

3D LASER SCANNER USING FABSCAN

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Abstract: When it comes to 3D scanning, thoughts often tend towards the endless opportunities to study things and shapes that were previously impossible. This scanner will use a linear Laser to scan objects and make their point cloud. A linear laser has projection as a line (in comparison to point laser which has projection as a point). Using this laser, we will generate a 3D point cloud of the object. The object to be scanned is placed on a rotating platform and laser is made to fall on it (preferably in dark). The webcam takes pictures of the object with line projection of the laser using which, the code returns cylindrical co-ordinates of all bright points from the picture taken, which creates a 3D point cloud, executable in Fabscan.

Keywords—Linear Laser;3D point Cloud;Structured Light Method;

I. INTRODUCTION

A 3D scanner is a device that analyses a real-world object or environment to collect data on its shape and possibly its appearance. The collected data can then be used to construct three-dimensional models.

The technology that we are using for our project is known as Structured Light Method. Structured-light 3D scanners project a pattern of light on the subject. The pattern is projected onto the subject using a laser. A camera, placed slightly far from the pattern projector, looks at the shape of the pattern and calculates the distance of every point in the field of view. Structured-light scanning is still a very active area of research. Perfect maps obtained from the structured light patterns also solve the correspondence problem and allow for the error detection and correction.

In our hardware we are using a laser diode, used a webcam to capture images. For rotating the platform (on which object to be scanned is kept), we have used a continuous rotating stepper motor. All this setup is assembled on a MFD wooden box with dimensions 600mmX300mm.

After capturing images from webcam, we do image processing and obtain brightest point from every row of each image, and then save the data as a file. In this we are using “FABSCAN” software which runs through computer.

Collected 3D data is useful for a wide variety of applications. These devices are used by the entertainment industry in the production of movies and video games. Other common applications of this technology include industrial design, orthotics and prosthetics, reverse engineering and prototyping, quality control/inspection and documentation of cultural artifacts.

II. METHODOLOGY AND IMPLEMENTATION

The principle that we are using for our project is known as **Structured Light Method**. It is the process of projecting a known pattern (often grids or horizontal bars) on to a scene. The way that these deform when striking surfaces allows vision systems to calculate the depth and surface information of the objects in the scene. Structured light uses structured light without interfering with other computer vision tasks for which the projected pattern will be confusing. Structured-light scanning is still a new area of research. Seen from different viewpoints, the pattern appears geometrical in shape which also solves the correspondence problem and allow for error detection and error correction.

The main advantage of structured-light 3D scanners is that it is faster and precised .Instead of scanning one point at a time, structured light scanners scan multiple points or the entire field of view at once. Scanning an entire field of view in a fraction of a second generates profiles that are exponentially more precise. This reduces or eliminates the problem of distortion from motion. Some existing systems are capable of scanning moving objects in real-time.

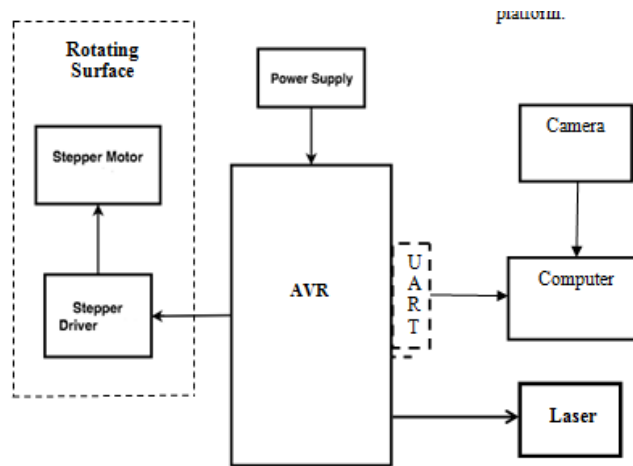


Fig 1: Block Diagram of 3D Scanner

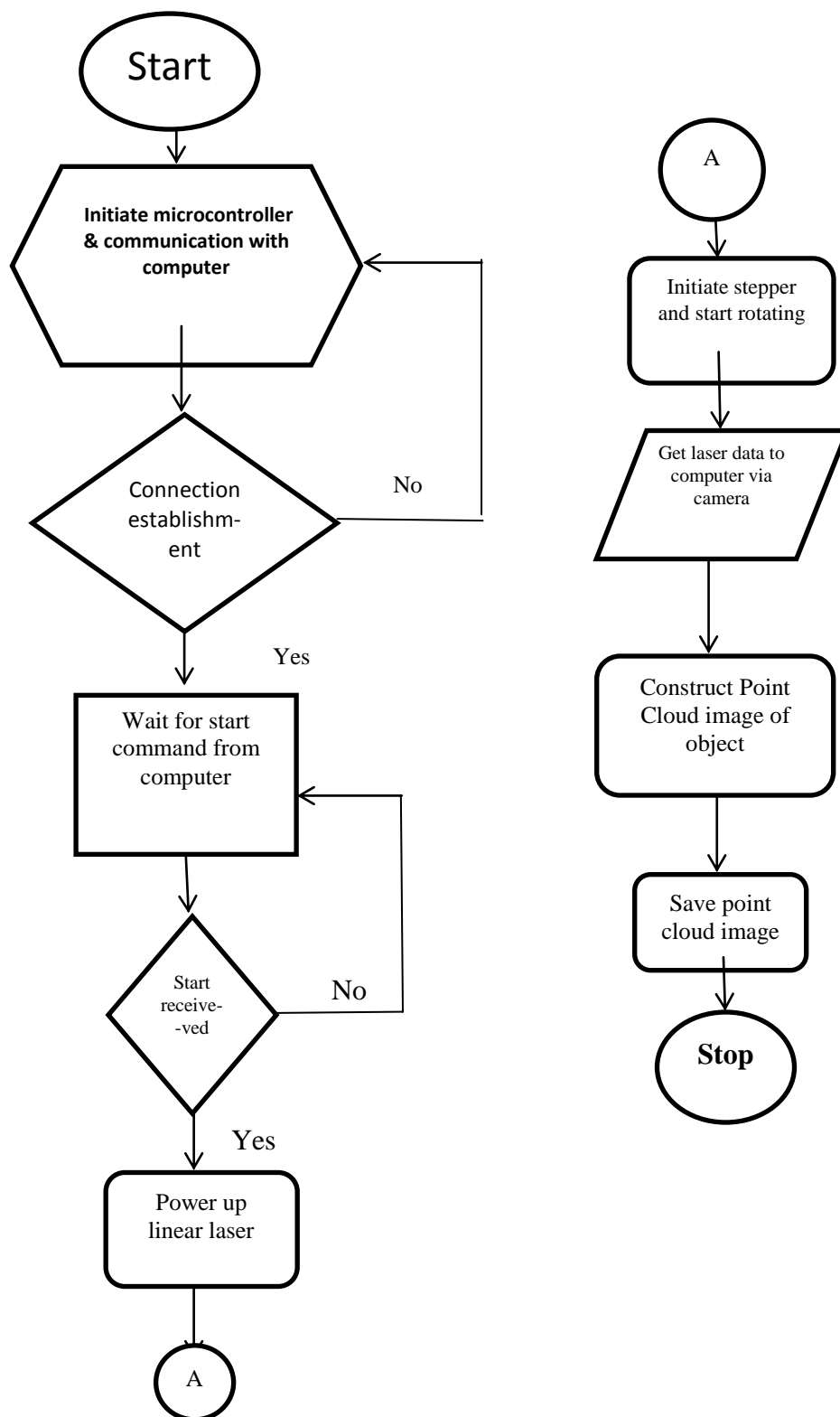
The connection between the UART and computer is half-duplex. The role of UART is, the computer sends command to microcontroller & then microcontroller carries the process of scanning and sends back the scanned object data to the computer.

The Microcontroller receives the command from the computer and starts the command from computer and it will power up the linear laser and also initiates the rotation of stepper motor. When the ray of laser reflected on the external surface of the object in certain pattern, the webcam captures the pattern and stores it in computer.

Fabscan software reconstructs the scanned object data taken from webcam and creates point cloud of the object and compiles 3D model.

Following operations takes place step by step:

- Place the object on the rotating platform.
- Initialize the hardware system using computer.
- Open the Fabscan software, select the Webcam and Detect laser from it.
- Stepper motor will start rotating and also laser will start working
- Adjust the webcam and Laser according to the placed object
- Start scanning from the Fabscan software.

**Fig 2: Flowchart**

III .SOFTWARE USED

FABSCAN:

It is an open source software which creates meshlab of the object and is mainly used in 3D scanning. For implementing the scanning in the project open the FabScan software and select serial port and camera. Click on file-control panel. After that click on detect laser and select 'enable'. Fetching the Frame make sure that the blue horizontal line touches the top of the turning table and the yellow horizontal line touches the bottom of the turning table. Also the yellow vertical line should pass through the centre of the turntable. A non-aligned camera will result in distorted scans!

After setting up, put an object inside scanner and press the start scan button. The scanned object will appear on screen in terms of point cloud image.

When scanning procedure is completed you can save the scanned 3D object as a 3D point cloud .pcd or .ply file.



Fig 3: Actual Object placed inside the box(for darkness)



Fig 4: Scanned Object in Fabscan Software



Fig 5: Overall setup of 3D Laser Scanner

IV. Algorithm Used In Fabscan

The scanned object is in terms of point cloud image. The software used for scanning is FabScan. The algorithm used for generating point clouds in FabScan is closest point algorithm. Iterative Closest Point (ICP) is an algorithm employed to minimize the difference between two clouds of points. In the Iterative Closest Point in some sources, one point cloud (vertex cloud), the reference, or target, is kept fixed, while the other one, the source, is transformed to best match the reference.

The algorithm iteratively revises the transformation (combination of translation and rotation) needed to minimize an error metric, usually the distance from the source to the reference point cloud. ICP is one of the widely used algorithms in aligning three dimensional models given an initial guess of the rigid body transformation required.

When scanning procedure is completed we can save the scanned 3D object as a 3D point cloud .pcd or .ply file.

V. RESULTS AND DISCUSSION

A step-by-step approach in 3D laser scanner using FabScan has been followed.

This system possesses structured light method used in linear laser which scans multiple point or entire field of view at once. This helps to reduce the problem of distortion from motion.

In this system, output i.e., 3D point cloud image is created with the help of point cloud of geometric samples on the surface of the object using FabScan software which uses Closest Point algorithm.

The components we have used in 3D laser scanner are easily available and affordable. The industrial based 3D laser scanner is too costlier and bulkier which is impossible to use in small industries. Thus to overcome this problem we have built 3D scanner with small in size and less in cost using same application.

Thus the design of 3D Reconstruction of Physical Objects Using 3D Scanner & Mesh Lab is completed and validated successfully.

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