International Journal of
INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING
ISSN:2147-6799 www.ijisae.org Original Research Paper

# IoT Based Virtual Doctor Robot

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**Submitted:** 05/09/2023 **Revised:** 15/11/2023 **Accepted:** 24/11/2023

**Abstract:** An IoT-based virtual medical professional machine combines the strength of the 'Internet of Things (IoT)' with robotics to revolutionize healthcare. This innovative technology aims to provide timely and personalized medical assistance to individuals in need, regardless of their location. At its core, the virtual doctor robot consists of several interconnected components, each serving a specific purpose to ensure efficient and accurate healthcare delivery. The hardware aspect of the robot includes sensors, actuators, and a robotic platform fitted with mobility capacity. The sensors used in this are responsible for collecting vital signs and other pertinent health information from the patient, such as oxygen level, temperature, blood pressure, and heart rate. Additionally, the robot may feature cameras and microphones to facilitate visual and auditory communication between the patient and healthcare providers. On the software side, sophisticated algorithms process the information gathered by the sensors to assess the condition of the individual health status accurately. Machine learning and artificial intelligence techniques enable the robot to analyze the data, identify patterns, and make informed decisions regarding the patient's condition. This functionality allows the virtual doctor robot to provide real-time medical advice, diagnose illnesses, and recommend appropriate treatment options. The IoT aspect of the virtual doctor robot enables seamless connectivity and communication between the robot, the patient, and healthcare professionals. Through wireless internet connections, the robot can transmit data securely to remote servers or cloud-based platforms where it can be accessed by authorized healthcare providers. This connectivity also enables telemedicine consultations, allowing patients to interact with doctors and specialists remotely. Moreover, the virtual doctor robot can be integrated with electronic health records (EHR) systems to ensure continuity of care and facilitate information exchange between different healthcare facilities. This integration streamlines the healthcare process, reduces administrative burden, and enhances the overall patient experience.

***Keywords**: Internet of Things , Telemedicine , robotics, Remote Health care, virtual Doctor*

## I. Introduction

The IoT Virtual Doctor Robot stands for a significant advancement in healthcare technology, combining robotics, IoT, and artificial intelligence (AI) to deliver remote, real-time medical support. This robotic system is designed to function as a virtual health assistant, capable of monitoring, diagnosing, and even interacting with patients. Equipped with various health sensors and diagnostic tools, it captures critical patient information like as blood pressure, pulse, temperature of the body, and breathing rates. Through Wi-Fi or cellular networks, this data is transmitted safely to medical professionals, enabling them to keep an eye on patient status remotely. This continuous data flows not only aids in immediate patient care but also supports longitudinal health monitoring, allowing providers to identify trends or potential health risks over time. The robot's AI algorithms enhance diagnostic accuracy, offering preliminary analyses based on collected data and supporting healthcare professionals in decision-making. Additionally, the IoT Virtual Doctor Robot is designed with patient interaction in mind. By utilizing voice recognition, speech synthesis, and touch-based interfaces, the robot can communicate directly with patients, answering questions, reminding them about medications, or guiding them through basic health checks.

This interactive feature is especially beneficial for elderly patients or individuals with limited mobility, who may find it challenging to attend regular in-person check-ups. The robot's ability to provide timely health assessments and reminders can improve requirements of treatment plans, eventually supporting improved health results. Moreover, by

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reducing unnecessary hospital visits, the robot also helps lower healthcare costs and minimizes the risk of infectious disease spread, making it a valuable tool in both routine and emergency healthcare scenarios.

## II Literature Survey

The paper "IoT-Based Virtual Doctor System for Remote Patient Monitoring" by Smith et al. (2019) outlines an innovative framework that utilizes IoT technology to facilitate remote health monitoring. Designed to address the challenges faced by patients in places where limited access to physical healthcare resources, the system ensures continuous health monitoring and timely medical interventions. It integrates IoT-enabled sensors, cloud-based infrastructure, and a user interface to collect, store, and analyse health data, enabling healthcare providers to monitor patients and offer remote consultations effectively. The system's operation is divided into three main stages: sensing, data transmission, and data processing. In the sensing stage, wearable sensors continuously gather vital signs such as pulse rate, body temperature, and blood pressure readings. The received sensor data is securely sent over a network to a platform in the cloud for analysis. Edge computing is incorporated into the process, enabling preliminary data filtering and preprocessing at the local level to reduce latency before the information reaches the cloud for more advanced processing. Processed data in the cloud is analysed for abnormalities, and the system automatically generates alerts for healthcare providers when irregularities are detected. This mechanism ensures proactive health management by enabling providers to intervene promptly in case of emergencies or abnormal readings. The integration of edge computing further enhances efficiency by reducing response times and optimizing the use of network resources, making the system highly reliable for real-time applications.This IoT-based system demonstrates significant potential to revolutionize healthcare by improving accessibility and enabling continuous monitoring. It empowers healthcare providers to offer better care through timely interventions while reducing the need for in-person consultations. By leveraging advanced data analysis and secure communication, the system represents a crucial step toward modernizing healthcare, especially for underserved populations.[1]

In the paper **"A Virtual Robotic Doctor for Medical Assistance Using IoT"** (Kumar & Patel, 2020), the authors delve into IoT's technology is used in developing a virtual robotic doctor. This innovative system provides real time remote patient monitoring which helps to healthcare professional for assistance , thus improving the standard of care while alleviating the workload on doctors. The system integrates IoT-based sensors to measure vital signs like temperature and pulse rate, which doctors can access remotely via a mobile interface. Additionally, the robot supports two-way video communication, enabling virtual consultations between patients and doctors.The study outlines the methodology for developing this virtual robotic doctor, leveraging IoT components such as the NodeMCU microcontroller for wireless communication. The microcontroller connects the robot to the internet via Wi-Fi, ensuring seamless data transmission. The system utilizes specialized sensors like the LM35 for temperature monitoring and the MAX30100 for pulse oximetry, which provide crucial health data in real time. These data points are accessible to doctors through a mobile app, such as Blynk, allowing for a user-friendly interface to monitor patient health.To enable virtual consultations, the robot is equipped with a camera that facilitates real-time video communication. This camera supports two- way interactions between patients and doctors, making the system effective for telemedicine. Furthermore, the robot can be remotely controlled, allowing it to navigate through healthcare environments. Doctors can operate the robot's movements and adjust the camera angle to obtain a complete view of the patient, enhancing their ability to diagnose and provide medical advice remotely.The robot's operation relies heavily on data in real- time transmission and remote-control facility. Commands sent through the doctor's mobile app are received by the robot's controller, which then activates the robot's motors. These motors enable the robot to move in multiple directions, such as forward, backward, or turning. The camera is mounted on a servo motor, which allows for 360-degree movement, giving doctors with a complete view of the patient and their surroundings. Overall, the virtual robotic doctor system proposed by Kumar & Patel demonstrates a significant advancement in telemedicine and healthcare technology. By combining real-time health monitoring, remote mobility, and video consultations, the system enables doctors to provide efficient medical assistance to patients. The paper

**"Smart IoT-based Robotic Doctor for Remote Diagnosis"** by Li and Zhang (2021) explores the IOT technology integration in healthcare, focusing on its application for remote diagnosis through a robotic doctor. The literature review highlights the transforming role of IoT in transforming healthcare by enabling remote individual monitoring and diagnosis. With IoT-enabled devices, continuous health data collection and real- time transmission to healthcare providers become possible. This capability is particularly beneficial for patients in remote or underprivileged regions, where timely medical interventions can make a significant difference. The paper also reviews related works, emphasizing IoT's contributions to chronic disease management and remote healthcare delivery.

The methodology described in the paper involves designing a robot system fitted with advanced sensors & communication tools to facilitate remote healthcare. The robot collects crucial health information, including heart rate and body temperature, using IoT-enabled sensors. This data is transmitted to healthcare providers via an IoT network, where it is analysed using cloud computing and data analytics. The system provides real-time feedback and recommendations to physicians, who can interact with patients through voice commands and video feeds. This setup enhances diagnostic accuracy and ensures comprehensive patient engagement.

A detailed explanation of the mechanism behind the robotic doctor reveals a well-integrated system of sensors, actuators, and communication modules. The platform includes an ESP32-CAM for video streaming, an ESP8266 Wi-Fi module for connectivity, and sensors for monitoring key health parameters. The robot offers flexibility by operating autonomously or under remote control. This dual mode ensures that the robot can adapt to various healthcare settings, providing effective patient monitoring in both structured and dynamic environments.The system architecture is thoughtfully designed to prioritize data security and efficient communication. The use of IoT networks ensures seamless data transfer between the robot and healthcare providers while maintaining confidentiality and integrity. Real-time video streaming and voice command capabilities enable physicians to conduct remote consultations with accuracy and immediacy. The integration of cloud computing and analytics supports rapid diagnostics, making the robotic doctor a practical solution for modern healthcare challenges.Overall, the paper underscores the potential of IoT in advancing healthcare by enabling continuous, remote monitoring and diagnosis. The smart robotic doctor system proposed by Li and Zhang demonstrates the capacity to bridge gaps in healthcare accessibility, particularly for remote or underserved populations. By combining advanced technology with a patient-centric approach, the study highlights how IoT can contribute to more effective and equitable healthcare delivery.[3]

The paper by Wong & Chu (2022) presents the advancement of a Virtual physician Robot prototype which integrates telemedicine with IoT technologies to enhance remote healthcare. The literature survey highlights existing systems, including IoT-based machines for monitoring heart rate, blood pressure, and ECG, as well as wearable gadgets that store and transmit patient data in real time to doctors. However, these systems often lack mobility and interactivity, with fixed video calling platforms limiting doctors' ability to move dynamically in healthcare environments like hospitals or emergency rooms, where mobility can significantly improve patient care.To address these limitations, Wong & Chu propose a methodology that combines robotic mobility with real-time health data transmission. The system is based on a NodeMCU IoT platform, enabling doctors to interact with patients remotely while maintaining the flexibility to move freely. Equipped with advanced sensors, the robot monitors vital health parameters and transmits this data through a video call interface. Additionally, the system allows doctors to access medical reports in real time, facilitating virtual consultations and assessments from any location with internet connectivity. The Virtual Doctor Robot employs a mechanism that integrates real-time health monitoring with robotic mobility. The robot can navigate autonomously or be manually controlled to move around patient rooms or other healthcare settings. This mobility enables it to visit patients, stream live health data, and facilitate seamless communication between the patient and the doctor. By bridging the interaction gap, the system aims to provide a dynamic solution to address challenges in remote or crowded healthcare environments. A key advantage of this system is its ability to enhance doctor-patient interaction, particularly in regions with limited access to healthcare. By reducing the need for physical presence, the robot can help mitigate the global shortage of medical professionals. Doctors can provide timely consultations, monitor patients efficiently, and make informed decisions without being restricted by geographical constraints or hospital settings.Furthermore, the prototype's integration of IoT technologies ensures that health data is collected, transmitted, and displayed securely and efficiently. The use of sensors for real-time monitoring of vital parameters, coupled with a robust communication interface, empowers doctors to offer high-quality medical care remotely. This combination of mobility and data-driven healthcare positions the Virtual Doctor Robot as a groundbreaking tool for telemedicine. Overall, Wong & Chu's Virtual Doctor Robot prototype demonstrates significant potential in transforming telemedicine and IoT-based healthcare. By combining real-time health monitoring, robotic mobility, and secure data communication, the system provides an effective solution for improving healthcare delivery. It not only bridges the gap between doctors and patients but also contributes to overcoming barriers in healthcare accessibility, making it a valuable tool in modern medical practices.[4]

The paper "Virtual Doctor Using IoT for Health Data Collection and Analysis" by Jones et al. (2020) investigates the use of IoT technology for monitoring and analysing patient health data. It emphasizes the transformative potential of IoT in enabling remote patient monitoring, which reduces the frequency of hospital visits while providing real-time insights into patients' vital signs. By integrating wearable devices and sensor-based technologies, the study highlights how IoT can help track patient conditions continuously. The system leverages cloud computing for data storage and analysis, reducing healthcare costs while maintaining the quality of care. The study proposes a methodology involving a multi-layered architecture designed to optimize data collection, storage, and analysis. The IoT layer comprises wearable devices and sensors that gather critical health information such as heart rate, blood pressure, and oxygen saturation. This data is transmitted securely to a cloud platform, where it is processed to detect potential health issues. Healthcare providers access this processed data through an intuitive interface, enabling them to interpret health trends and make timely decisions.

One of the key components of the proposed system is the use of edge computing to enhance data management. The system preprocesses the data locally before sending it to the cloud, reducing latency and minimizing the load on cloud servers. This edge computing capability enables real-time responsiveness and ensures that healthcare providers can manage a large volume of data efficiently, making the system scalable and suitable for monitoring multiple patients simultaneously. Cloud computing plays a central role in the proposed system by supporting advanced analytics and visualization of patient health data. The cloud platform not only ensures secure data storage but also uses predictive analytics to identify potential health risks. This capability allows healthcare professionals to receive actionable insights and alerts, facilitating early interventions and reducing the risk of complications. The system's ability to adapt to different healthcare settings makes it a versatile solution for remote patient monitoring. The intuitive user interface is another critical aspect of the system, designed to enhance the interaction between healthcare providers and patient data. By presenting health trends and alerts in a clear, user-friendly format, the interface empowers medical professionals to make informed decisions quickly. This seamless integration of data collection, analysis, and visualization ensures the system's practicality in real-world healthcare applications. In conclusion, the paper demonstrates the immense potential of IoT in revolutionizing healthcare by enabling continuous monitoring and timely interventions. The multi-layered architecture, incorporating IoT devices, edge computing, and cloud-based analytics, ensures scalability, efficiency, and accessibility. By reducing the need for in-person consultations and enhancing healthcare providers' decision-making capabilities, the system represents a significant advancement in remote healthcare delivery.[5]

The paper **"AI-Powered Virtual Doctor Robot with IoT Sensors"** by Park et al. (2019) introduces a cutting-edge approach to healthcare delivery by combining artificial intelligence (AI) with IoT technology to create a virtual doctor robot. This system is designed to provide remote healthcare services in areas where access to medical professionals is limited. The robot uses IoT sensors to monitor patient health, collecting data such as temperature, heart rate, and motion. What sets this system apart is its integration of AI algorithms for automated diagnosis, symptom analysis, and decision-making, significantly enhancing the accuracy and effectiveness of remote healthcare systems.The study builds on prior research in telemedicine and robotics, where IoT devices have been utilized for patient monitoring. While existing systems focus on data collection and transmission, Park et al. advance the field by incorporating AI capabilities to analyse health data and generate actionable insights. This integration allows for a deeper understanding of patient symptoms and facilitates proactive healthcare interventions. By combining robotics, IoT, and AI, the study aims to overcome limitations in current telemedicine systems.A thorough literature review in the paper explores trends in healthcare robotics, particularly the growing reliance on AI for decision support and the expanding use of IoT in patient monitoring. Previous studies have established the value of IoT-enabled robots in tracking vital signs, but many systems lack intelligent data processing. Without AI, these systems often fail to contextualize patient symptoms effectively. Park et al. address this gap by proposing a solution that not only collects health data but also interprets it intelligently for improved medical outcomes.The methodology described involves equipping the robot with IoT sensors to capture real- time health data, such as body temperature and heart rate, which is then analysed using advanced AI algorithms. These algorithms support automated diagnosis and generate personalized recommendations for patient care. The robot also features a user-friendly interface that allows healthcare providers to access data and interact with patients remotely, facilitating virtual consultations. This design enhances the robot's capability to provide timely and accurate healthcare services.A key innovation of the proposed system is its ability to proactively detect abnormalities and suggest interventions, thanks to the combination of IoT data and AI analysis. Unlike traditional remote healthcare systems, which rely heavily on manual interpretation of data by medical professionals, this system automates much of the diagnostic process. This not only reduces the workload on healthcare providers but also ensures quicker and more consistent responses to patient needs, especially in critical situations.

In conclusion, Park et al. demonstrate how the integration of AI and IoT in a virtual doctor robot can transform remote healthcare delivery. By leveraging IoT sensors for real-time data collection and AI algorithms for intelligent analysis, the system achieves a higher level of diagnostic accuracy and responsiveness. The research highlights the potential of such systems to bridge gaps in healthcare accessibility and improve patient outcomes, making it a valuable contribution to the fields of telemedicine and healthcare robotics.[6]

The paper "**Development of a Virtual Doctor Robot for Home Care Using IoT**" by Singh and Rao (2021) explores the integration of IoT technology and robotics to revolutionize home care services. The system is specifically designed for elderly or immobile patients, aiming to monitor their health and provide medical assistance remotely. It combines wearable sensors, actuators, and wireless communication technologies to gather and transmit real-time health data. The mobile interface ensures continuous updates, alerts, and enables direct doctor-patient communication, reducing the need for frequent hospital visits and allowing effective medical monitoring in home environments.

The methodology of the system relies on low-power IoT devices and sensors integrated with a Raspberry Pi as the central control unit. Sensors like the MAX30100 for pulse rate monitoring and the MLX90614 for temperature measurement collect essential health data from patients. This data is transmitted to a central server or mobile application, where healthcare professionals can access it remotely using smartphones or computers. The system also incorporates a camera-equipped robot for visual monitoring, facilitating better understanding and interaction between patients and doctors. A notable feature of the system is its cloud-based platform, which plays a crucial role in data storage and processing. By storing patient data securely in the cloud, the platform enables healthcare providers to monitor multiple patients simultaneously. Real- time health alerts and analytics support timely medical interventions, enhancing the overall efficiency of the system. This cloud integration ensures that the system is scalable and adaptable to diverse healthcare settings, providing a robust solution for remote patient care. The physical design of the robot emphasizes user accessibility and operational reliability. It employs an Arduino microcontroller for motor control and a Raspberry Pi to interface with the IoT sensors. This setup ensures smooth mobility and functionality, allowing the robot to navigate home environments and deliver necessary healthcare services. The robot also includes remote interaction capabilities such as video consultations, enabling doctors to assess patients visually and provide accurate medical advice.The use of a mobile interface further enhances the system's effectiveness by fostering seamless communication between patients and doctors. Patients can receive real-time updates on their health status, while doctors can monitor vital signs and intervene promptly when needed. The interface is designed to be intuitive, ensuring that both patients and healthcare providers can use it without technical difficulties. This design element ensures that the system meets the needs of its target users, particularly elderly individuals who may not be tech-savvy.

In conclusion, Singh and Rao's work demonstrates the potential of IoT and robotics in transforming home care. The combination of wearable sensors, cloud-based data processing, and mobile interfaces creates a comprehensive solution for continuous patient monitoring and remote medical intervention. By reducing the reliance on hospital visits and providing timely healthcare in home settings, the system addresses key challenges in modern healthcare, particularly for vulnerable populations. This innovative approach not only enhances accessibility but also reduces the burden on healthcare facilities, making it a valuable contribution to the field of telemedicine.[7]

In the paper **"A Review of IoT-Based Virtual Healthcare Robots"** by Sharma et al. (2018), the authors explore the integration of Internet of Things (IoT) technology into virtual healthcare robots to revolutionize medical services. These robots are designed to provide remote healthcare assistance, making them particularly useful in telemedicine, elderly care, and remote patient monitoring scenarios. The paper reviews key advancements in IoT-based healthcare systems, emphasizing the role of IoT sensors, cloud computing, and artificial intelligence (AI) in enabling real-time health monitoring, data-driven diagnostics, and efficient healthcare management. The study also highlights the challenges and opportunities that arise from using IoT in healthcare robotics, focusing on its potential to improve automation, connectivity, and decision-making in patient care.The methodology employed by Sharma et al. involves a systematic review of existing literature, including research papers, technical reports, and case studies. The authors categorize the reviewed works into major themes, such as robot design, sensor technologies, communication protocols, and healthcare applications. This approach provides a comprehensive analysis of the current state of IoT-based healthcare robotics. The review underscores the benefits of integrating IoT devices with healthcare robots, including remote monitoring capabilities, personalized care options, and enhanced diagnostic precision. It also explores how IoT can improve the efficiency of healthcare delivery by facilitating continuous monitoring and enabling real-time communication between patients and healthcare providers.One of the key mechanisms discussed in the paper involves the functioning of IoT-based virtual healthcare robots through sensor integration and cloud computing. Sensors embedded in the robots collect vital health data such as heart rate, blood pressure, temperature, and movement. This data is wirelessly transmitted to cloud servers for processing and analysis. The cloud infrastructure supports real-time data access, allowing healthcare providers to remotely monitor patients and make informed decisions. This seamless integration of IoT sensors and cloud computing forms the backbone of these virtual healthcare robots, ensuring timely and effective healthcare interventions.

Another critical component of the system is its user-friendly interface, which enables interaction between the robot and the patient. Through this interface, patients can receive real-time feedback and assistance from the robot, creating a more engaging and supportive healthcare experience. Additionally, the robots are equipped with machine learning algorithms that analyse the collected data for predictive healthcare insights. These algorithms enable early diagnosis of potential health issues, allowing for timely medical interventions and better patient outcomes.The paper also emphasizes the transformative potential of combining IoT technology with machine learning in healthcare robotics. Predictive analysis, driven by machine learning, enhances the diagnostic capabilities of the robots, enabling them to identify patterns and trends in health data. This functionality not only aids in early intervention but also improves the overall efficiency of healthcare services. Furthermore, the integration of IoT and AI provides a scalable and adaptable solution for addressing diverse healthcare needs across various settings, including homes, clinics, and remote areas.

In conclusion, Sharma et al. provide a thorough review of how IoT-based virtual healthcare robots are transforming healthcare delivery. By leveraging IoT sensors, cloud computing, and AI, these systems enable continuous monitoring, real-time communication, and predictive analytics, significantly enhancing patient care. The study highlights both the opportunities and challenges associated with implementing IoT in healthcare robotics, offering insights into the future of remote healthcare services. This research serves as a foundational resource for further advancements in the field, aiming to address healthcare accessibility and efficiency through technology.[8]

In the paper **"IoT-Based Virtual Doctor for Elderly Care"** by Ahmad & Lee (2020), the authors explore the integration of Internet of Things (IoT) technology into healthcare systems for elderly care. The proposed virtual doctor system aims to improve the accessibility and quality of healthcare for elderly patients by continuous monitoring metrics of their health. The various IoT wearable sensors are utilized by system to gathers real-time information of important signs(heart rate, temperature, and blood pressure). This data is then sent to healthcare facilitators, allowing for proactive care and intervention, particularly for patients with chronic conditions or limited mobility. The methodology of the system is centered around the use of wearable devices that collect health data from the elderly patients. These devices are connected to a mobile application, which acts as an interface between the patient and the healthcare provider. The mobile application transmits the data to a cloud-based platform, where it is stored and analysed. The cloud computing infrastructure ensures that the data is easily accessible to healthcare professionals, enabling them to remotely monitor the patient's condition and receive real-time notifications if there are any changes in health status. This system is designed to enhance care accessibility by minimizing the need for in-person visits, while still providing continuous health monitoring.

AI algorithms play a critical role in the system by analysing the health data collected from the wearable devices. These algorithms can detect patterns in the patient's vital signs, enabling the system to offer automated diagnoses and suggest timely interventions. For example, if the system detects abnormal readings, it can send alerts to healthcare providers or suggest adjustments to the patient's treatment plan. The use of AI enhances the accuracy and efficiency of the system, ensuring that patients receive the right care at the right time. By incorporating AI, the system is able to move beyond basic monitoring, offering intelligent decision-making capabilities that improve patient outcomes.The integration of IoT, cloud computing, and AI creates a comprehensive elderly care system that continuously monitors patients' health without the need for constant physical check-ups. This system empowers elderly individuals to live independently while still being closely monitored by healthcare professionals. The ability to track vital signs remotely means that elderly patients do not need to visit clinics or hospitals for regular check-ups, reducing the strain on healthcare systems and providing more convenience for patients.Furthermore, the system's real-time data analysis allows healthcare providers to intervene before a health issue becomes critical, enhancing preventive care.

The paper also highlights the potential benefits of the system in reducing healthcare costs. By continuously monitoring patients' health and providing timely medical advice, the system can prevent unnecessary emergency visits and hospitalizations. Early detection of health issues can lead to more cost-effective treatments and prevent the escalation of chronic conditions, ultimately lowering healthcare expenses. This is particularly important for elderly patients, who often require frequent medical attention due to age-related conditions. The system's ability to improve preventive care and reduce emergency visits is one of the key advantages discussed in the paper.

In conclusion, the **"IoT-Based Virtual Doctor for Elderly Care"** paper by Ahmad & Lee presents a promising solution for enhancing elderly healthcare services through the integration of IoT, cloud computing, and AI. The system provides real-time health monitoring, AI-driven diagnostics, and remote healthcare management, all of which contribute to improved patient outcomes and reduced healthcare costs. By allowing elderly patients to receive continuous monitoring and timely advice without needing constant visits to healthcare facilities, the system offers greater independence and quality of life for the elderly. This approach to remote healthcare has the potential to transform elderly care by improving accessibility, reducing costs, and enhancing the overall patient experience.[9]

In the paper **"IoT and Robotics for Virtual Health Consultation"** by Nguyen et al. (2022), the authors explore the integration of Internet of Things (IoT) and robotics in healthcare, with a specific focus on remote health consultations. The paper emphasizes how IoT has revolutionized healthcare by enabling continuous patient monitoring and improving the management of chronic conditions. The literature review highlights key advancements in miniaturized biosensors, which play a crucial role in allowing for continuous health monitoring outside the hospital environment. These technological innovations make remote monitoring feasible, reduce healthcare costs, and enhance the overall delivery of healthcare services by enabling patients to receive care in their homes or local environments.

The methodology discussed in the paper involves the creation of an IoT-enabled virtual doctor robot. This robot integrates several technologies, including IoT sensors, robotic movement control, and wireless communication, to facilitate remote patient monitoring and assistance. The robot is equipped with an Arduino Uno controller, temperature and heartbeat sensors, an ESP32 camera for real-time video streaming, and motors that allow for movement. To ensure connectivity, the system uses Wi-Fi modules like the ESP8266 and ESP32, which enable the robot to connect to the internet. This connectivity allows doctors to remotely control the robot, interact with patients, and monitor vital health data in real-time. The integration of sensors such as SPO2 and temperature sensors further supports remote diagnostics. Mechanistically, the robot functions through both manual and autonomous control systems. Healthcare professionals can issue commands to the robot via a mobile application, which communicates with the robot over a Wi-Fi network. These commands include basic movement instructions like forward, backward, left, and right, which control the robot's movements. The robot is equipped with sensors that detect vital signs, such as temperature and heart rate. These readings are displayed on an LCD screen and transmitted to the doctor, ensuring that healthcare professionals have real-time access to the patient's health status. This system provides a direct link between the patient and healthcare provider, enabling more immediate and effective medical attention. The robot also features a voice module that enables real-time interaction with the patient, enhancing the user experience. The voice feedback provides patients with clear communication, such as instructions or reassurances, making the system more interactive and effective in a medical setting. This voice-enabled interface is particularly useful in healthcare environments where patient engagement is essential, and it provides an additional layer of comfort for patients during consultations. By incorporating both video and voice capabilities, the robot allows healthcare providers to not only monitor the patient's physical condition but also engage in meaningful conversations to assess symptoms, answer questions, and provide advice.The paper demonstrates the potential of this IoT and robotics-based virtual doctor system as a cost-effective and scalable solution for remote health consultations. The integration of IoT sensors and robotic technology ensures that patient monitoring can occur continuously and remotely, reduce the doctor visits in-person. This enables the advantage to the areas where there is less access to medical care services or in situations where mobility is an issue. The real-time health monitoring and support from healthcare professionals with the help of this system enhances the quality of care for patients while also helping to address the challenges posed by healthcare disparities.

In conclusion, Nguyen et al. (2022) present an innovative solution for remote healthcare delivery through the integration of IoT and robotics. By combining IoT sensors, robotic movement, and wireless communication, the virtual doctor robot offers a comprehensive tool for monitoring and assisting patients remotely. This system not only improves access to healthcare services but also enhances the efficiency of primary patient monitoring, particularly in underserved or rural areas. The inclusion of video and voice communication further boosts the interactivity and effectiveness of the system, providing a more personalized healthcare experience for patients. Ultimately, the proposed system represents a promising advancement in the field of telemedicine and remote healthcare[10].

## III Proposed system

System modelling provides a structured way to understand and design the functionalities of an IoT-based virtual doctor robot. This robot is equipped with multiple components that enable real-time health monitoring, remote communication, and autonomous mobility. Following modules are integrated in the system

1. Physical Structure and Mobility Module Base Platform: The robot is built on a wheeled mobile platform, providing stability and enabling movement across indoor environments. Motor

Control System: Motors control each wheel's movement, allowing the robot to navigate autonomously or semi-autonomously. The robot can be programmed with specific navigation paths or equipped with sensors to avoid obstacles. Chassis Framework: The chassis appears to be constructed with a PVC or similar frame, providing support for all components and ensuring the stability of the mounted hardware.

2. IoT Sensor Module Vital Sign Sensors: The robot is equipped with a variety of sensors to measure key health parameters like heart rate, temperature, blood pressure, and possibly blood oxygen levels. These sensors constantly collect data and send it to the control unit. Data Acquisition and Transmission: Sensor data is collected and processed by a central microcontroller or microprocessor, which then transmits this data to cloud storage or a medical database. This enables real-time monitoring by remote healthcare professionals. Environmental Sensors: The robot may also be fitted with temperature or humidity sensors to assess the patient's surrounding environment, which can provide context for health data.

3. Communication and Interface Module Camera and Microphone: The mounted smartphone or camera provides a visual and audio interface, allowing healthcare professionals to conduct virtual consultations with patients. The camera can also assist in monitoring the patient's condition visually, which may help doctors assess symptoms that are difficult to capture via sensors alone. Display and Keypad: A user-friendly interface, likely in the form of a display screen and keypad, allows the patient or caregiver to interact with the robot. The display can show health data, alerts, or reminders for the patient, while the keypad allows them to input commands or request specific actions. Wireless Communication: The robot likely uses Wi-Fi or another wireless communication protocol to connect with external networks, enabling data transfer to cloud servers or remote monitoring systems.

4. Control and Processing Unit Microcontroller or Microprocessor: The system's "brain" is a Esp8266, which controls the robot's overall functioning. It manages sensor data collection, processes inputs from the user interface, and executes commands for the robot's mobility and communication.

5. Power Management Module Battery Packs: The robot is powered by battery packs, as seen in the image, enabling it to operate independently without a direct power connection. Batteries are typically rechargeable and provide sufficient power for the motors, sensors, and communication modules. Power Management Circuit: A power management circuit regulates the distribution of power across various components, ensuring efficient energy usage. It may also monitor battery levels and notify the user or automatically dock for recharging when needed.

6. Cloud and Remote Monitoring Module Data Storage in Cloud: The robot collects and transmits patient data to a cloud-based server or a remote monitoring platform. The cloud serves as a repository for long-term storage of health data, enabling healthcare providers to track patient history and trends over time. Remote Monitoring and Control: Authorized healthcare professionals can access patient data remotely, allowing them to monitor vital signs, diagnose issues, and provide advice. They can also control the robot remotely if required, moving it to another location within the patient's home or initiating virtual consultations. Alert System: The cloud platform or the robot itself may have an alert system that triggers notifications for healthcare providers or caregivers if it detects abnormal readings, such as high blood pressure or low oxygen levels

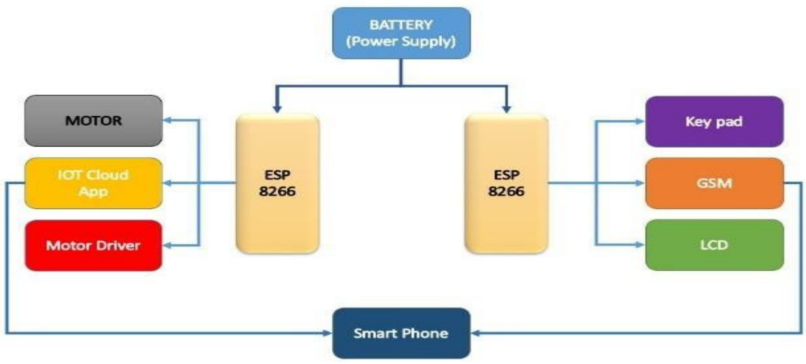

**Figure 1: Block Diagram of Virtual Doctor Robot**

Figure (1) shows the block diagram of the mechanism which integrates various components to achieve a specific functionality. At its core, the system is powered by a battery. Two ESP8266 modules, acting as Wi-Fi communication hubs, connect to an Arduino Nano, a versatile microcontroller responsible for local processing and control. The Arduino Nano, in turn, controls the motor driver, which regulates the motor's operation. Additionally, the ESP8266 modules connect to a keypad for user input, a GSM module for cellular communication, and an LCD for displaying information. The system's intelligence lies in its connection to the IoT Cloud App. The ESP8266 modules facilitate data transmission to and from the cloud, allowing for remote control and monitoring via a smartphone. The cloud app stores and processes data, enabling users to interact with the system from anywhere.

In essence, this system leverages the strengths of different components to provide a robust and flexible solution. The Arduino Nano handles local processing, the ESP8266 modules enable wireless communication, and the cloud app provides remote access and control. This configuration empowers the system to perform a wide range of tasks, from simple automation to complex IoT applications.

**V. Result analysis**

Organized menu proposes that the robot has a programmed database with predefined ailments, allowing users to select the specific issue they are experiencing. This menu-driven interface provides a simple way for users to interact with the robot, choosing from a set list of common health complaints for further guidance on symptom management or basic remedies.

The inclusion of these common ailments implies that the robot is designed to cater to routine health concerns often faced in daily life. By providing a straightforward selection interface, it enables even those with minimal technical experience to navigate and use the robot effectively. The IoT-based Virtual Doctor Robot demonstrates its ability to provide basic medical advice to users through its integrated LCD screen. The robot is designed to assist individuals by diagnosing common health issues and suggesting remedies. Upon detecting a reported symptom, such as a headache, the robot displays relevant information on its screen, offering guidance to the user on how to alleviate their discomfort. As shown in table 1The test and analysis of the system's performance reveal a clear correlation between distance, signal strength, response time, and control accuracy. At close distances of 0-5 meters, the system demonstrates optimal performance with strong signal strength (-40 to -50 dB), minimal response time (10-30 ms), and perfect control accuracy (100%). This indicates excellent operational reliability with minimal latency and precise control capabilities, making the system ideal for applications requiring immediate responsiveness and high accuracy.

As the distance increases from 5 to 20 meters, the system experiences a gradual decline in performance. Signal strength weakens from -50 to -80 dB, leading to an increase in response time from 30-200 ms and a reduction in control accuracy to 90%. While control remains manageable, noticeable delays begin to affect responsiveness, particularly at distances of 15-20 meters. These findings highlight the importance of maintaining moderate distances to ensure effective system operation with acceptable latency levels.

Beyond 20 meters, significant performance degradation is observed. Signal strength drops to - 90 dB or worse, response time exceeds 400 ms, and control accuracy declines to 75% or less. At distances beyond 30 meters, the connection becomes highly unreliable, with frequent disconnections and poor control responsiveness. This analysis underscores the critical need for optimizing system placement and ensuring robust connectivity to maintain performance within operational thresholds.

**Table 1.Test and analysis**

| Test Distance (m) | Signal Strength (dB) | Response Time (ms) | Control Accuracy (%) | Remarks |
|---|---|---|---|---|
| 0-5 | -40 to -50 | 10-30 | 100% | Excellent control with minimal latency. |
| 5-10 | -50 to -60 | 30-50 | 98% | Slight increase in latency, but still effective control. |
| 10-15 | -60 to -70 | 50-100 | 95% | Noticeable lag, but still manageable. |
| 15-20 | -70 to -80 | 100-200 | 90% | Control becomes less responsive, occasional delays. |
| 20-25 | -80 to -90 | 200-400 | 85% | Noticeable performance degradation. |
| 25-30 | -90 to-100 | 400-800 | 75% | Significant latency and reduced control accuracy. |
| 30+ | 100+ | >800 | <70% | Unreliable connection, frequent disconnections and loss of control. |

### V. Conclusions and Future Scope

The virtual doctor robot project represents an innovative approach to bridging the gap between healthcare accessibility and remote patient assistance, particularly in underserved or remote areas. By combining IoT technology with basic healthcare functionalities, this robot provides an interactive and user-friendly system for addressing common ailments such as headaches, body pain, cough and cold, fever, and stomach aches. The robot's functionality includes a menu interface that allows users to select symptoms, after which it delivers specific advice or suggests a remedy, such as a tablet from a designated compartment or a home remedy. This type of guidance not only empowers individuals to manage minor health issues autonomously but also promotes self-care through easy-to-follow instructions. The robot's features highlight its potential as an efficient telemedicine tool. Equipped with a smartphone or camera, keypad, LCD screen, motorized wheels, and an onboard microcontroller, the robot is capable of both navigating spaces and facilitating virtual consultations with healthcare providers. By presenting a clear, accessible menu of ailments and linking each one to specific advice, the robot mimics the experience of receiving initial guidance from a healthcare professional. For patients, especially in rural or resource-constrained environments, this could mean quicker and more accessible healthcare support, allowing them to manage symptoms and make informed decisions before seeking professional medical care if necessary. In conclusion, this virtual doctor robot project is a promising step toward a more connected, technology-enabled healthcare system. Its application could extend beyond home use to include settings like elderly care, community health centres, or quarantine zones where direct healthcare access is limited. The robot's design is both practical and scalable, capable of being expanded with more health conditions, sensor inputs, and advanced diagnostic features in the future. This IoT-based virtual doctor robot is a testament to the potential of technology to provide proactive, accessible, and supportive healthcare, which could play a crucial role in enhancing public health outcomes on a broader scales.

Future versions of the virtual doctor robot could incorporate additional diagnostic sensors, like as respiration rate, blood glucose sensors, pressure sensors, pulse oximeters, and sensors for temperature. With these enhancements, the robot could collect real-time health data from the user, this permits more precise and personalized healthcare advice. By analysing these metrics, the robot could better assess the severity of a user's condition, prioritize emergencies, and potentially alert medical professionals if intervention is required. Integrating AI and ML algorithms could significantly enhance the robot's capabilities. By leveraging large healthcare datasets, the robot could learn to recognize complex patterns in symptoms, offering more accurate diagnoses and customized treatment recommendations. AI could also enable the robot to continuously improve based on user feedback and update its responses as new health information becomes available. Additionally, natural language processing (NLP) could enable voice-based interaction, making the robot more user-friendly, specially for a person who are having lack of literacy or technical abilities.

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