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DESIGN AND DEVELOPMENT OF INTEGRATED ANTENNA FOR HEALTH MONITORING SYSTEM

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Abstract— **In present period, antenna is assuming an unmistakable part for further developing wellbeing and personal satisfaction. Pacemakers, profound brain inserts, endoscopy, microwave imaging and clinical instruments for thermal ablation are few instances of medical services instruments which are taking the advantages of antenna and wireless technology. Antenna can be embedded, put on body and gulped to move determination data from the human body to the outer screen and further to the specialist or concern individual through web. A wearable gadget is an innovation that is worn on the human body. With the scaled down and low power sensor advancements; it tends to be utilized in wearables for getting and communicating data about medical services and their environmental factors. The signs are detected by the wearable gadget which is mounted on the patient to be checked; these signs are the information of wellbeing boundaries like temperature/pulse. The sensors alongside the transmitter segment are cut onto the patient and the parameters are gathered. The antenna is planned utilizing CST Studio Suite 2022. A rectangular patch comprised of copper is utilized as emanating patch and the ground is likewise made with copper.**

Keywords— Antenna, wearable gadget, medical services, sensors, transmitter, CST Studio Suite 2022, rectangular patch

I. INTRODUCTION

A microstrip patch antenna is a type of antenna that can be used for a variety of medical applications. They are small and easy to use, making them ideal for a wide range of medical procedures. Microstrip patch antennas have a number of advantages over other types of antennas. They are very small and can be easily hidden on the body. They are also very light and can be worn for long periods of time without causing discomfort. Microstrip patch antennas are also very easy to use. They can be connected to a variety of medical devices and can be used for a variety of different medical procedures. One of the most common types of printed antennas is the microstrip antenna. In today's world of wireless communication systems, it plays a crucial role. Utilizing a standard method of microstrip fabrication, the construction of microstrip antennae is very straightforward. A microstrip patch antenna has a ground plane and a radiating patch on one side of a dielectric substrate. The patch can be rectangular, circular, triangular, elliptical, or any other common shape and is typically made of a conducting material like copper or gold. On the dielectric substrate, the radiating patch and feed lines are typically attached. There are numerous applications for the microstrip patch antenna in wireless communication. For instance, a square or circular patch microstrip antenna can produce the circularly polarized radiation patterns necessary for satellite communication. Microstrip antennas with a circular polarization are what are used in GPS systems. Due to their location, they are quite pricey for their small size. Microstrip antennae are also utilized in mobile communication, healthcare, and RFID (radio frequency identification). A reader and a tag are the two main components of an RFID system. It typically operates between 30 Hz and 5.8 GHz. Microwave energy is said to induce hyperthermia the most effectively when treating cancerous tumors. The radiator that will be used for this should be light, easy to use, and durable. These requirements can only be met by a patch radiator.

The RF system used in this paper uses the frequency in range of 2.4 GHz. RF transceiver is used is this system because its operating frequency is high and attenuation is low. The strategy for the correspondence is laid out with the assistance of ESP32S, RF transceiver module and transmitting and receiving antenna. Health parameters like temperature and heart rate are sensed using MLX 90614 and pulse sensor MAX30102 respectively. The sensor gets the wellbeing boundaries and the controller investigates the information which is sent through RF module. The sensors alongside the transmitter side are attached onto the human body from whom the wellbeing boundaries are required and through the sensors, the readings are collected. The observed information is handled and communicated with the assistance of the transceiver module through the planned communicating microstrip patch antenna. On the getting segment the information is gathered through the receiving antenna and the transceiver module and handled by the controller. An application is created and data is collected on it. Further this gathered information can be envisioned by the specialist and getting to the patient details, investigate the boundaries, accordingly serving to monitor the strength of the patient.

II. LITERATURE SURVEY

Survey I

This paper reviews some of those studies done in research papers using the techniques and results used by them. Design and Analysis of Wearable Antenna for Wireless Body Area Network To cite this article: S. Karthikeyan 2019 IOP Conf. Ser.: Mater. Sci. Eng. 590 012022. The patch and the ground layer perform a more important task of isolating and decoupling the wearable antenna from the human body[1]. The patch size of the antenna is increased to reduce the return loss and to improve efficiency even the SAR value is reduced when the patch size increases. Polydimethylsiloxane (PDMS) as the. The design is done using CADFEKO 5.5 and the results are also verified with the same software [4]. A compact planar dipole antenna is built by using fully flexible materials such as nitrile butadiene rubber polymer composition is used as substrate.

To send diagnostic data from the body to an external monitor and on to a doctor or concerned person via the internet, antennas can be implanted, placed on the body, or swallowed. Near-field electromagnetic radiation, impedance, and reflection coefficient variations in the electrical parameter of the antenna can also be analyzed for non-invasive disease detection. Antennas are important for cancer detection, motion detection, and the detection of breast and brain tumors[8]. Additionally, the heating effect of electromagnetic fields can be used to treat cancerous cells. In this overview paper, creators take care of all the conceivable use of radio wire and the difficulties looked by recieving wire originators to make them reasonable for a particular application.

Survey II

In this research paper, we have learned about The rapid development of low-power wearable devices has raised the need for WBAN implementation solutions. [3]It is essential to work on developing a flexible antenna that can be incorporated into a wide range of applications in addition to the necessity of reducing the dimensions of the device and increasing its power consumption. This paper is an investigation of wearable radio wire plans for remote body region network applications. The study includes a review of the existing wearable antenna literature. Size optimization is used in the design of a wearable antenna.ANSYS High-Frequency Structural Simulator (HFSS) software is used to design the antenna.2.45 GHz is the operating frequency of the designed antenna.[3]. The ground is also made of copper, and the radiating patch is a rectangular patch made of copper.The bed sheet cotton used as the substrate has a loss tangent of 0.00786 and a relative permittivity of 3.27. The size of the receiving wire is 40mm*34mm*1.26mm. The designed antenna's properties, such as gain, directivity, and VSWR, are investigated. The ANSYS HFSS software is used to investigate the properties[7].

Survey III

In recent years, there has been a tremendous increase in the demand for wearable technologies.

In many cases, wireless body area networks (WBAN) are the context in which wearable antennas are utilized. The wearable antennas face significant difficulties in WBAN due to the body's presence. Specific requirements, such as structural deformation, precision, accuracy, and size precision in fabrication methods, must be given top priority when designing wearable antennas. Since there are a lot of researchers working in this area, significant progress has been made recently. This article aims to critically examine wearable antennas in light of novel designs, including miniaturized button antennas, miniaturized single-band antennas, and miniaturized multi-band antennas, as well as their distinct smart applications in WBAN.In conclusion, some possible future paths have been identified.Wearable technology has numerous uses, as previously stated; However, the widespread applications of WBAN in health care, sports, the battlefield, emergency operations, and the care of elderly and disadvantaged children have garnered significant attention [8–13].In order to support wireless devices like Industrial Scientific Medical (ISM) and Wireless Local Area Networks (WLAN), etc., today's wireless communications technology necessitates wide BW miniaturized planar antennas.[9].

Compact antenna systems are capable of achieving both high performance and miniaturization for these advanced wireless technologies. A miniaturized antenna is also a good choice for the WBAN system because it takes up less space on or off the human body and reduces the amount of continuous radiation exposure. But it's hard to keep a wearable antenna's high performance while making it small[5].

Block Diagram

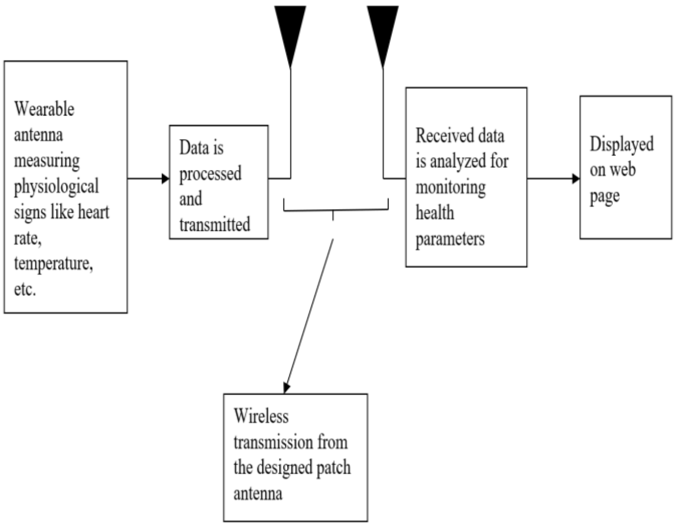

Fig. 1-a

The health parameters are gathered continuously by the wearable antenna. The sensors are in contact with the human body. In the proposed system, the parameters such as body temperature, pulse rate, etc. is collected which can be monitored. The data is collected and transmitted through the antenna with the essential delay. The transmitting and the receiving frequency of the antenna is 2.4GHz. On the receiving side, the receiving antenna receives the data sent by the transmitting antenna which goes to the controller for analysis and is converted to a CSV file. This is then represented on an application.

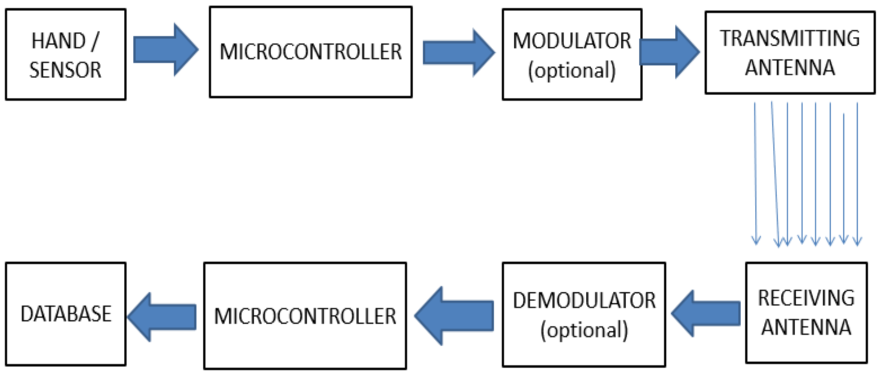

Fig. 1-b

III. SOFTWARE DESCRIPTION

CST Studio Suite

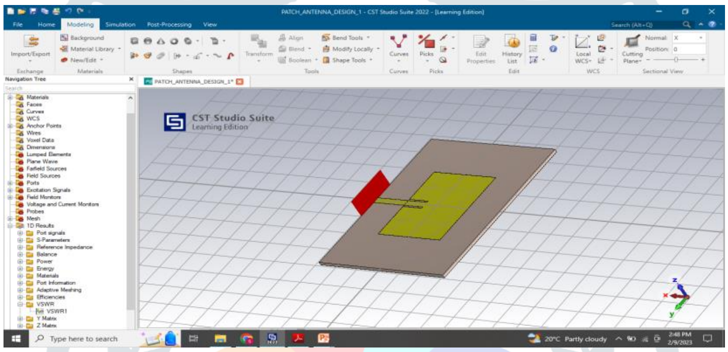

Fig. 2

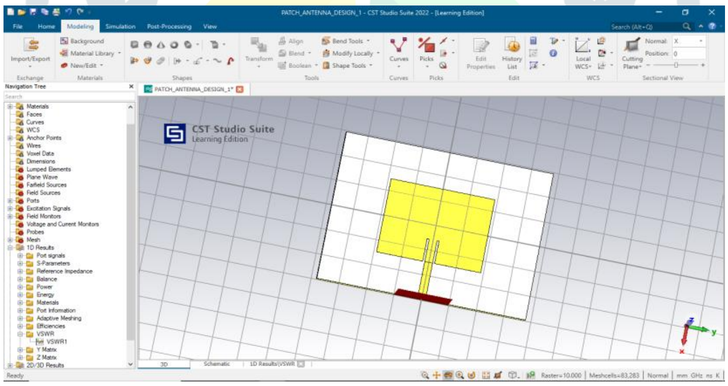

Fig. 3

CST Studio Suite is an Electromagnetic analysis software package developed by **SIMULIA**, used to design, analyze, and optimize Electromagnetic Systems. CST Studio Suite contains many different solvers, all in a single user interface, that allow us to simulate the performance of a wide variety of Electromagnetic systems for both low-frequency and high-frequency applications.

CST Studio Suite offers simple-to-use tools to guide us through our antenna design and optimization process. One of the tools we often begin with is **Antenna Magus**. Antenna Magus is an application that allows us to choose certain design specifications, broken down by industry, which contain information such as frequency bands and radiation patterns.

IV. HARDWARE DESCRIPTION

ESP 32S

Fig. 4

ESP32 is a series of low-cost, low-power system on a chip microcontrollers with integrated Wi-Fi and dual-mode Bluetooth. The ESP32 series employs either a Tensilica Xtensa LX6 microprocessor in both dual-core and single-core variations, Xtensa LX7 dual-core microprocessor or a single-core RISC-V microprocessor and includes built-in antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power-management modules.

MAX30102

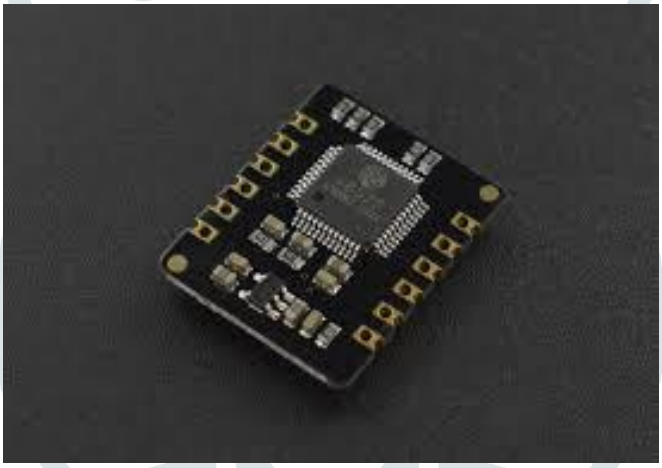

Fig. 5

The MAX30102 is an integrated pulse oximetry and heart-rate monitor module. It includes internal LEDs, photodetectors, optical elements, and low-noise electronics with ambient light rejection. The MAX30102 provides a complete system solution to ease the design-in process for mobile and wearable devices. The MAX30102 operates on a single 1.8V power supply and a separate 3.3V power supply for the internal LEDs. Communication is through a standard I2C-compatible interface. The module can be shut down through software with zero standby current, allowing the power rails to remain powered at all times

Applications

- Wearable Devices
- Fitness Assistant Devices
- Smartphones
- Tablets

Benefits and Features

- Heart-Rate Monitor and Pulse Oximeter Sensor in LED Reflective Solution
- Tiny 5.6mm x 3.3mm x 1.55mm 14-Pin Optical Module
- Integrated Cover Glass for Optimal, Robust Performance

- Ultra-Low Power Operation for Mobile Devices
- Programmable Sample Rate and LED Current for Power Savings • Low-Power Heart-Rate Monitor (< 1mW)
- Ultra-Low Shutdown Current (0.7µA, typ)
- Fast Data Output Capability
- High Sample Rates
- Robust Motion Artifact Resilience
- High SNR
- -40°C to +85°C Operating Temperature Range

MLX 90614

Fig. 6

The MLX90614 is an infrared thermometer for non-contact temperature measurements. Both the IR sensitive thermopile detector chip and the signal conditioning ASIC are integrated in the same TO-39 can. Integrated into the MLX90614 are a low noise amplifier, 17-bit ADC and powerful DSP unit thus achieving high accuracy and resolution of the thermometer.

The thermometer comes factory calibrated with a digital SMBus output giving full access to the measured temperature in the complete temperature range(s) with a resolution of 0.02°C.

The user can configure the digital output to be pulse width modulation (PWM). As a standard, the 10-bit PWM is configured to continuously transmit the measured temperature in range of -20 to 120°C, with an output resolution of 0.14°C.

Features and benefits

- Small size and low cost
- Easy to integrate
- Factory calibrated in wide temperature range: -40 to 125°C for sensor temperature and -70 to 380°C for object temperature
- High accuracy of 0.5°C over wide temperature range (0..+50 C for both Ta and To)
- Medical accuracy of 0.1°C in a limited temperature range available on request
- Measurement resolution of 0.02°C
- Single and dual zone versions
- SMBus compatible digital interface for fast temperature readings and building sensor networks
- Customizable PWM output for continuous reading
- Available in 3V and 5V versions
- Simple adaptation for 8 to 16V applications
- Power saving mode
- Different package options for applications and measurements versatility
- Automotive grade

LoRa Module

Fig. 7

The LoRa Module allows you to communicate to the LoRaWAN wireless network. This technology makes it possible to communicate from a battery-powered device directly to a server, even for several years.

Features

- LoRaWAN module CMWX1ZZABZ-078 (Murata)
- Communication using UART and AT commands
- SMA antenna ANT-SS900
- Standby power consumption 2 µA
- Operating voltage range: 1.8 to 3.6 V
- Operating temperature range: -20 to 70 °C
- Dimensions: 33 x 55 mm

V. RESULT

The simulation of Antenna is done on CST Studio Suite 2022. The resonating frequency of antenna is 2.4 GHz. The S parameter simulation is shown in the Fig. 8 the voltage standing wave ratio also called as VSWR is shown in the Fig. 9 and the radiation pattern of the antenna is shown in the Fig. 10

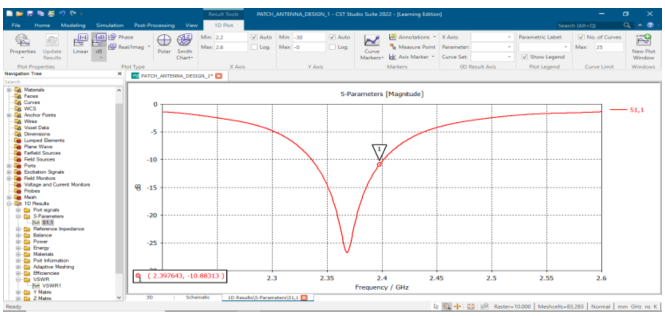

Fig. 8

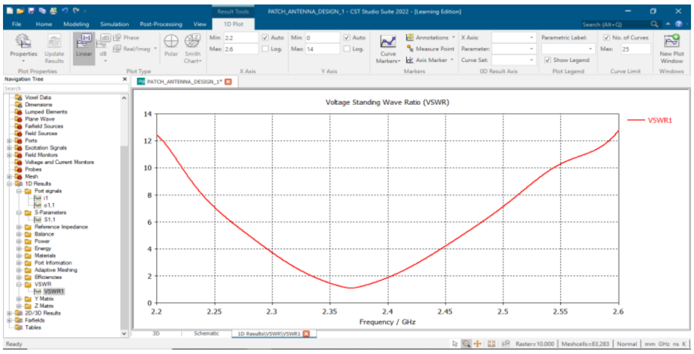

Fig. 9

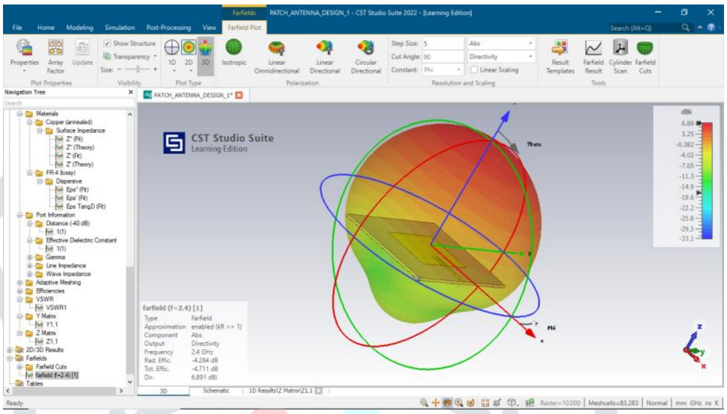

Fig. 10

Design and simulation of Microstrip patch antenna was done successfully. But as it was difficult to extract the file for manufacturing purpose, prototype of the antenna was not made. Hence, instead of using Microstrip patch antenna, a helical antenna was used of both transmitting and receiving side. The Data collected from the sensors is stored in the Microcontroller and transferred through the antenna to the receiver. Once the "Get Data" button is clicked, the received data is transferred to the Cloud and is displayed on the User Interface of the Designed Application Programming Interface (API).

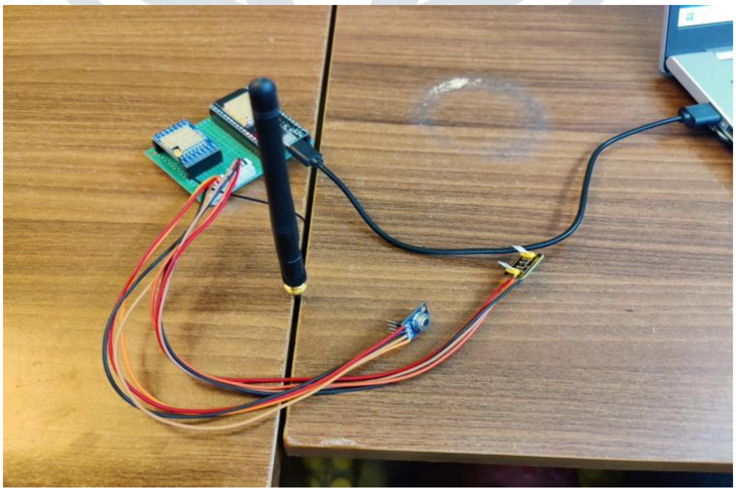

Fig. 11

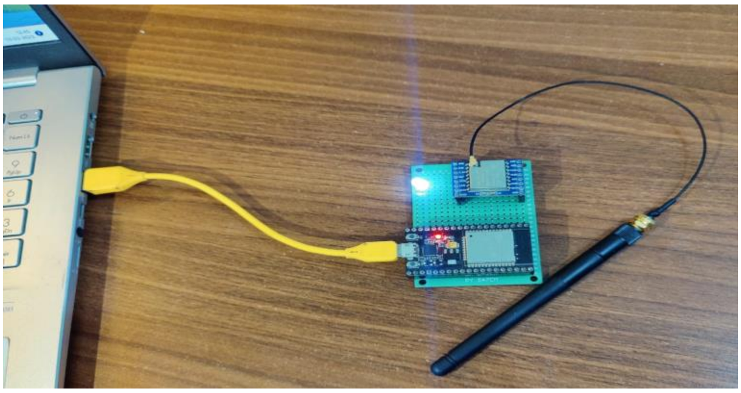

Fig. 12

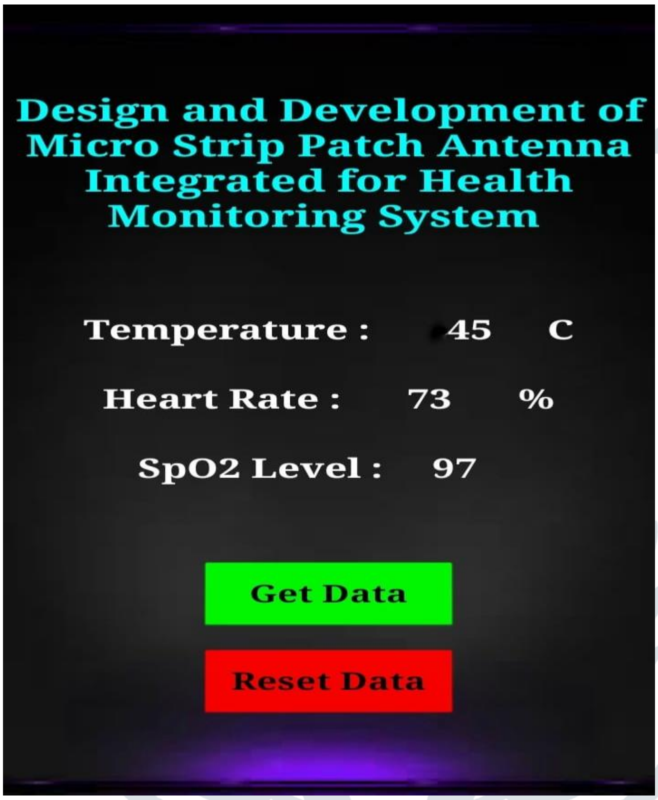

Fig. 13

VI. CONCLUSION

After discussing the design and development of antenna integrated for health monitoring system, it is clear that this technology has tremendous potential to revolutionize healthcare. By enabling real-time monitoring of patient vitals, doctors can make faster and more informed decisions about treatment plans. The integration of antennas into wearable devices also makes health monitoring more convenient and accessible to patients. This allow individuals to take a proactive approach towards their own health by detecting potential issues early on. Furthermore, the use of advanced data analytics software can help identify patterns in the data collected from these devices. These insights can then be used to develop personalized treatment plans for each patient based on their unique needs. The future looks bright for antenna integrated health monitoring systems. The benefits they offer in terms of improved health outcomes and increased accessibility cannot be ignored. As technology continues to evolve at an unprecedented pace, we are excited to see what new innovations will emerge in this field next.

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