STM JOURNALS

Recent Trends in
Electronics & Communication Systems

ISSN: 2393-8757
Volume 11, Issue 2, 2024
May–August
DOI (Journal): 10.37591/RTECS

https://journals.stmjournals.com/rtecs/

Review RTECS

CNC-based Rangoli Drawing Machine

Rajshekhar Nandargi[1,*], Shreya Kamble[2]

Abstract

The CNC based Rangoli drawing machine is an artful fusion of technology and traditional artistic expression. This automated device, utilizing computer numerical control (CNC) principles, is designed for crafting intricate designs on sand or creating vibrant Rangoli patterns with precision and efficiency. Users can program the machine with their desired designs, specifying every detail, and watch as it meticulously dispenses sand or colored materials onto the canvas. It offers a versatile platform for artists and enthusiasts to explore a myriad of artistic styles and complexities, making it suitable for both traditional and contemporary art forms. With its ability to reproduce intricate patterns consistently, the CNC Sand and Rangoli draw machine is invaluable for artists, event decorators, and those seeking to showcase their creativity with uniformity. This innovative device not only preserves the essence of traditional art but also brings it into the digital age, allowing for endless possibilities in sand art and Rangoli design. Intricate designs are made on the ground using colored powders, rice, or flowers in the traditional Indian art form of rangoli. Although making rangoli designs by hand takes a lot of talent and time, it has a cultural value and enhances the attractiveness of festive occasions. Utilizing cutting-edge computer numerical control (CNC) technology, the CNC-based Rangoli Drawing Machine automates the fabrication of these exquisite patterns. This study demonstrates how technology can both maintain and improve traditional art forms by examining the features, design, and advantages of CNC-based rangoli drawing machines.

Keywords: CNC, sand art, rangoli, automation, precision, microcontrollers, stepper motors, artistic expression

INTRODUCTION

What we are essentially trying to construct here is a CNC or computer numerical control machine. CNC machining is a manufacturing process in which pre-programmed computer software dictates the movement of factory tools and machinery. Using this, we can accomplish several complex 3D/2D cutting and printing tasks with a single set of prompts. The language behind CNC machining is alternately referred to as G-code, and it is written to control the various behaviors of a corresponding machine, such as the speed, feed rate and coordination. In today's CNC protocols, the production of parts via pre-programmed software is mostly automated. The dimensions for a given part are usually set into place with computer-aided design (CAD) software and then converted into an actual finished product with computer-aided manufacturing (CAM) software [1]. However, for our purpose, we will not need these CAD or CAM as we are merely creating a simple 2D model, which we can easily convert to G Code and input into our Arduino.

***Author for Correspondence**
Rajshekhar Nandargi
E-mail: rajshekhar.nandargi_skncoe@sinhgad.edu.com

[1]Professor, Department of Electronic and Telecommunication Engineering, Smt. Kashibai Navale College of Engineering, Vadgaon, Pune, Maharashtra, India
[2]Student, Department of Electronic and Telecommunication Engineering, Smt. Kashibai Navale College of Engineering, Vadgaon, Pune, Maharashtra, India

Received Date: June 19, 2024
Accepted Date: July 23, 2024
Published Date: July 30, 2024

Citation: Rajshekhar Nandargi, Shreya Kamble. CNC-based Rangoli Drawing Machine. Recent Trends in Electronics & Communication Systems. 2024; 11(2): 11–17p.

G-code, or "geometric code", is a programming language for CNC that instructs machines where and how to move. Most machines speak a different "dialect" of G-code, so the codes vary depending on type, make, and model. G-code follows some

© STM Journals 2024. All Rights Reserved

variation of the alpha numeric pattern: N## G## X## Y## Z## F## S## T## M##, where N is the Line number or which line of the 2D model we are at (for indexing), G is the Motion, i.e. how fast the nozzle moves or in what pattern (Circular, straight, etc.), X, Y and Z are the destination coordinates, F is the Feed rate, for defining the surface speed of the cutting tool in inches per min, S is the Spindle speed, which is the rotational speed of the cutting tool in revolutions per min, T is the Tool selection, to select which mill or lathe to use, and M refers to the Miscellaneous functions like coolant, spindling, etc. We will not need all of these functions for our purposes (Just flow rate, motion type and X and Y coordinates), however most G-Code implementing machines require all these parameters.

LITERATURE REVIEW

Jit SenGupta and Suman Deb [2] explore the integration of techno-aesthetic values in their work, which aims to simulate human perception through the study and replication of Rangoli patterns. Based on human modeling methodologies, their research seeks to create a design framework that mimics the human viewing and drawing process. The authors emphasize the importance of critical thinking, creativity, and innovation at the intersection of technology and aesthetics. Their innovative approach to combining technical modeling with traditional art forms like Rangoli offers a fresh perspective. Numerous studies in the field have attempted to use different modeling techniques to capture the essence of human perceptual processes.

Chauhan, Singh, and Kumar (2014) examined the parameterization of traditional Indian Rangoli design patterns in their study. The goal of their research was to construct a computational method to depict Rangoli designs, which are typically created by hand using intuition and human labor. The authors provide an automated, digital framework for Rangoli creation, capturing its geometric and aesthetic qualities through the definition of parameters and algorithms. This study demonstrates how historic art forms can be innovated upon and preserved using contemporary computing tools, laying the groundwork for future research in the fields of computational creativity, cultural informatics, and pattern recognition.

There has been a growing body of research in recent years on the development of CNC based rangoli drawing machines. Some of the key findings from this research include effective use of CNC technology for rangoli drawing: Researchers have demonstrated that CNC technology can be effectively used to create intricate and detailed rangoli designs [4–8].

- Development of various drawing tools: different types of drawing tools have been developed for CNC based rangoli drawing machines, including pens, brushes, and dispensers for colored powders.
- Integration of sensors and feedback mechanisms: Sensors and feedback mechanisms have been integrated into CNC based rangoli drawing machines to improve precision and accuracy [9–11].
- Exploration of various material surfaces: Researchers have explored the use of CNC based rangoli drawing machines on a variety of material surfaces, including floors, fabrics, and walls.
- Development of user-friendly software: User-friendly software has been developed to make it easier for users to create and edit rangoli designs for CNC based machines [12–14].

The integration of CNC (Computer Numerical Control) technology into traditional rangoli drawing represents a fascinating intersection of cultural heritage and modern innovation. Several key studies have delved into this area, shedding light on the benefits, challenges, and prospects of CNC-based rangoli drawing machines.

METHODOLOGY

The methodology employed in the development and implementation of the “Dynamic Corporate Website for Information Dissemination and E-Commerce” project followed a systematic approach, encompassing various stages from requirements gathering to deployment. The process began with analysis of the project requirements, including the identification of key features and functionalities essential for achieving the project's objectives.

© STM Journals 2024. All Rights Reserved

Requirements Gathering

The gathering phase initiates with comprehensive market research to understand existing CNC technologies and rangoli art trends. This analysis aids in identifying potential user requirements and market gaps. Additionally, stakeholder identification, including artists, event organizers, and potential users, is imperative for gathering insights. Allocating resources for hardware components, software development, and skilled personnel is crucial. Establishing partnerships with suppliers for CNC components and rangoli materials ensures a reliable supply chain.

Design and Prototyping

Moving forward, the design and prototyping phase commences with the development of a conceptual design based on gathered requirements and stakeholder feedback. Detailed engineering designs and specifications, encompassing mechanical, electrical, and software components, are then created. With these plans in place, a functional prototype of the CNC machine is constructed. Thorough testing ensues, evaluating accuracy, speed, and reliability. Iterative improvements are made based on test results and user feedback to refine the prototype.

Development

Following successful prototyping, the development phase focuses on manufacturing the CNC machines in larger quantities [5]. Simultaneously, software development progresses to ensure seamless control and operation of the machines. Training sessions are organized to educate users and operators on effective and safe machine operation. Logistics planning is critical, coordinating shipping, installation, and setup at customer locations.

Testing and Quality Assurance

Subsequently, the testing and quality assurance phase involves rigorous evaluation of the CNC machines to ensure they meet performance and safety standards. Thorough testing is conducted to assess accuracy, speed, and reliability under various conditions. Quality assurance measures are implemented throughout the manufacturing process to maintain consistency and reliability in the final products.

Deployment and Launch

Finally, the deployment and launch phase involve marketing the CNC rangoli drawing machine to generate awareness and interest among potential customers. A launch event or participation in trade shows and exhibitions provides an opportunity to showcase the machine to a wider audience. Establishing sales channels and distribution networks ensures accessibility to customers worldwide. Ongoing customer support, maintenance services, and software updates are provided to ensure customer satisfaction. Continuously gathering feedback from customers and users informs future product development and improvement.

BLOCK DIAGRAM

Being aware of CNC technology: Computers are used in computer numerical control (CNC) technology to operate machine tools. CNC machines can produce complex designs with great accuracy because they are programmed to follow exact movements and operations. CNC technology, which is frequently utilized in industrial and production settings, may also be modified for artistic and creative uses, such as rangoli drawing. Design flow is shown in Figure 1.

The CNC Rangoli Drawing Machine's Design and Parts

Typically, the CNC-based Rangoli Drawing Machine is made up of the following essential parts:

- The controller, often known as the brain of the CNC machine, translates the design instructions into exact motions of the drawing tool.
- *Stepper motors:* These motors allow to produce intricate patterns by moving the drawing tool along the X, Y, and occasionally Z axes.

© STM Journals 2024. All Rights Reserved

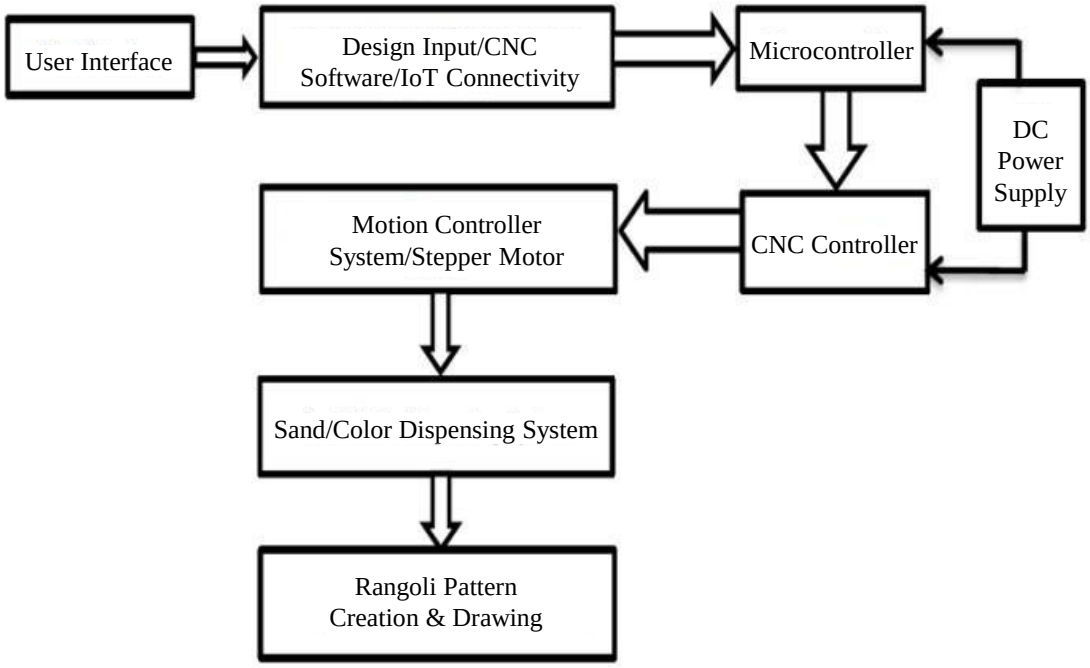

Figure 1. Design flow.

- The tool used to discharge colored powders or other materials to produce the rangoli design is called the drawing tool. It can be modified to work with various rangoli materials.
- The structural elements that give the drawing tool stability and support are the frame and gantry.
- *Software:* The rangoli designs are designed using CAD/CAM software, which also produces the required G-code that the controller needs to direct the machine's motions.

Design Input Processing

- Identify user needs through stakeholder engagement, surveys, and market research.
- Brainstorm design ideas, assess feasibility, and select the most promising concept.
- Develop technical specifications, create CAD models, select components, and mitigate risks.
- Build a prototype, conduct functional and user testing, iterate design improvements, and document findings.

CAD and CAM Software

CAD (Computer-Aided Design) software facilitates the creation of intricate 2D and 3D rangoli designs and machine components with precision and accuracy. CAM (Computer-Aided Manufacturing) software then translates these designs into machine-readable instructions for CNC machines, generating toolpaths and optimizing machining processes. Together, CAD and CAM software streamline the design-to-production workflow, enabling users to create and manufacture complex rangoli designs efficiently.

Microcontroller

Simulation is shown in Figure 2. Microcontrollers serve as the brain of CNC-based rangoli drawing machines, controlling their operation and coordination. They receive input from sensors and user interfaces, process data, and execute commands to control motors and actuators. By running pre-programmed algorithms, microcontrollers ensure precise movement and pattern execution, enabling accurate reproduction of rangoli designs. Simulation result is shown in Figure 3.

CNC Controller

Serving as the brain of the system, the CNC controller interprets the G-code and generates precise control signals. This block ensures coordinated movements of the CNC machine components.

© STM Journals 2024. All Rights Reserved

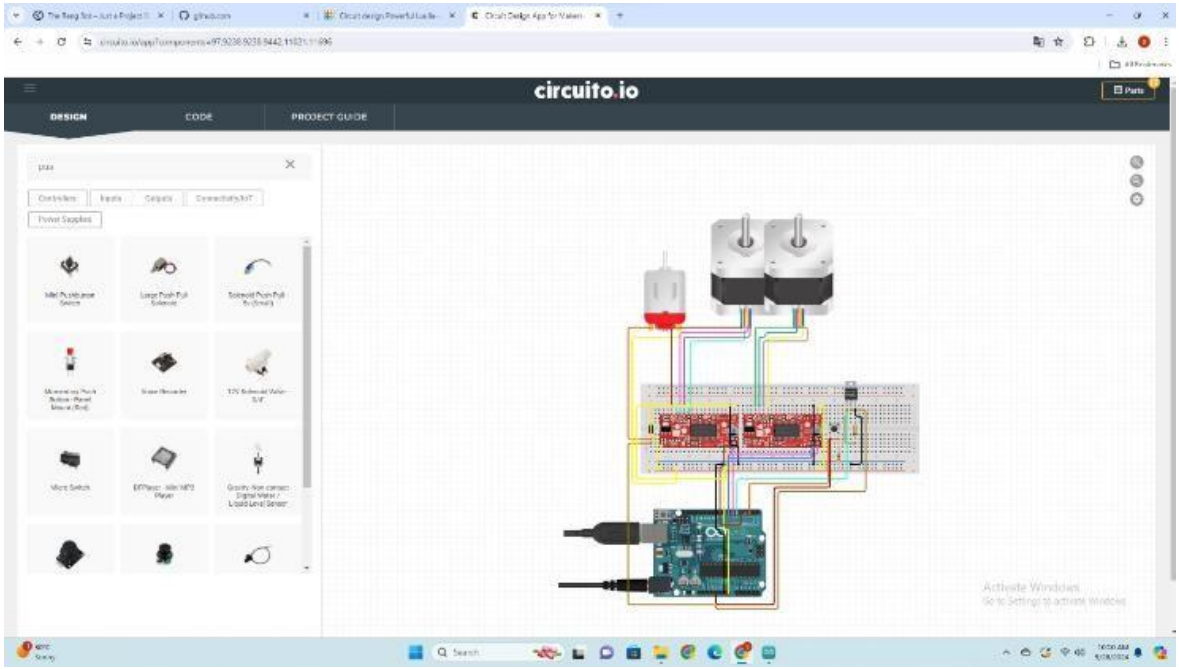

Figure 2. Simulation circuit.

Figure 3. Simulation result.

Stepper Motor Drivers

Connect stepper motor drivers to the microcontroller. These drivers provide the necessary power and control signals to move the stepper motors accurately.

Stepper Motors

Connect stepper motors to the stepper motor drivers. Stepper motors are responsible for precise movements in the X, Y, and Z axes of the CNC platform.

Sand Dispenser Mechanism

Connect a controlled mechanism, such as a servo motor or solenoid, to the microcontroller. This mechanism should dispense sand onto the surface according to the CNC instructions.

© STM Journals 2024. All Rights Reserved

Color Dispenser Mechanism

Connect a controlled mechanism, such as a servo motor or solenoid, to the microcontroller. This mechanism should dispense rangoli colors onto the surface based on the CNC instructions.

RESULT

The rapid advancement of industry and advanced technology has made a significant contribution to human growth. This idea was made possible by industry requirements like excellent and high precision quality, all of which may be met by computer-controlled machinery like computer numerical control machines (CNCs) [2]. An X-Y plotter is used in this project to write or draw two-dimensional data on a rectangular coordinate system. The data includes materials sorted by cost and a variety of applications, such as stepper motors and servo motors, which can be distinguished from one another based on factors like cost, speed range, and peak torque capability [3]. Two stepper motors are used for X-Y movement, and a servo motor is used to move the pen holder. G-code is the control language used to operate the CNC machine. The machine is instructed to move to different locations at a predetermined speed via this function [3]. Using the program Inkscape, text is converted to G-code, which is then sent to the microcontroller through the Universal G-code Sender (UGS). Text that has been translated to G-code is fed to the CNC machine by the microcontroller. The part programmer can describe the moved point's coordinates using G-code, and it can also provide the normal vector to the desired point.

CONCLUSION

The CNC-based rangoli drawing machine revolutionizes traditional rangoli art by offering precise, consistent, and intricate designs with minimal effort. It saves time and labor, making it ideal for various applications, from festivals to commercial events. This technology bridges cultural heritage with modern innovation, ensuring rangoli art's relevance and accessibility in the future. Its potential for customization and future advancements promises even greater versatility and creativity.

Acknowledgement

We extend our sincere gratitude to all those who contributed to the development and realization of the CNC based rangoli drawing machine. Special thanks to faculty members for their invaluable expertise, guidance, and support throughout the project. We are also grateful to the users and stakeholders who provided feedback and insights, shaping the machine's design and functionality.

REFERENCES

1. Img2CAD. Img2CAD Software. [Online]. Available: http://www.img2cad.com/. [Accessed: 12-December- 2015].
2. SenGupta J, Deb S. Smart structure for automated rangoli. In: Shetty N, Prasad N, Nalini N, editors. Emerging Research in Computing, Information, Communication and Applications. New Delhi: Springer; 2015. p. 569–78. DOI: 10.1007/978-81-322-2550-8_54.
3. Chauhan A, Singh K, Kumar A. Parameterization of Indian Traditional Rangoli Design Patterns. Int J Comput Appl. 2014;99(12):12–16. DOI: 10.5120/17369-7895.
4. Kulkarni M. Case study on an Indian SME: Nikash CNC Engineers Pvt. Ltd. BULMIM J Manag Res. 2020;5(1):8–16. DOI: 10.5958/2455-3298.2020.00002.1.
5. Sampson III MB. Discrete-to-complete: the fundamentals of design directed robotics [master's thesis]. Cambridge, MA: Massachusetts Institute of Technology; 2022. Available from: https://hdl.handle.net/1721.1/144541.
6. Vadalkar S. An emerging trend in rangoli design: A case study of Sanskaar Bharati in Maharashtra, India. Int J Des Soc. 2018;12(4):1–12. DOI: 10.18848/2325-1328/CGP/v12i04/1-12.
7. Dutta S. The Mystery of Indian Floor Paintings. Chitrolekha International Magazine on Art and Design. 2011; 1(1): 14–27.
8. Omkar Jeevan Ankalkope, Praveenkumar Bhojane, Adit Urmil Mehta, Kaushiki Sachin Sashital, Ritwik PK, Rohan Sandeep Mahatekar. Design and Development of Arduino Based Drawing Robot. Int J All Res Educ Sci Methods. 2023 Sep; 11(9): 249–259.

© STM Journals 2024. All Rights Reserved

9. Apoorv Chaudhary, Ankit Mhatre, Anantkumar Sharma, Amey Tiwramkar. Design and Development of CNC Writing and Drawing Machine. VIVA-Tech Int J Res Innov. 2021; 1(4): D31–D36.
10. Asiya J, Archana B, Harish S, Hamsalekha VS. Development of Speech to Text Machine. Int J Res Eng Sci Managt. 2020 Jan; 3(1): 597–598.
11. Mahesh Raut, Ganesh Shete, Vipul Shinde, Ashok Suryawanshi. Automatic mini CNC machine for PCB drawing using Arduino. Int Res J Eng Technol (IRJET). 2019 Jun; 06(06): 310–313.
12. Jegan RR, Gnanasundaram E, Gowtham M, Sivanesan R, Thiyagarajan D. Modern design and implementation of XY plotter. 2018 Second International Conference on Inventive Communication and Computational Technologies (ICICCT), Coimbatore, India, 2018. pp. 1651-1654. doi: 10.1109/ICICCT.2018.8473093.
13. Ghulam Dastgeer, Muhammad Asad, Ali Saad SS. Wireless Base CNC Mini Plotter Three Axis Control Machine. Int Res J Eng Technol (IRJET). 2018 Jul; 05(7): 774–778.
14. Puja Girhe, Shubham Yenkar, Arpita Chirde. Arduino Based Cost Effective CNC Plotter Machine, Int J Emerg Technol Eng Res (IJETER). 2018 Feb; 6(2): 6–9.

© STM Journals 2024. All Rights Reserved