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Development of a Low-Cost, CD Drive-Based Assistive Drawing Device for Individuals with Motor Disorders

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Abstract
Our study introduces a inexpensive assistive drawing tool for motor skill rehabilitation that uses recycled CD drives. The technology offers a therapy platform for people with motor impairments by combining robots and artificial intelligence (AI) to promote creative engagement and muscle memory development. The gadget takes user input via a text or speech interface, which AI models then process to produce matching designs. The plotting mechanism, which is powered by CD drive actuators, then transforms these designs into G-code and runs them. The system's economical and environmentally friendly design attempts to close the gap between rehabilitation and technology. The effectiveness of the suggested system is shown by the experimental findings, which also illustrate how it could promote inclusivity in healthcare and rehabilitation. The development of cognitive and motor skills in people with motor disorders can be greatly impacted by the device's capacity to enable them to complete fine motor activities.
Keywords: *Assistive Technology, Motor Skill Rehabilitation, Artificial Intelligence, Robotics, Sustainable Design.*

1. Introduction
The system's economical and environmentally friendly design attempts to close the gap between rehabilitation and technology. The effectiveness of the suggested system is shown by the experimental findings, which also illustrate how it could promote inclusivity in healthcare and rehabilitation. The development of cognitive and motor skills in people with motor disorders can be greatly impacted by the device's capacity to enable them to complete fine motor activities. The technical implementation offers a smooth and effective workflow for inclusive creative by integrating Arduino-based control systems, CNC plotting mechanisms, and AI models. While the robotic gear precisely implements the plans, the AI component guarantees a variety of artistic options. By bridging the gap between rehabilitation and technology, this multidisciplinary approach promotes inclusivity and accessibility in creative fields. This study demonstrates how artificial intelligence (AI) and robotics have the potential to expand the possibilities of human expression and make art accessible to everyone by tackling the particular difficulties faced by people with motor impairments [1-4].

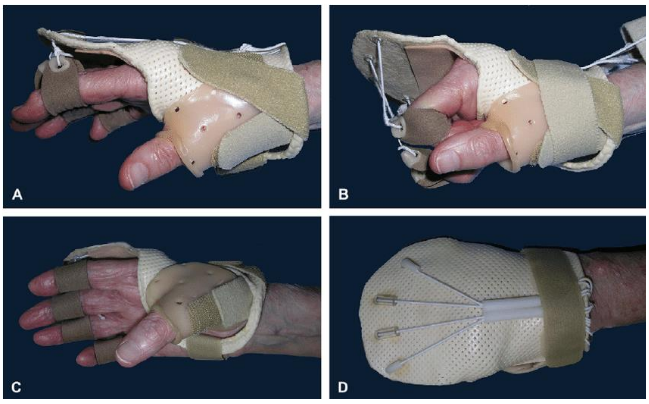

Figure 1 Splint Kit

Innovative solutions that empower people with motor impairments have emerged from the nexus of art, assistive technology, and artificial intelligence (AI). The incorporation of AI-driven tools has created new opportunities for creative engagement and rehabilitation, as art has historically been a potent

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conduit for human expression. The potential of AI to enhance human creativity and offer easily accessible remedies for those with motor impairments serves as the inspiration for this research. For those with motor impairments, especially children, executing fine motor skills like writing, sketching, or using tools can be extremely difficult. Patients utilize splint kits mostly to improve their muscle memory. These restrictions may have an effect on social and cognitive development, underscoring the need for cutting-edge assistive technology. This project's main goals are to:

- Design and implement an affordable, AI-powered assistive drawing tool that lets people with motor impairments make art.
- To offer a venue for the growth of motor skills, self-assurance, and creative expression.
- To promote general development and self-esteem by bridging the gap between artistic ability and physical constraints, shown in Figure 1.

2. Literature Survey

The design and development of a Computer Numerical Control (CNC) machine that may automate writing and drawing jobs was suggested by Ruturaj C. Gaikwad et al. [2023]. The paper describes the entire process of developing the machine, from defining specifications to testing and quality control, using Inkscape, an open-source vector graphics program. Using an Arduino Uno and motor driver integrated circuits, Shani Ranjan et al. [2018] suggest designing and building a low-cost 2D plotter Computer Numerical Control (CNC) device. The machine's ability to automatically layout 2D text or images adds to the body of literature by offering a more affordable and user-friendly design for CNC machines. The automatic 2D plotting feature highlights its potential for a range of applications, while the Arduino-based implementation lowers complexity and expense. All things considered, this work advances the creation of inexpensive CNC machines, encouraging accessibility and creativity in the industry. To improve user interaction, Aslan I et al. [2016] suggest combining pen input on tablets with mid-air gestures. To investigate the possibilities of this combined input approach, the scientists carried out a number of investigations, including lab-based trials and a Field Research using a sketching application prototype. The findings imply that providing pen and mid-air input can enhance tablets' conventional pen and multi-touch input, giving users greater flexibility [5-7]. Pradip Patil et al. [2020] propose a cost-effective Computer Numerical Control (CNC) plotter machine designed for educational institutions and laboratories. This machine enables users to draw circuit layouts on Printed Circuit Boards (PCBs) and create sketches on paper or other solid surfaces. A microcontroller, an Arduino UNO, and open-source software like Processing and Inkscape are used in the suggested system to operate the device. The CNC plotter's motor driver subsequently receives these instructions and uses them to carry out the plotted designs. The suggested solution has a number of benefits, such as precision, affordability, and convenience of use. The system is affordable due to the use of open-source software and an Arduino UNO, and it is user-friendly due to its user-friendly interface and automated plotting process. The technology is a perfect fit for labs and educational institutions because of its capacity to precisely layout intricate designs. The design and implementation of a Field-Programmable Gate Array (FPGA) based Computer Numerically Controlled (CNC) lathe controller that is compatible with G-code is suggested by Mufaddal A. Saifee and Dr. Usha S [2018] Mehta. By deciphering and carrying out G-code instructions, this controller makes precise and reliable machining operations possible. The FPGA, microcontroller, and motor control modules that make up the suggested system cooperate to process G-code commands, govern communication, and power the machine's motors. For a variety of machining applications, the combination of FPGA technology and G-code instructions offers a scalable and adaptable platform that offers enhanced flexibility, efficiency, and precision. A thorough strategy is put forth by Xinwen Chi et al. [2021] to tackle China's informal e-waste recycling issues. To enhance China's total e-waste management, they recommend the establishment of new formal e-waste recycling systems that take into consideration the country's informal sectors. Instead of outlawing or

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competing with the informal sector, this strategy incorporates them into the official recycling process. The authors also stress the necessity of creating incentives to encourage informal recyclers to follow correct recycling procedures and send more e-waste to the official recycling industry. the creation of additional regulations to improve working conditions, recycling rates, and the effectiveness of unorganized players. China can improve the safety of remanufactured electronic items, lower the negative effects of informal e-waste recycling on the environment and human health, and boost the overall effectiveness of e-waste management by implementing this strategy. A "Hybrid-Cluster Graph" approach to voice-based summarization is proposed by Mrunal Subodh Bewoor et al. [2022], providing a practical solution for multitaskers, the disabled, and those with visual impairments. By employing a hybrid strategy that blends clustering and graph-based approaches, the system accurately condenses lengthy texts into brief summaries. Text-to-speech technology is then used to turn these summaries into audio, making information intake easy and accessible. The main objective of the innovative bio-inspired hopping robot proposed by Maliha Kabir et al. [2024] is to achieve nimble and adaptable movement appropriate for a range of surveillance applications by imitating the effective locomotion of jumping animals. Inspired by the amazing jumping capabilities of nature, the robot's design integrates concepts of dynamic control and efficient energy transmission. In order to enable self-righting, steering, and takeoff, the robot has three legs and has a novel thrust mechanism that is powered by just two servo motors. The hopping robot's leg mechanism, actuation technique, and control system are covered in detail in the study, which emphasizes the robot's stability, resilience, and capacity to modify its center of mass to perform hops in different directions [8-12].

3. Methodology

3.1 Voice-to-Text Generator (Webpage)

The voice-to-text generator is a website that converts user voice to text using speech recognition technologies, Figure 2. This enables users to use voice instructions to enter the design they want. The website recognizes and transcribes the user's voice using a combination of machine learning algorithms and natural language processing (NLP).

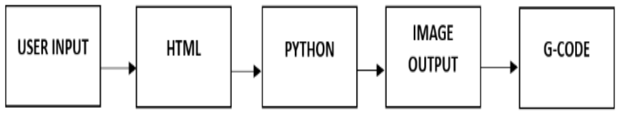

Figure 2 Block Diagram for the Software Process

3.2 Text Input to Python Script

A Python script then receives the transcribed text. This software generates images by using GPUs and online servers. Based on user input, the script analyzes images from the internet and creates a matching image. To create the image, the Python software combines machine learning and computer vision methods.

3.3 Image Generation and Download

The generated image is then downloaded to the local system. This image will serve as the basis for the 2D sketch that will be used to generate the G-code. The image generation process involves the use of Generative Adversarial Networks (GANs) or other deep learning models to generate the image, Figure 3.

Figure 3 User Interface for the AI Model

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3.4 Image Conversion to 2D Sketch

Inkscape is then used to turn the downloaded image into a 2D sketch. A digital image processing program called Inkscape examines the image's pixel locations. In order to simplify the image and facilitate the G-code generation process, this step is required. In order to simplify the image, image processing methods are used during the conversion process.

3.5 G-Code Generation

The G-code is then produced using the 2D drawing. CNC machines are controlled by a programming language called G-code. Using computer-aided design (CAD) software, the 2D sketch is transformed into a G-code file as part of the G-code generating process.

3.6 Arduino and Pronterface Integration

After that, the produced G-code is entered into Pronterface, a program for managing and keeping an eye on CNC machines. The Arduino board, to which the Pronterface is linked, reads the G-code and transmits commands to the CNC machine. To carry out the idea, the Arduino board combines motors and sensors.

3.7 Hardware Setup

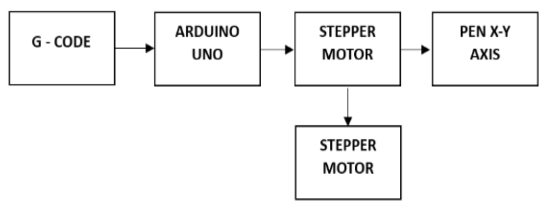

Figure 4 Block Diagram of the Hardware Components

- **CD Drive for E-Waste:** The CD drive serves as a charting device. In order to draw the design onto a real surface, it is altered to accommodate a pen or marker.
- **Arduino Board:** The system's brain is the Arduino board. It transmits commands to the CNC machine after reading the G-code. To carry out the idea, the Arduino board combines motors and sensors.
- **L293D Motor Driver Shield:** The movement of the plotting mechanism is managed by the L293D motor driver shield. It offers an easy method of connecting the Arduino board to the motors.
- **Stepper Motor:** The plotting mechanism's movement is managed by the stepper motor. It gives you exact control over how the pen or marker moves.
- **Servo Motor:** The pen or marker's angle is controlled by the servo motor. It gives you exact control over how the pen or marker is oriented.
- **Power Supply:** The Arduino board, motors, and other parts are powered by the power source. It offers a steady and dependable power source.
- **Breadboard and Jumper Wires:** The components are connected using jumper wires and a breadboard. They offer a practical means of system testing and prototyping.
- **Pen or Marker:** The design is drawn onto a tangible surface with a pen or marker. The plotting mechanism holds it in place, Figure 4.

3.8 Printing the Image

The Pronterface application program is used to print the image. The CNC machine carries out the design after receiving instructions from the Arduino board. The user's preferred design is physically represented via the printed image. A plotting mechanism is used in the printing process to transfer the design onto a tangible surface.

4. Results and Analysis

The study's findings show how well the suggested approach works to translate voice inputs into visual outputs. With great precision, the voice-to-text generator was able to record spoken input and convert it into text. Using user-provided word prompts, the text-to-image generating feature also generated visually coherent and contextually relevant images. An outdated CD drive was used to create a hardware prototype that demonstrated a useful method of upcycling electronic trash. 2D drawings and shapes produced by the system's software outputs were

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precisely traced by the system. The findings show that the system has great promise for people with motor impairments, allowing them to communicate with technology through speech and encouraging their independence and inventiveness.

5. Discussion

For people with locomotive problems, the suggested system shows how assistive technologies can help close the gap. By combining voice-to-text conversion and text-prompt-to-image production, users can create images using voice commands, encouraging self-reliance and creativity, Figure 5.

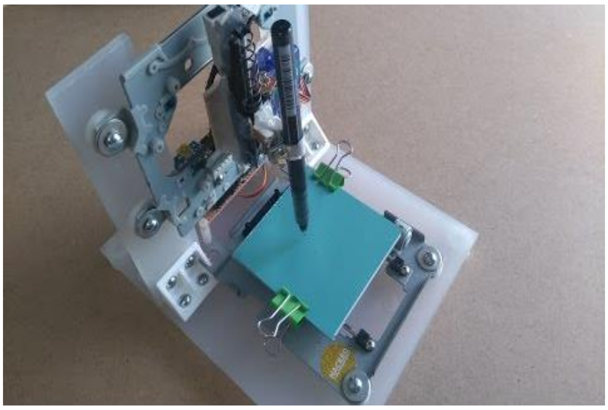

Figure 5 Hardware of the Proposed System

The hardware implementation's utilization of recycled components emphasizes how crucial sustainability is to the advancement of assistive technology. The system is a useful tool for people with motor problems because of its adaptability for therapeutic, educational, and creative uses. To increase the accuracy and responsiveness of the system, more research is required. To improve the system's functioning and design, user testing and input are also crucial. All things considered, the suggested system shows how technology may empower people with motor diseases, and its development emphasizes how crucial interdisciplinary cooperation and user-centered design are when developing assistive technologies.

Conclusion

The research shows how to successfully combine text prompt-to-image production, voice-to-text conversion, and reused e-waste technology to produce a flexible and affordable system for people with locomotor diseases. The system overcomes the drawbacks of conventional input techniques by enabling users to effortlessly enter orders or thoughts using speech.

Future Work

- **Medical Interaction Device:** Modify the system to serve as a medical assistive device, allowing patients with severe motor problems to use voice commands to interface with caretakers or medical equipment.
- **Low-Cost Educational Tool:** Make the system an accessible resource for teaching design, art, and fundamental computer skills, especially in underserved communities. Use multilingual features to connect with a worldwide audience.
- **Continual Advancement:** Expand the system's software and hardware capabilities to close communication, education, and accessibility barriers.
- **User Testing and Feedback:** To improve the system's functioning and design, test it with users and get their input.
- **Scalability and Sustainability:** Make sure the system is sustainable and scalable by utilizing inexpensive and environmentally favorable parts.

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