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Three Dimensional Structure Scanning Technology for Digital Reconstruction of objects

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Abstract: Traditional methods of measuring and recreating objects are often slow and less accurate, especially when dealing with complex geometries. Manual drawing or modeling can lead to loss of fine details and errors in reconstruction. To overcome these limitations, modern 3D scanning techniques use sensors, lasers, and cameras to capture detailed information quickly and efficiently.

Index Terms **- 3D drawing, laser sensor, Camera module, Stepper motor**

I. INTRODUCTION

In today's digital era, converting real-world objects into accurate digital models has become very important in fields like engineering, healthcare, and design. Traditional methods of measurement are often time-consuming and may lead to errors, especially when dealing with complex shapes.

This project focuses on developing a simple and cost-effective 3D scanning system capable of capturing the shape and structure of physical objects and converting them into digital 3D models. The system uses basic components such as an Arduino Uno, stepper motor, and a laser module to scan objects from multiple angles. The captured data is processed and combined to generate a complete

The proposed approach follows a structured process including data acquisition, processing, and reconstruction. The aim is to achieve better accuracy while keeping the system affordable and easy to use. This project demonstrates how low-cost hardware combined with proper algorithms can provide reliable 3D reconstruction.The outcome of this work can be useful in applications such as product design, reverse engineering, education, and digital preservation.

II. LITERATURE SURVEY

Rahman et al. (2023) proposed a low-cost distance sensor-based 3D scanner capable of capturing both external and internal structures with AR integration. Neto et al. (2021) and Panjvani et al. (2019) developed LiDAR-based systems offering high accuracy but at higher cost. Previous methods like Borghese et al. (1998) and Acosta et al. (2006) used laser-based techniques with limitations in quality and functionality. [1] The study by (Afteni et al., 2022) highlights the importance of 3D scanning in evaluating the dimensional accuracy of machined parts. The authors explain how non-contact 3D scanning, using ATOS Core, enables precise comparison between scanned models and CAD designs, improving quality control and reducing inspection time. The paper concludes that 3D scanning provides fast, accurate, and efficient inspection, making it highly suitable for modern manufacturing industries.[2]

Silva et al. (2024) reviewed different 3D scanning technologies for designing customized orthoses and found that photogrammetry and structured light scanning provide accurate and efficient body digitization. The study highlights that these methods reduce patient discomfort and improve orthosis fitting compared to traditional plaster methods[3] Stefańska et al. (2024) studied the use of terrestrial laser scanning (TLS) for construction management and structural documentation, highlighting its ability to generate accurate 3D point cloud models for complex structures like metro tunnels. The study shows that TLS improves measurement accuracy, reduces time, and enhances BIM-based design and reconstruction processes[4] Trebuňa et al. (2018) explained 3D scanning technology as a non-contact method that captures object geometry using laser-based point clouds and converts them into digital 3D models. The study highlights different scanning techniques like triangulation and time-of-flight, emphasizing their applications in reconstruction, reverse engineering, and industrial design.[5]

III. METHODOLOGY

The proposed 3D scanning system works by combining laser projection, camera sensing, and controlled object rotation to generate an accurate digital model.

Initially, the object to be scanned is placed on a motorized turntable. A stepper motor rotates the object slowly, allowing it to be scanned from all angles. At the same time, a laser or structured light is projected onto the surface of the object. This creates a visible line or pattern on the object.

A camera module captures images of this laser line as the object rotates. These images contain information about the shape and depth of the object's surface. The captured data is then sent to the processing unit (Arduino + external software), where image processing algorithms are applied.The system converts these images into a point cloud, which is a collection of data points representing the surface of the object. After that, advanced reconstruction algorithms convert the point cloud into a complete 3D model.

Finally, the generated model is displayed on a computer using scanning software and can be exported in formats like STL, OBJ, or PLY for further use such as 3D printing or design aanalysis

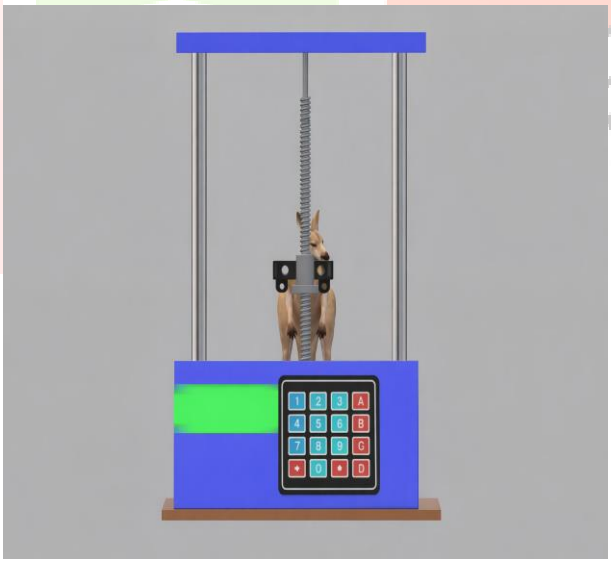

Fig 1 . Overall system design

IV. Finding

1. The system successfully captures object shape using a combination of laser and camera module.
2. Integration of the camera module improves accuracy compared to only sensor-based scanning.
3. Smooth rotation using a stepper motor ensures uniform data collection from all angles.
4. The generated point cloud provides a good representation of the object's surface.
5. Minor errors may occur due to lighting conditions, object texture, or camera calibration.

V . Conclusion

This project demonstrates the design and implementation of a cost-effective 3D scanning system using simple electronic components. By integrating a laser module with a camera, the system is able to capture detailed surface information and generate a digital 3D model of real-world objects.

The proposed approach is efficient, affordable, and suitable for applications such as education, product design, and basic reverse engineering. Although there is scope for improving accuracy and processing speed, the system provides a strong foundation for developing more advanced 3D scanning solutions.

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