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3D Scanner using Arduino Board

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Abstract: *A 3D scanner refers to creating a generalized and simplified representation of the functionality, data output and operation of 3D scanner. It is often used in engineering, computer programs and various applications. The proposal of this project is to construct a scanner for scanning of smaller objects and visualizing them in a computer.3D scanner is commercially available using techniques like image processing, laser, etc. These techniques are high-resolution webcams and high-end equipment like laser source. They have good accuracy, but it is equally expensive. We will talk about a way to create a cheap standalone 3D scanning system, which through the use of processing information taken by a camera and line laser, can create digitized 3D models. This model can be used in digital animation or printed with 3D printers for a wide verity of applications.*

The scanner was designed using Solid Edge and utilizes two stepper motors to scan objects. One motor is used to rotate a platform that the object is placed upon and the second stepper motor is used to move an elevator on which a distance sensor is mounted.

Keywords: 3D Scanner, 3D Printer

I. INTRODUCTION

The 3D printing has changed the prototyping. models making and research field by making things faster and easier. well, if 3D models can be printed from 3D designs, 3D scanning allows us to scan physical models and generate digital 3D models of the same. this allows for easy cloning, creating digital copies of historical artifacts, creating 3D models of live animals and much more. The 3D Scanning is the disruptive technology is 3D Scanning which has product in various industries including healthcare products development, simulation and the arts. The 3D scanner is used in various sectors like, automotive cars and medical sectors etc.

Ft ware to run the program code the Arduino IDE software is nothing but the works like editor compiler and linker type. The 3D scanner using Arduino board is a very simple project and it working smartly with the help of Arduino board.The brain of machine is Arduino it has various pins and different components like resisters, capacitors, USB port, power port, I/O pins, digital pins etc. And it has the brain of the board that is nothing but the CPU / Microcontrollers.

In microcontrollers consists of memory, processors ports like P0,P1, P2,P3 etc. on chip ROM and on chip RAM is integrated on one chip.

The various types of microcontrollers are used in Arduino board like 8051 microcontroller, PIC microcontrollers, ARM and AVR type microcontrollers. this project is the combination of Hardware and Software. to run the machine the source code will lode in Arduino board using some IDE tools. So we have used the Arduino IDE s

Basically, to run the project we are using high level Programming Languages like C ,C++,JAVA,PYTHON, ADVANCEJAVA, JAVA SCRIPT and MATLAB etc.

In the sector of electronics and communication we have to know minimum 4 programming languages. Basically, to simplify and understandable of project we have use the C programming language . C programming language is simple to understand and also to Arduino board.

In project we have use some mechanical parts like Stepper motor, smooth shaft, shaft holder, z – axis etc. To collect the data of scanned object we have SD card module and to control the stepper motors we have stepper motors drivers of IC UNL 2008 etc. To see the collected scanned pics, we have use MESHLAB software from (Microsoft corporation)

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II. LITERATURE REVIEW

John R. Nyquist and S. Terry Stoops presented a laser triangulation-based scanner using an Arduino board in their 2013 article, "Design and Construction of a Low-Cost 3D Scanner Using Open-Source Hardware and Software," which is considered one of the early works on the implementation of a 3D scanner using Arduino. Their scanner rotated a laser with a stepper motor, a photodiode captured the reflected light, and an Arduino board analyzed the data.

In their article "Design and Implementation of a 3D Scanner Based on Kinect and Arduino" (2015), Ali Al-Rubaie and Mohamad Al-Nuaimy suggested a 3D scanner utilizing Arduino and a Kinect sensor. Their scanner employed the Kinect sensor to gather depth information, which an Arduino board then processed to produce a 3D point cloud.

Yi Xiong, Yixuan Wei, and Qianyi Huang offered a different strategy in their 2019 work, "Design of a 3D Scanner Based on Arduino and Infrared Laser Triangulation Sensor." To record the 3D geometry of things, their scanner utilized an Arduino board and an infrared laser triangulation sensor. They also rotated the item while scanning it using a motorized turntable. The potentiometer, which has small interfaces, simple assembly instructions, and user-friendly gcharacteristics, may be used to change the detection range of the sensors.

In their work "Low-cost and Portable 3D Scanner Based on Structured Light and Arduino Platform" (2021), a group of researchers described a 3D scanner utilizing a structured light source and an Arduino board. A structured light pattern was projected and captured by their scanner utilizing a projector and camera. An Arduino board then analyzed the data to produce a 3D mesh

3D modeling research and development, National University of Defense Technology, Changsha 410073, School of Information System and Management, Xi-Dao LUAN, Yu-Xiang XIE, Long YING, and Ling-Da WU. Use in Arduino is an open source computer hardware and software firm, initiative, and user group that creates single-board gadgets and interactive items that can sense and manage real objects. Overview of 3D Laser Scanner Techniques Mostafa Abdel-Bary EBRAHIM is a professor at the King Abdulaziz University's Faculty of Engineering in Rabigh, Kingdom of Saudi Arabia. Impact Elément A brushless DC electric motor that divides a whole revolution into a number of equal steps is known as a stepper motor, step motor, or stepping motor. As long as the motor is suitably scaled to the application in terms of torque and speed, the position of the motor may then be instructed to move and hold at one of these stages without any position sensor for feedback (an open-loop controller).

Aim of Project

The aim of this project is to design and develop a low-cost, open-source 3D scanner using Arduino, capable of capturing accurate 3D models of small to medium-sized objects.

Objectives

1. Design and assemble the 3D scanner hardware: Utilize Arduino, sensors, and actuators to create a functional 3D scanner.
2. Develop the scanning software: Write algorithms and code to control the scanning process, capture data, and reconstruct 3D models.
3. Achieve accurate 3D modeling: Optimize the scanner's performance to capture detailed, accurate 3D models of objects.
4. Minimize costs: Use affordable, readily available components to keep the project's overall cost low.

The scope of this project includes:

1. Hardware Development: Design and assemble the 3D scanner hardware using Arduino, sensors, and actuators.
2. Software Development: Develop the scanning software using Arduino IDE, including algorithms for data capture, processing, and 3D model reconstruction.
3. System Integration: Integrate the hardware and software components to create a functional 3D scanner.
4. Testing and Calibration: Test and calibrate the 3D scanner to ensure accurate and reliable results.

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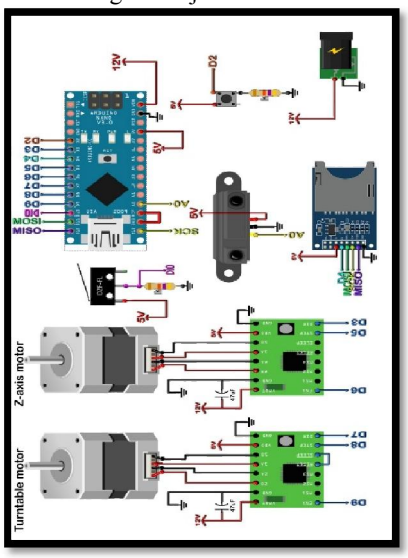
III. METHODOLOGY OF THE PROJECT

The proposed methodology for the 3D scanner utilizing Arduino and stepper motors, integrated assembling the IR sensor, stepper motors, and Arduino microcontroller into a cohesive system. The IR sensor is positioned on a controllable platform driven by the stepper motors, all interconnected to the Arduino. Subsequently, software development ensues, crafted in Arduino's language.

This software orchestrates the stepper motors' movement, orchestrates data collection and processing from the IR sensor, and orchestrates the creation of a 3D point cloud representing the scanned object. Emphasis is placed on user-friendly and customizable software design. The scanning process commences by placing the object in front of the IR sensor and activating the system.

The programmed stepper motors systematically manipulate the IR sensor to capture data from various angles. Laser emissions from. the IR sensor bounce off the object's surface and are registered by the sensor. Collected data is relayed to the Arduino for processing.

Following data acquisition, the software undertakes data processing tasks, employing algorithms to analyse the collected data and generate a 3D point cloud delineating the object's surface.



Circuit Diagram of Project

Arduino Mega Board Model

Arduino is an open-source computer hardware, open-source software and microcontroller-based device building kit and interactive objects that can sense and control physical devices. Arduino designs and manufactures software, software and software.

The project is focused on the design of the microcontrollers. The board contains a combination of digital and analog input/output(I/O) pins, which can connect to specific expansion boards (termed shields).

Stepper Motor

A stepper motor is a type of motor that moves in discrete steps, providing precise control over its position. It consists of multiple coils that are energized in a specific sequence to generate rotational movement.

Stepper motors are commonly used in applications requiring accurate positioning, such as 3D printers, CNC machines, and robotics. The stepper motor used in this project is controlled by the Arduino and drives the platform holding the IR sensor. It typically requires a separate DC power supply, with voltage requirements ranging from 5-12V, depending on the specific motor.

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Sharp IR Sensor:

The Sharp IR sensor utilizes infrared light to measure distance accurately. It emits infrared light pulses and measures the time it takes for the pulses to bounce back after hitting an object. This time delay is used to calculate the distance to the object. The sensor typically operates at 5V and can interface directly with the Arduino's digital pins for data transmission. It provides reliable distance sensing capabilities, making it suitable for applications such as proximity detection, object avoidance, and 3D scanning.

SD Card Module:

The SD card module provides a means to read and write data to an SD card, enabling storage capability for saving scanned data or other information generated by the system. It interfaces with the Arduino via SPI (Serial Peripheral Interface) communication protocol and typically operates at 5V.

The SD card module typically operates at 5V and can be powered directly from the Arduino's 5V output pin. When connected to the Arduino, the module draws power from the microcontroller's on-board voltage regulator, ensuring a stable supply voltage. However, if the SD card module requires additional current beyond what the Arduino can provide, an external power supply may be necessary. It's essential to provide a stable power supply to the SD card module to ensure reliable data storage and retrieval operations.

Push Button

The push button is a simple switch used to initiate actions when pressed. It provides a tactile interface for user interaction, allowing users to trigger specific functions or commands within the system.

The push button typically operates at 5V and can be connected to one of the Arduino's digital input pins. It serves as a user-friendly input mechanism for initiating the scanning process or triggering other actions as needed.

16x2 LCD Display

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displayingcustom characters, special and even animations etc.

Advantages

Using Arduino to build a 3D scanner offers cost-effectiveness, a learning platform, and the flexibility to adapt to specific projects, while also providing a foundation for deeper exploration in robotics and automation**.**

- **Low Cost:** Arduino Nano is a low-cost microcontroller board, making it an affordable option for building a 3D scanner.
- **Compact Size:** Arduino Nano is a small board, allowing for a compact 3D scanner design that can be easily integrated into various applications.
- **Easy to Program:** Arduino Nano is programmed using the Arduino IDE, which is easy to learn and use, even for those without extensive programming experience.

Applications: -

- An Arduino-based 3D scanner can be used for various applications, including reverse engineering, 3D printing prototyping, art restoration, and documenting existing conditions in construction.
- Reverse Engineering
- Prototyping and 3D Printing
- Art and Cultural Heritage Preservation
- Construction and Engineering

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- Automotive and Manufacturing Industries
- Vision-Guided Robotics (VGR)

IV. CONCLUSION

The 3D scanner using Arduino is a low-cost, open-source solution for creating 3D models of objects. The project demonstrates the potential of Arduino as a platform for building complex systems. The scanner's accuracy and resolution can be improved by refining the sensor's sensitivity and the scanning algorithm.

In conclusion, the 3D scanner report demonstrates the successful capture and digitization of [object/area being scanned] with high accuracy and detail, offering valuable data for [intended use, e.g., prototyping, reverse engineering, quality control].

This project involved designing and developing a 3D scanner using Arduino, which enables the creation of detailed three-dimensional models of objects. The scanner uses a combination of sensors, motors, and software to capture and process data.

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