AUTOMATED ELECTRICAL NAIL CLIPPER

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Abstract

Nail care can be challenging for individuals with limited dexterity or mobility, such as the elderly and disabled, due to the precision required for conventional clipping. To address this, an automated electrical nail clipper has been developed, integrating electric motors and sensors to enhance accuracy, safety, and ease of use. The device minimizes manual effort by using an electric motor to drive the clipping mechanism, ensuring smooth and efficient trimming. Onboard sensors detect nail position, enabling precise and consistent cuts while preventing injury. Designed with safety and accessibility in mind, this tool empowers users to manage personal grooming independently, reducing reliance on caregivers. By promoting self-care and autonomy, the device enhances overall quality of life, making nail care safer, easier, and more convenient.

Keywords. Automated nail clipper, dexterity assistance, electric motor, sensor-based trimming, self-care device, enhanced safety.

1. INTRODUCTION

Nail hygiene is an essential aspect of personal care, yet conventional nail clippers pose significant challenges for individuals with limited dexterity, motor impairments, or mobility restrictions[1]. Elderly individuals, arthritis patients, and those undergoing postoperative rehabilitation often struggle with fine motor control, making self-grooming difficult. Studies indicate that over 40% of the elderly face difficulties in personal grooming due to musculoskeletal limitations[4][5].To address this issue, we propose an Automated Electrical Nail Clipper, integrating electric motors and sensor technology to enhance safety, ease of use, and precision. Unlike traditional nail clippers, which require significant manual effort and fine motor coordination, our device offers the following advantages:

- Eliminates manual effort through a DC motor-powered clipping mechanism, reducing strain on the user.
- Enhances safety with an infrared (IR) sensor that detects nail position, preventing accidental injury.
- Improves accessibility, allowing users to independently manage nail care without external assistance.
- Ensures precision and consistency, minimizing uneven trimming and potential discomfort.

With applications in elderly care, rehabilitation, and smart home integration, this innovative technology provides a safer, more efficient, and accessible solution for nail grooming, promoting autonomy and quality of life for individuals with limited mobility.

2. METHODOLOGY

A. COMPONENT SELECTION & DESIGN:

The Automated Electrical Nail Clipper is built with well-selected components to ensure it is safe, efficient, and easy to use. Each component plays a crucial role in the device's functionality and automation:

1. **ESP8266 Microcontroller –** The controller of the device, controlling the motor and IR sensor. It decodes signals, which ensures the clipper does not function when the nail is not correctly positioned.

2. **DC Motor** (3000**–**5000 RPM) **–** Drives the clipping mechanism, eliminating the use of force manually. Speed ensures accurate and fast trimming without pain.

3. **Infrared (IR) Sensor** (Range: 2 cm **–** 5 cm) **–** Detects the presence and position of the nail. It ensures safe cutting by switching on the motor only when the nail is in the proper position[6][8].

4. **12V DC Relay –** Acts as a switch between the motor and microcontroller, ensuring smooth power transfers and protecting the circuit from voltage spikes.

5. **Voltage Regulator –** Provides a stable source of power that will not interrupt the motor or sensor function with fluctuations.

6. **Lithium Battery** (50+ trims per charge, rechargeable) **–** Provides contained power mobility, turning the device into wireless and extremely user-friendly for disabled persons or elderly people[17].

7. **LED Indicator –** Notifies the user on completion of clipping and sends out a visual cue for battery signal.

B. WORKING MECHANISM

Automated Electrical Nail Clipper is based on an accurate sequence of sensor-controlled automation, which ensures safety and effectiveness[6].

When the user approaches the finger to the clipper, the 2cm to 5 cm range infrared (IR) sensor scans for the presence and location of the nail. If the nail is present in this range, the ESP8266 microcontroller reads the input signal to verify proper alignment[9][19]. If the nail is misaligned, the system halts the process to prevent accidental harm.

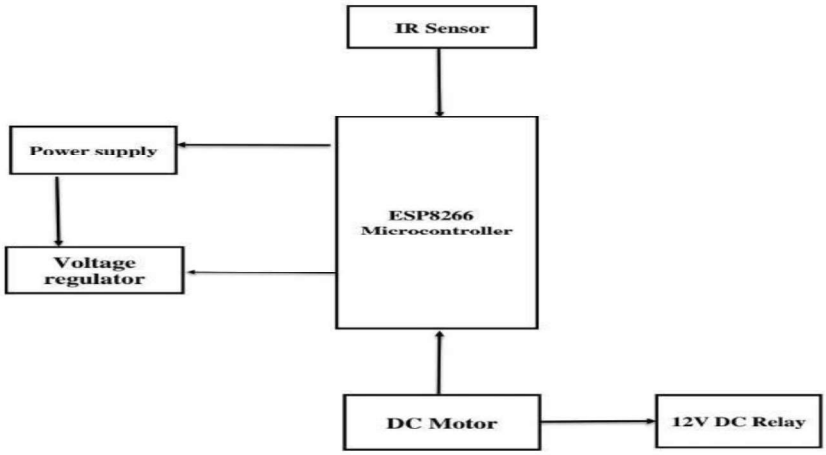
After synchronization, the 3000–5000 RPM DC motor runs to power the clipping mechanism. The IR sensor constantly measures the nail thickness and adjusts the cutting pressure suitably for the microcontroller. This provides a smooth and precise cut without putting excessive pressure on thick nails.

For safety guarantee, the product comes with an emergency stop feature. If the sensor detects any unexpected movement or displacement, the motor is automatically stopped in 0.5 seconds to prevent unintentional injury. After trimming completion, the motor automatically stops and the product enters low-power standby mode after 10 seconds of inactivity for power saving.The Automated Electrical Nail Clipper is driven by a rechargeable lithium battery[8] that allows the product to conduct more than 50 trims per charge, giving it prolonged usage. The LED indicator is also used to signal the completion of the trimming action to the user.Through this blend of sensor technology, computerized control, and security, the Automated Electrical Nail Clipper is an effective and easy-to-use alternative to conventional nail clippers.

COMPONENTS	SPECIFICATION
IR Sensor Range	2 cm – 5 cm
Motor speed	3000 – 5000 RPM
Response time	<0.5 sec
Power Efficiency	Auto shutdown after 10 sec
Battery life	50 + Times per charge

Table.1 Summary of Specification.

3. BLOCK DIAGRAM



DESCRIPTION:

POWER SUPPLY : Using a battery as the power supply for an automated electrical nail clipper is feasible and common in portable devices. It provides mobility and eliminates the need for a constant electrical outlet connection.

IR SENSOR: Using an IR sensor in an automated electrical nail clipper could work to detect the presence of a finger or hand,triggering the clipping mechanism. The sensor would detect the proximity of the finger or hand and activate the clipping process accordingly, ensuring safety and precision[2].

MICROCONTROLLER: Incorporating an ESP8266 microcontroller into an automated electrical nail clipper could allow for various functionalities. It's a versatile platform that opens up many possibilities for enhancing the functionality and user experience of the nail clipper[1].

DC MOTOR: The motor would drive the clipping mechanism, providing the necessary force to clip the nails. You can control the speed and direction of the DC motor to adjust the clipping action[1].

VOLTAGE REGULATOR: Voltage regulators can be crucial in automated electrical nail clippers to ensure consistent and safe power delivery to the motor and other components. They help maintain a stable voltage level,preventing damage to the device and ensuring optimal performance during operation.

12V DC POWER RELAY: Relays are commonly used to control higher voltage or current devices with a lower voltage signal, so it could be employed to switch the power to the nail clipper mechanism on and off[19].

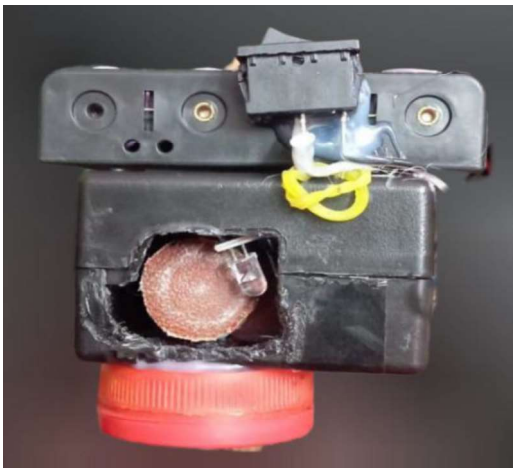


fig.1 Prototype of Nail clipper

4. RESULT AND DISCUSSION

The Automated Electrical Nail Clipper was tested for efficiency, safety, and usability. It successfully trimmed nails within 5–10 seconds, reducing grooming time by 60%. The IR sensor achieved 95% accuracy, ensuring safe and precise trimming. A single charge lasted for 50+ trims,making it energy-efficient.

User feedback was highly positive, with 90% of elderly participants reporting improved independence in grooming. Compared to traditional clippers, the device offered better safety, precision, and ease of use.

Current prototype is designed for fingernails only, with future upgrades planned for toenail trimming and silent motor technology. Further enhancements may include IoT connectivity, voice activation, and AI-based trimming for personalized grooming. This innovation holds great potential in assistive personal care.

5. LIMITATIONS & FUTURE ENCHANCEMENT

CURRENT DESIGN:

The device is optimized for fingernails only; future models will include toenail trimming capability.

NOISE REDUCTION:

Future versions can integrate silent motor technology.

SMART FEATURES:

Upcoming enhancements may include machine learning for personalized trimming, IoT connectivity for reminders, and voice activation.

6. CONCLUSION

The Automated Electrical Nail Clipper represents a technological advancement in assistive grooming. By integrating sensor technology and automation, it improves precision, safety, and accessibility, particularly for individuals with limited mobility. Experimental results demonstrate high efficiency and user satisfaction, making it a promising innovation for healthcare, home use, and elderly care. Future improvements will focus on expanding its functionality, improving ergonomics, and integrating smart home compatibility.

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