM FOR MANAGING HETEROGENEOUS SENSORS IN A DISPERSED AND DISPARATE WIRELESS SENSOR NETWORK. INTERNATIONAL JOURNAL OF SENSOR NETWORKS, 27(3), 149-162, 2018.

ELHAYATMY, G., DEY, N., & ASHOUR, A. S., INTERNET OF THINGS BASED WIRELESS BODY AREA NETWORK IN HEALTHCARE. IN THE INTERNET OF THINGS AND BIG DATA ANALYTICS TOWARD NEXT-GENERATION INTELLIGENCE (PP. 3-20). SPRINGER, CHAM, 2018.

MARQUES, G., PITARMA, R., M GARCIA, N., & POMBO, N., INTERNET OF THINGS ARCHITECTURES, TECHNOLOGIES, APPLICATIONS, CHALLENGES, AND FUTURE DIRECTIONS FOR ENHANCED LIVING ENVIRONMENTS AND HEALTHCARE SYSTEMS: A REVIEW. ELECTRONICS, 8(10), 1081, 2019.

BHILARE, N., SHAH, S., SHAH, R., DAVDA, R., CHAUGHULE, A., & BHELANDE, M., SMART REAL-TIME HEALTH MONITORING SYSTEM. RECENT TRENDS IN ANALOG DESIGN AND DIGITAL DEVICES, 3(3), 2020.

MA, Y., WANG, Y., YANG, J., MIAO, Y., & LI, W., BIG HEALTH APPLICATION SYSTEM BASED ON HEALTH INTERNET OF THINGS AND BIG DATA. IEEE ACCESS, 5, 7885-7897, 2016.

MERCK, S. F., CHRONIC DISEASE AND MOBILE TECHNOLOGY: AN INNOVATIVE TOOL FOR CLINICIANS. IN NURSING FORUM (VOL. 52, NO. 4, PP. 298-305), 2017.

ANDREU-PEREZ, J., LEFF, D. R., IP, H. M., & YANG, G. Z., FROM WEARABLE SENSORS TO SMART IMPLANTS-–TOWARD PERVASIVE AND PERSONALIZED HEALTHCARE. IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING, 62(12), 2750-2762, 2015.

ALMOGREN, A., AN AUTOMATED AND INTELLIGENT PARKINSON DISEASE MONITORING SYSTEM USING WEARABLE COMPUTING AND CLOUD TECHNOLOGY. CLUSTER COMPUTING, 22(1), 2309-2316, 2019.

CAVALLIERI, F., BUDRIESI, C., GESSANI, A., CONTARDI, S., FIORAVANTI, V., MENOZZI, E., & ANTONELLI, F., DOPAMINERGIC TREATMENT EFFECTS ON DYSARTHRIC SPEECH: ACOUSTIC ANALYSIS IN A COHORT OF PATIENTS WITH ADVANCED PARKINSON'S DISEASE. FRONTIERS IN NEUROLOGY, 11, 1954, 2021.

MOIN, A., ZHOU, A., RAHIMI, A., MENON, A., BENATTI, S., ALEXANDROV, G., & RABAEY, J. M., A WEARABLE BIOSENSING SYSTEM WITH IN-SENSOR ADAPTIVE MACHINE LEARNING FOR HAND GESTURE RECOGNITION. NATURE ELECTRONICS, 4(1), 54-63, 2021.