# *Healthcare 5.0: A paradigm shift in digital healthcare system using Artificial Intelligence, IOT and 5G Communication*

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***Abstract:*** **The induction of Artificial Intelligence (AI) concept with the application of smart intelligent devices and adoption of high-speed data transmission networking techniques in healthcare unit, set a benchmark in the ideology of healthcare to a new level. Developments and advancement of new technologies in healthcare units and improvement in people's quality lifestyle lead people to live a healthier life. AI embedded machines like smart wearable devices with highly integrated efficient sensors which help to monitor, collect and diagnose disease from the symptoms extracted from the sensory data; robot nurse to timely monitor and record patient's health condition in the absence of medical practitioners help the users to know about the health condition irrespective of the location. Internet of Things (IoT) devices with AI touch cannot be considered as a solution to the limitations in fourth generation healthcare systems. Seamless data transmission rate with least or no data loss, traffic free transmission channels, cost effective, no time data retrieval and machine to machine (M2M) or device to device (D2D) communication in IoT era are the major challenges in healthcare 4.0. Further the healthcare use cases urgency like remote surgeries and Tactile Internet as an internet network that combines ultra-low latency with extremely high availability, reliability and security for the next evolution of IoT, needs human to machine or M2M or D2D communication. The possible solution needs 5G or fifth generation communication as the elementary network infrastructure. The paper summarizes all the fundamental concepts like AI, IoT and 5G communication to model healthcare 5.0.**

***Keywords: Healthcare 5.0; Artificial Intelligence; Internet of Things; 5G Communication***

## I. INTRODUCTION *(HEADING 1)*

The automation and Artificial Intelligence (AI) are two booming concepts in healthcare5.0, which are set to revolutionize any kind of workplace. AI in healthcare5.0 covers the concept of accurate and automated diagnosis of disease prediction; remote patient monitoring and treatment; robotics surgical system; AI therapy that includes online course for the people struggling with social anxiety; processing and analyzing results etc. AI is a concept that has no boundary of smart developments. It is the ability of algorithms for machines to estimate the concluding results without human intervention. Due to the rapid growth and advancement of technologies in healthcare termed as smart health system. With the touch of wireless fifth generation revolution or the induction of 5G in smart healthcare system is a new era of medical scenario. The recent development in smart healthcare like emerging 5G technology, edge computing, interconnected devices of the Internet of Things (IoT), and data analytics, as well as different smart techniques, have enabled connected healthcare services for a happier and healthier life [1]. With the advancement in technology are not only changing the world around us but also driving the wireless industry to develop the next generation of network technology. It will facilitate to connect the entire world through noise free, uninterrupted and worldwide communication technology that can successfully connect anything to anyone, anywhere, anytime, and anyhow, regardless of the device, service, network, or geographical existence. The combination of 5G and IoT devices in smart healthcare scenario helps to increase cellular coverage, network performance and address security related concerns in future [2][3]. mHealth application is one of the major developments in 5G healthcare. mHealth stands for mobile health, is the general term for the integration of mobile communications, wearable sensing, and medical technologies for easy and remote healthcare delivery. The adoption of new technologies, new business ideas and new workflows through highly secure channels that are transforming healthcare is the base of smart healthcare system [4][5][6][7].

AI is a broader concept that includes various set of instructions which enable the computer to act automatedly without the direct presence of human. The concept of combining AI, 5G communications services and IoT in one platform can revolutionize the healthcare to a new era i.e. healthcare5.0 or smart health5.0 or smart medical5.0 [8][9]. The responsibilities that AI algorithms can do are the jobs which require human intelligence to complete it, such as pattern and speech recognition, image analysis, and decision making. It also facilitates the users to utilize available resources to their maximum potential [10]. It provides smart and intelligent ways to cure health and additionally provide remote health treatment, disease diagnosis, health monitoring, access of emergency services with no time, that can increase the life expectancy of a serious patient and secures healthy living [11][12][13].

Integration of AI approaches for accurate disease detection and prediction, makes a model intelligent. Intelligent design through these approaches, enhances the capability of healthcare unit, so that anyone can be benefited

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through it. Almost every research laboratory starting from the pathology labs to disease monitoring research lab and blood banks [14] for automated matching and detection of the blood groups of any blood samples collected etc, are processed through smart, intelligent, interactive design tools that are incorporated with advanced and highly effective AI algorithms. Whenever decision making comes into field, AI approaches become the first preference to develop or design any model with intelligence. It offers a sophisticated version of the "one-size-fits-all" approach, a way of simplifying design processes by shifting some of the decision-making responsibilities away from the model designer to machine.

It becomes the primary research area of the researchers and many organizations as AI applications in healthcare may help to better understand the care pathway of each patient, medical decisions, or the impact of new drugs. Chronic disease prediction; reduce readmission rushes; prevent hospital acquired infections (HAIs); predict propensity-to-pay; identifying diseases and diagnosis; drug discovery and manufacturing; medical imaging diagnosis; personalized medicine; smart electronic health records with authenticated access; virtual nurses; clinical trial and research; crowdsourced data collection; better radiotherapy; outbreak prediction; autonomous robotic surgery etc. are the some of the crucial application areas of AI in healthcare.

In smart healthcare scenario, the registered patient, doctors including the specialists can access the medical reports through electronic AI portals and prescribed the required treatments. But the data security, secure data transmission via web and the filtered users to view and access specific data to avoid data piracy or data loss. AI programs can able to design a system that authenticate users and set permission to view and access the only data which are requested, the visibility of rest is hidden. As compiling and analysing information (like medical records and other past history) is the very beginning phase in healthcare system, storing and efficient management of data is the recent most and extensively used application of AI and digital automation like the robots collect, store, re-format, and trace data to provide faster, more consistent access. The AI robots analyze tests, X-Rays, CT scans, data entry, and other mundane tasks faster and more accurately. It's carried the same concept like the genetics and genomics look for mutations and the way to predict disease from the information extracted from DNA samples. The scan reports of body can detect cancerous cells and vascular diseases earlier and predict the probable health issues that might affect the patient's health, based on their genetics. Wearable smart digital health trackers such as FitBit, Apple, Garmin etc. monitors heart rate and activity levels of its users [9]. The smart devices send alerts to the users as well as to the concerned doctors (and AI systems) about the health condition of personals and patients health, so that doctors and a person can diagnose the health condition for regular monitoring and can do the need full before time. An automated AI embedded webcam of smartphones automatically confirm that patients are taking their prescriptions and helps them manage their condition. The digitized smart wearable devices are commonly accepted by the users with serious medical conditions, patients who tend to go against doctor advice, and participants in clinical trials. One of the smart applications of AI system is a digital nurse. It monitors and records patient's condition and follow up with treatments, between doctor visits [5][15]. The program uses AI to support patients, specializing in chronic illnesses and also gives basic health information and advice for parents of ill children. The app or the AI built web portals can able to answer the questions asked by its users about medications and whether symptoms require a doctor visit based on the history of the registered user's medical reports and common medical knowledge. These data are fed into the AI built application which also uses speech recognition to compare against a database of illnesses and generate the result of query. Cardiology and radiology are two disciplines where the amount of data is huge, to analyze and time consuming. These two disciplines are the booming research areas of healthcare5.0 in the future that should only look at the most complicated cases where human supervision is useful.

AI in healthcare5.0 in this era of smart healthcare, where each individual wants to be smart and live a healthier and long life by knowing their probable disease prediction the time before its attack. Basically, the concept of integrating AI in health focuses on the saying; "prevention is better than cure" i.e. it's easier to stop something happening in the first place than to repair the damage after it has happened and it open up a wide research area for researchers to grow and excel in the field of AI in healthcare[16][17][18][19][20].

## II. Healthcare 5.0 Scenario

Smart healthcare concept is nothing but controlling, managing and handling different modules of hospital system in one platform remotely starting from patient OPD visits to Operation to Pathology Test etc., where all modules like Super Admin, Admin, Receptionist, Doctor, Accountant, Pathologist, Blood Bank, Radiologist, Nurse, Receptionist and Patient are interlinked to each other and all modules are controlled via main controller. Basically, the medical data are large in number, so for efficient handling and storage purpose, data are stored in cloud platform. The collected data are then transmitted through cloud to respective departments for further analysis and decision making. Sensors and actuators are implemented in each department for data capturing and transmission. Pathologists and doctors analyse and diagnose the abnormalities from the registered patients' tissue samples collected in different forms like images like scan reports, X-ray reports, smears with the help of AI models. As AI models can able to diagnose affected tissues by analyzing a huge data set of same kind within fraction of time that can speed up the further treatment procedure. Once the patients get registered, then they can collect their reports, submit bills and can visit concerned doctors remotely via mobile devices. Doctors can able to provide medical support to the registered patients remotely. The smart super admin and admin module handles the overall smart hospital management system through smart online mobile portal. Receptionist keep all the records of registered patients, cabin/bed status, specialists' and staffs' shift schedule etc.

Once a patient gets admitted or registered his/her medical diagnosed records is stored and can be viewed and accessed by doctors or other staffs including the patient through its unique id generated while registration process. Smart waste management system comprises smart dustbins with embedded different sensors in it to sense the status of the dustbins. The regular health status can be monitored and analysed through smart wearable IoT devices [13][15], robot nurses and through AI tools and techniques implemented by the hospitals. The below fig. 1 depicts a conceptual healthcare5.0 model that comprises some basic required smart modules like main controller with Industrial IoT(IIoT); smart IoT mobile devices; smart blood bank [14] to reduce the processing and waiting time in emergencies; smart pathology labs for automatic disease prediction in collaboration with AI tools; smart waste management module for easy and timely waste management which can control the spreading possibilities of contaminated diseases; 5G communication services installed in inter and intra network services like small base stations with femto, pico, micro cells which covers a limited vicinity of around 0.1 to 2 km coverage, approx. 30 to 2000 users and macro or main base stations which covers more coverage of around 30kms, approx. more than 2000 users. Healthcare5.0 requires high and seamless data rate for remote diagnosis and surgeries. The probable solution is installation of 5G cellular network services as the essential parameters are high user data rate (10 to 20Gbits), seamless coverage area, can able to handle 1000 times more high traffic in transmission channel, ultra-low cost for communication, highly secure data transmission and ultra-low latency. The combination of AI units, IoT devices and 5G communication services, has the ability to change the traditional healthcare scenario to healthcare5.0 scenario [8][9][11][12][17][18][19][20][21].

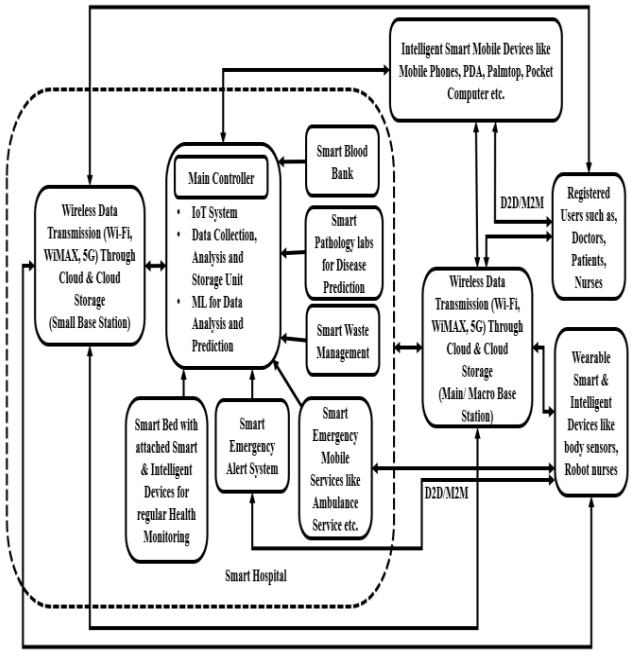


Figure. 1 Healthcare5.0 Framework

### *A. Role of 5G Communication module*

High speed data transmission, unlimited coverage area, high capacity to control network traffic, highly responsive, low cost and the ability to connect a lot more devices at once (for sensors and smart intelligent interactive devices) are the key features of 5G communication modules to improve patient experience with personalized, preventative care. Adding ultra-high-speed 5G cellular network in smart healthcare can help reliable and quick transmission of huge data medical image files of data size around 1 gigabyte of information per patient per study. It enhances the remote monitoring health process. Figure 2 depicts the basic 5G network architecture in smart healthcare scenario.

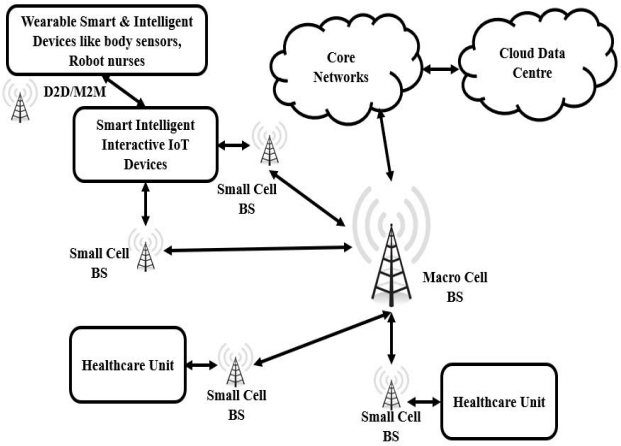


Figure. 2 5G Cellular Network Architecture

The data generated from healthcare units are very huge in size. Cloud storage is used for effective maintenance, storage and process of huge datasets. Core networks act as middleware, that responsible for data extraction, transmission of data to and fro the cloud storage and distributed the data via internet services. It is responsible for effective data transmission. Macro cell base station (Macro cell BS) used in cellular network to provide wide area coverage approximately 30 kms of range. It uses low frequency bands to provide connectivity and mobility. The small cell base station (Small cell BS) can access the cloud data via Macro cell BS. It uses high frequency bands to provide high throughput data transmission. In MBS or macro cell base station can handle more than 2000 users at a time but SBS or small cell base station can handle approx. 30 to 2000 users at a time. SBS used in cellular network to provide wide area coverage approximately 0.1 km to 2 km of range. The fifth-generation healthcare units rely on high speed data rate such as 137 Mbps to 1.6 Gbps for remote surgery. So, the solution is the induction of small cell cellular networks that ranging from shorter to larger organization. It is categorized as femto cells, pico cells and micro cells. The femto cells used to increase the coverage and capacity within a small area like hospital or smart home etc. It covers the range of around 0.1 km. and can efficiently handle 30 users. Within a network. The pico cells used for more coverage and capacity purpose and is used to boost the cellular and

wireless coverage within a small area. It covers the range of approx. 1 km and can efficiently handle 100 users. The micro cells used for larger area in comparison to femto and pico small cells. It covers the range of approx. 1 km and can efficiently handle 100 users. In 5G cellular network technology device to device (D2D) or machine to machine (M2M) communication can be directly established. Here, devices or machines can directly communicate with each other rather than via base stations. It outperforms in highly dense networks to exchange information and share their mediums and the interference can be reduced efficiently [1][6][8][22].

### B. Use of IoT in Smart Health Monitoring

IoT and smart IoT devices enable remote monitoring in healthcare services and change the concept of traditional healthcare to smart healthcare. The different embedded body sensors, actuators efficiently collect data from the intelligent interactive devices and sends through 5G cellular networks to cloud and to main controller where the huge amount of data are gone through thorough monitoring process [8]. In smart pathology labs, data are managed and analysed. The advanced analytics in AI machines, applied to this data, for effective decision-making and disease diagnosis. The remote monitoring of patient's health helps in reducing the length of hospital stay and prevents re-admissions [17][18]. It also has a major impact on reducing healthcare costs significantly and improving treatment outcomes. The patient engagement as interactions with doctors have become easier and more efficient that lead to service satisfaction. If any disorder or emergency arises while monitoring of patients by data analysis, automatically an alarm will trigger the smart emergency services like ambulance with the patient details like health reports, patient's exact location, possible necessary medications etc. while the ambulance will pick the patient and reach hospital, respective nearest health unit also will get notify about the emergency case, so that the patient can able to avail timely care [23].

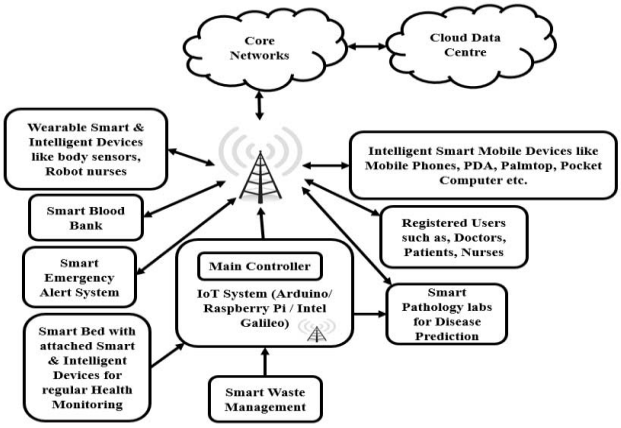


Figure. 3 IoT based Healthcare5.0 Framework

The cons of IoT in healthcare includes, reduction of unnecessary treatment cost, improvised treatment, faster disease diagnosis, providing proactive medical treatment, efficient management of drugs and medical equipment, help in effective decision making, smooth healthcare operations with reduced errors, waste and system costs etc. [2][3][9][11][12][13][21].

### C. Smart Intelligent and Interactive Wearable Devices

The smart devices effortlessly record health records and send the report to cloud data center for proper analysis and health condition prediction remotely. Wearables devices like fitness bands [9] and other wireless connected devices like blood pressure (sphygmomanometer) sensor and heart rate monitoring cuffs, electrocardiogram (ECG) sensor, airflow sensor for breathing, electromyography (EMG) sensor, patient position (accelerometer) sensor, galvanic skin response (GSR) sensor to monitor sweating, pulse and oxygen in blood (SPO2) sensor, body temperature sensor, glucometer etc. give patients to avail personalized attention. These devices can set alarm or send an alert notification to remind calorie count, exercise check, appointments, blood pressure variations etc. and also the physicians can able to observe patients' health more efficiently irrespective of the patients' positioning. Remotely they can keep monitoring patients' regular suggested treatment plans and alerted smart emergency system at the time of requirement of any immediate medical attention [15].

### D. Smart Blood Bank

Blood is a very essential medical supplies and it can be considered as the most important lives saver at the time of emergencies. Blood banks are the main supplier of blood. But the major problem is the availability of blood donor in emergencies and the lengthy process of registration to collect matched blood. IoT integration in blood banks make the whole process simpler like donor availability, blood group analysis and dispatch the required amount of blood to the respective patient and online payment systems etc. [11]. Figure 3 depicts the overview of smart blood bank framework. In smart blood bank system, anyone can registered as donor who will be provided with a smart donor card by which they can give blood and can avail the basic facilities of a blood donor; and the patient can register in the blood bank portal with his/her medical reports, according to that report, the blood bank manage the overall process like blood sample monitoring, contact donors in case of unavailability of blood and send blood to the respective patient with no error and delay[12][13][14][20][21].

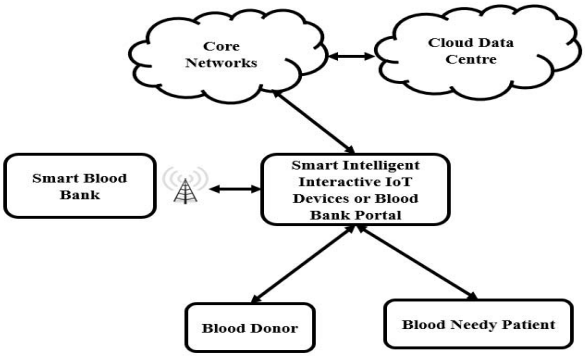


Figure. 4 Smart Blood Bank Framework

### *E. Smart Waste Management in Healthcare 5.0 Scenario*

Waste management is a concept to make healthcare units and environment sustainable. It can prevent the spreading of contaminated diseases as healthcare units are the main source of infectious and uncurable diseases. If it can't be controlled in time then it can lead to a serious health problem. IoT impact on waste management make the complicated procedure of waste management. Sensor-enabled IoT devices and internet-connected garbage bins can get information about the filling level of garbage, temperature, location etc. of various types data that the sensors gather like image data [11][12][13]. The gathered data are also sent to the diseases monitoring labs for keen analysis with AI techniques and prediction of any critical issues may arise due to wastes before its contamination [20].

### *F. Role AI Techniques in Healthcare 5.0 Scenario*

With the induction of AI in healthcare units, the huge data sets generated from the health units can be processed through different machine learning algorithms to do prediction and analysis for healthcare. It is very difficult for a lab technician or for medical practitioner to analysis any patient's sample and symptoms to diagnose disease from a huge dataset of each patients. Which can be handled effectively by various machine and deep learning algorithms with least error rate and higher accuracy as compared to the lab technicians. AI learning algorithms can process huge number of datasets that are collected from different smart IoT devices within faction of time and predict the result, that generated electronic health reports (ERHs) then send to the respective medical partitions for further analysis and suggestions [11][12][13][21]. AI machines can think like humans and act like super computer. It can detect illness faster and with better accuracy. Through the history of a patient's EHRs AI can assist the patients about their possible illness that may cause serious health problem in future and suggest its possible care, treatment and medications [16][17][18][19][20].

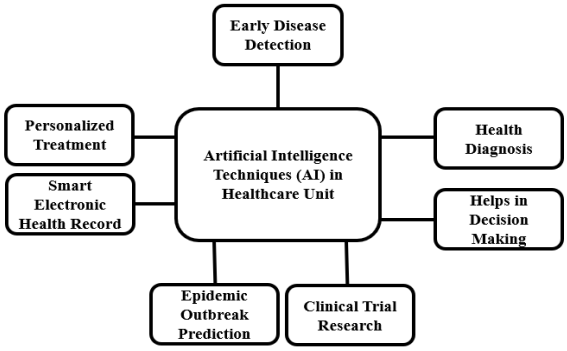


Figure. 5 AI Application Areas in Healthcare unit

## III. CONCLUSION AND FUTURE SCOPE

This paper presented a basic framework for modelling healthcare5.0. Its essential parameters are AI embedded machines like robot nurse, smart IoT devices and 5G communication services. Various researchers and scholars have introduced in their papers all the basic functionalities with communication links and flow of data through the healthcare 5.0 framework. After going through these developments, we have given a holistic picture on the smart healthcare system. It includes M2M/D2D, human to machine data flow, smart intelligent interactive wearable devices with active sensors, small base stations, main or macro base stations, cloud storage or healthcare server unit, IoT enabled smart hospital scenario and emergency alert services. We have introduced the concept of smart communication infrastructure i.e. 5G communication technology that is useful to cover each area of different range and reliable data transmission with high collision avoidance or traffic control; enhancing energy efficiency and quality of services; long battery life; and resource optimization. We have also introduced smart wearable devices which is used to record and generate daily health report to monitor the health condition. The AI models is used in healthcare5.0 with classification approaches to analyze huge amount of data and diagnose diseases with high accuracy. However, security factor is the major concern in 5G cellular network services as the data generated and stored may be encountered privacy loss or theft. There is a high chance of data loss or piracy issue in wireless network communication. So, data authenticity and integrity should be maintained during communication for disease prediction accuracy and to achieve user's confidence that open up a new opportunity for the researchers.

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