Voice Assistant Smart Dental Chair

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***Abstract*—This paper presents a voice assistant-smart dental chair that revolutionizes dental care by combining advanced technology with patient comfort. The chair's voice control functionality enables dentists to streamline procedures, improve efficiency, and enhance patient experience. With potential benefits including increased productivity, improved patient satisfaction, and enhanced accessibility, this innovation has the potential to transform the dental industry. This smart chair streamlines dental procedures, enhances the person's comfort, and provides data-driven insights for improved treatment outcomes. With advanced technologies, this innovation redefines the future of dentistry.**

***Index Terms*—Voice assistant, technology, Bluetooth module, Johnson Motor, innovation**

I. INTRODUCTION

A futuristic dental chair integrated with voice assistant technology, allowing dentists to control chair movements, access patient records, and manage treatments with voice commands. This innovative solution enhances patient comfort, modernizes dental procedures, and improves overall efficiency.

The integration of voice assistant technology into dental chairs represents a significant innovation in modern dentistry. This dental chair combines advanced technology with patient ease, enabling dentists to adjust various functions with voice commands. By streamlining dental procedures and improving efficiency, this technology has the potential to revolutionize dental care.

1.1KEY FINDINGS

Advanced features are voice-activated commands that control the chair functions, accessing patient records, and adjusting settings with voice commands. Augmented reality Integration, which enhances patient experience and education with interactive visuals. Biometric monitoring, which tracks the patient's vital signs and stress levels for improved care. Benefits for Dental masters with ergonomic design, which reduces the physical strain and improves working posture. Organizes workflow to automate physical tasks and improve efficiency through integrated systems. Data-driven insights that observe the patient’s data to inform treatment decisions.

Patients’ expertise in personalized comfort, which adjusts chair settings and atmosphere to individual preferences.
An interactive distraction that gives entertainment and education during procedures. Apprehension reduction, which utilizes gentle vibrations and massage techniques to ease patient anxiety.

Machinery integration of IoT connectivity enables the monitoring, predictive upkeep, and software updates. Artificial intelligence, which checks the patient’s data to estimate dental issues and optimize treatment plans. Data security ensures the protection of patients’ information with powerful security measures. It increases efficiency and productivity. It improves the patient’s satisfaction and comfort. It also enhances accessibility for doctors with mobility issues. With potential for improved treatment outcomes.

1.2COMPONENTS

1. Arduino Uno–It is an open-source microcontroller board ideal for beginners in electronics and programming. It is based on the ATmega328P chip and is often sold as a part of a starter kit. The board features digital and analog input/output pins that allow it to be connected to various components, such as sensors, motors, and LEDs.

Figure 1.1: Arduino Uno board

2. Johnson Motors are widely utilized in robotics and enthusiast projects because of their ease of control and dependable performance. They are also employed in medical devices, including dental chairs and hospital beds, as a result of their precise and smooth operation. In automobiles, Johnson Motors are commonly found in windshield wipers, power windows, and various small electric actuators. They are also used in household appliances such as mixers, vacuum cleaners, and fans. Typically, Johnson motors are brushed DC types, allowing simple control through voltage adjustment or pulse-width modulation (PWM). Their compact size, affordability, and faultlessness make them a desirable choice across many applications.

Figure 1.2: Johnson motor

3. Bluetooth Module- Bluetooth modules are small hardware components that turn on devices to communicate wirelessly over short distances. They are integrated circuits (ICs) that add Bluetooth functionality to a project or product. There are two main types of Bluetooth modules: Classic Bluetooth and Bluetooth Low Energy (BLE), as well as dual-mode selections that support both. They are improved for very low power utilization and are often used in battery-operated Internet of Things (IoT) devices, such as wearables and sensors.

Figure 1.3: Bluetooth module

4. Relay module- A 4-channel relay module is an electronic board that allows a low-power microcontroller, like an Arduino or Raspberry Pi, to control up to four independent, high-power electrical circuits. It primarily acts as a remote-controlled on/off switch for larger appliances and machinery that a microcontroller cannot immediately power. The module utilizes a low-voltage input signal to initiate an internal electromagnetic coil, which then physically moves a mechanical switch to complete or break a high-power circuit. Most 4-channel relay modules use a 5V or 12V DC signal for control.

Figure 1.4: Relay module

5. Power supply 12 5amp- A 12V 5A power supply provides a stable 12-volt direct current output and can supply up to 5 amperes (A) of current, resulting in a

maximum power of 60 watts. These are typically switching mode power supplies (SMPS) that convert AC to DC and are used for various devices like LED lighting, CCTV cameras, and small electronics. Many models feature built-in defence against over-voltage, over-current, and power surge for smooth running.

Figure-1.5: Powersupply 12 5amp

II. METHODOLOGY

The Voice Assistant Smart Dental Chair was developed through a step-by-step process that combines hardware design, software programming, and smart voice control. It has a requirement assessment in which we first studied how traditional dental chairs work and identified areas for improvement. Debates were held with dentists, patients, and engineers to understand what features a smart dental chair should have. The main goals were hands-free operation, better comfort, and enhanced health practices. In which we have hardware integration, where the dental chair was fitted with motors and actuators to control its movements, such as reclining, raising, or tilting. Sensors like ultrasonic and pressure sensors were added to monitor position and safety. A 12V relay and power supply were used to control the motors. The voice assistant system design in which we deal with an Atmega328 microcontroller was connected to an HC-05 Bluetooth module to receive voice commands from a smartphone or voice assistant app. Commands like “Chair up,” “Chair down,” or “Light on” were processed and converted into signals that move the chair using relays and switches.

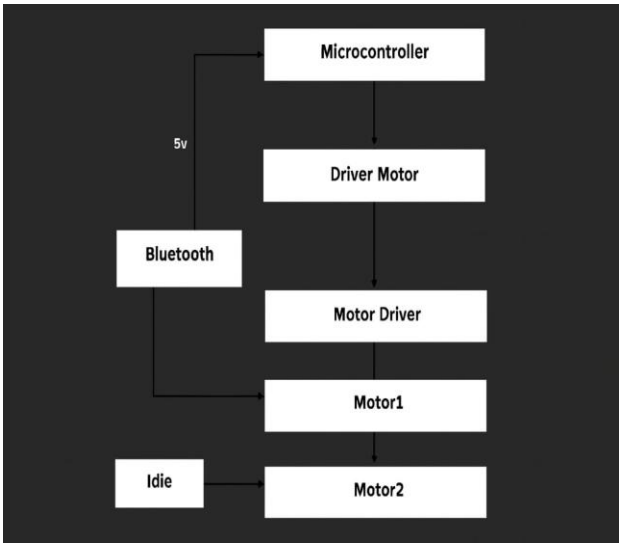

Figure 2.1: Block Diagram

The development of the Voice Assistant Smart Dental Chair follows a systematic engineering approach integrating embedded control, automation, and human–machine interaction. The process is divided into distinct stages:

1. System Design-
A comprehensive block diagram was first created to define data flow and component interaction. The chair’s main subsystems include:
Input Unit: Voice commands received via a Bluetooth-connected microphone.
Control Unit: An ATmega328 microcontroller processes the received instructions.
Output Unit: Actuators and relays execute chair adjustments and other functions.
Safety and Feedback: Limit switches and sensors prevent over-movement and ensure user safety.

2. Hardware Setup-
Microcontroller: ATmega328 serves as the core processing unit.
Bluetooth Interface: An HC-05 module enables wireless communication between the user’s mobile app/voice assistant and the controller.
Relays (12V, 1CO): Control high-power actuators responsible for reclining and positioning the chair.
Limit Switches: Detect end positions to prevent motor strain.
Power Supply: A regulated 12V, 5A source powers the full system.

3. Software and Voice Integration-
Voice commands are processed using a mobile-based voice recognition app linked via Bluetooth. Recognized commands—such as "Raise chair," "Tilt backrest," or "Turn on light"—are transmitted as serial data to the ATmega328. The microcontroller interprets each command and triggers corresponding GPIO pins that activate relays or motors.

4. Safety and Manual Control-
Safety logic halts all motion if a limit switch is triggered. A manual override switch panel is also provided, ensuring the chair remains operable in case of communication failure. Since dental environments require high hygiene, the voice control system helps reduce physical contact with the chair, lowering the risk of infection. Manual controls were also kept for emergencies.

5. Software Development-
The software was written in C/C++ for the microcontroller and Python for voice command handling. The program listens for voice input, processes the command, and performs the correct chair movement. Safety checks were included to prevent accidental or harmful motions.

6. Testing and Validation-
The system was tested in a lab setting to ensure proper operation. The tests focused on:
Functionality: Each voice command worked correctly.
Response Time: Commands were executed quickly.

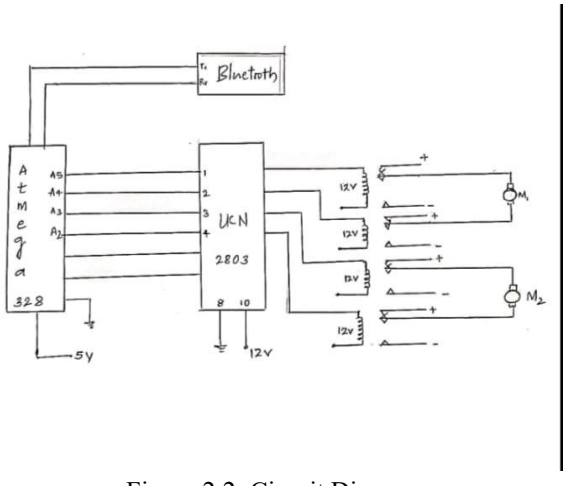

Figure 2.2: Circuit Diagram

III. RESULT

We use this app to give commands related to our needs to move the chair. It takes the command and converts it into mechanical work. Where we have speech input in which the user gives commands through a smartphone voice-assistant application, which converts the spoken words into digital text. Wireless Transfer here, in which the HC-04 Bluetooth module receives the text command from the smartphone and passes it serially to the Arduino UNO.
Actuation and Feedback, in which we have the relays switch the 12 V supply to the chair motors to move in the appropriate direction. Limit switches positioned at the extreme ends send signals back to stop the motor once the limit is reached. The entire circuit is powered by a 12 V, 5 A DC source. The software loop runs continuously, checking both incoming Bluetooth data and limit-switch status. This method ensures fast response, accurate motion, and safe operation.

Figure 3.1: Arduino Bluetooth control

Figure 3.2: voice assistant dental chair modal.

IV. CONCLUSION

The Voice Assistant Smart Dental Chair merges voice-recognition technology with embedded control to create a convenient and hygienic alternative to manually operated dental equipment. The system offers quick response, simple operation, and high reliability while maintaining affordability.

Further improvements could include integration of IoT networking, AI-based speech interpretation, multi-language command support, and sensor-assisted position feedback. The successful prototype demonstrates how embedded voice automation can enhance both practitioner efficiency and patient comfort in healthcare settings.

V. FUTURE SCOPE

Connecting the system to the internet (IoT) can help track how many times the chair was used and alert us if any part needs maintenance.

We're also thinking of adding safety sensors that stop the chair if there's any object or hand near it while it's moving.

A battery backup system can be included so that the chair works even if there is a power cut, which often happens in clinics.

Finally, we want to make a small Android app that can control the chair through Bluetooth or Wi-Fi, giving both voice and touch control options to the dentist.

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