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Infrared sensor based 3D image construction

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Abstract—*This paper explains the use of two infra-red sensors to obtain the accurate shape of an object with low implementation cost. The sensors are controlled using a PIC micro controller which obtains the data measured using sensors and will transmit it to the PC serially for plotting the 3D image of the object using MATLAB software. The data acquired by the IR sensor should be accurate to obtain the correct data and for that the distance is set to 5 cm. The data obtained are transmitted and plotted without any delay. The paper aims at developing a low-cost prototype of a 3 dimensional scanner, which can scan real world objects and plot it on a computer screen. This kind of scanners will be of useful in the research, design, manufacturing fields.*

Key words- **PIC, MATLAB, Infra-red sensor**

1.INTRODUCTION

The 3D scanning is a fast and accurate method of putting physical measurements of an object onto the computer in an organized manner, resulting in what is commonly called 3D scan data. Once the scan data is on the computer, all of the dimensions of the physical object can be taken, such as length, width, height, volume, feature size, feature location, surface area, etc. 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 digital three- dimensional models. A 3D scanner collects distance information about surfaces within its field of view. The "picture" produced by a 3D scanner describes the distance to a surface at each point in the picture. This allows the three dimensional position of each point in the picture to be identified.

Many different technologies can be used to build these 3D scanning devices; each technology comes with its own limitations, advantages and costs. 3D scanning saves money and especially time at every point of the manufacturing process, anywhere from design to production. Nowadays, a non contact- based 3D sensing is the most popular approach adopted in 3D data acquirement. It efficiently plays the role for an object to transfer its shape from physical world to virtual world in computer. In contrast to the passive method the active method with laser projection on an object is the famous technique in non-contact approach. The sharp contrast of IR rays and the IR proximity sensors contribute the 3D sensing easier and faster. And, according to the development of 3D scanner, the progressive technique will make the product become another popular device in the future world. Although the 3D scanning hardware has been designed well for decades, a scanningsolution for a complicated model is still an open problem to resolve. In general, a complicated model is hard to scan its complete data because of its various shapes, the scanner's field of view, and the freedom of moving apparatus of a scanner.

2. LITERATURE SURVEY

3D scanning is the technology used to scan the real world objects to obtain its shape, size and other features. This is a demonstration of how to design a 3D object scanner which scans the real world objects, generates highly accurate images giving information of each and every points of the object and plots it on the computer screen.

SitiAsmah Daud [1] proposed an infrared sensor rig in detecting shapes which measure the distance. Between the sensors and the object placed at the centre of the plate. The data received will be fully controlled by Arduino microcontroller and then sensors send to the MATLAB software to reconstruct the image of the object based on the values obtained. The proposed system uses a set of five sensors which is installed in the shape of a pentagon. The movement of the sensors will be controlled by the Arduino microcontroller and the data obtained will be stored .It is then used to plot the images in the MATLAB software.

Another 3D geometry using IR sensors proposed by Tar[4] uses IR sensors and IR emitters to measure the distance and creates 3D mono-graphic geometry of the sensed objects in this system the LEDs and photo- transistors are used . The resolution of the object's heights, orientation and distance will be very low but have a large sensing area of about 1m and it can be increased depending on the application.

G.Benet [5] proposed a system using IR sensors for distance measurement. Here the amplitude response of the sensors depends on reflected ray's amplitude and reflectance characteristics of the object .In this system the IR sensors are used in mobile robots which will be very attractive for enhancing real time operation .Here Benet also describes about the intensity of the back scattered light from objects and it is capable of measuring distances up to 1 m.

3.SYSTEM MODEL

The 3D object scanner consist of basically two parts (i) the embedded part and (ii) MATLAB part. The embedded part consists of the hardware components which are used for three dimensional scanning. In the embedded part there is a micro controller, a distance sensor, a motor controller, a stepper motor and a dc motor along with a

turntable and a threaded rod to move the object to be scanned and the sensor for effective scanning of the object in three dimensions. The micro controller act as the overall brain of the system which controls the motor controller for the proper working of the motor. Micro controller also receives the distance measured by the distance sensor as analog voltage; the analog to digital pins of the micro controller converts the analog data values to digital data. The converted digital datas are then transferred to the PC for plotting a three dimensional image of the object using mat lab. The data is transferred to the micro controller serially using a RS232 connector and a level converter.

Distance sensor used here is a reflective type sensor, which transmits the signal were it reflect back after striking the obstacle, the received light or sound is measured in terms of voltage and this analog voltage is then converted to digital voltage and then transferred to the PC for plotting 3D graph.

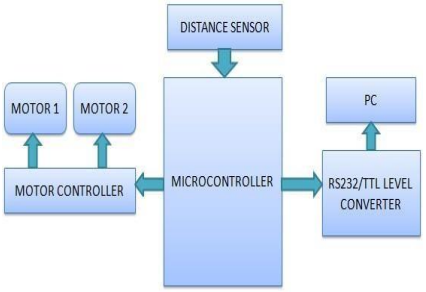

Fig. 1: Block diagram of the system

Motor controller used has to H-bridge circuit which can control rotation of two motors at a time. H- bridge circuit is used to rotate the motor in both directions by transferring current in both direction of the load. A stepper motor is used to rotate the turn table in steps so that the object is rotated in 360 degree. A DC motor is used to rotate the sensor through the threaded vertical rod vertically from the bottom to top of the object.

4.WORKING

The concept of the proposed 3D scanner is to measure the distance of various portions of the object from a particular axis. The mechanical arrangement of the 3D Scanner is shown below. The structure consists of a turn table, which can rotate 360 degrees, on which the object to be scanned will be placed. There will be a threaded vertical rod on the side of the turn table. As this vertical rod is rotated with the help of a motor, the distance sensor attached to it can move up and down through the thread. As seen in the block diagram, there are two main sections for the system- the embedded system section and the PC section. The embedded system section is built around a PIC 16 series microcontroller. A reflective type distance sensor (IR or ultrasonic) is connected to the microcontroller, which gives the distance between the sensor and any obstacle facing it.

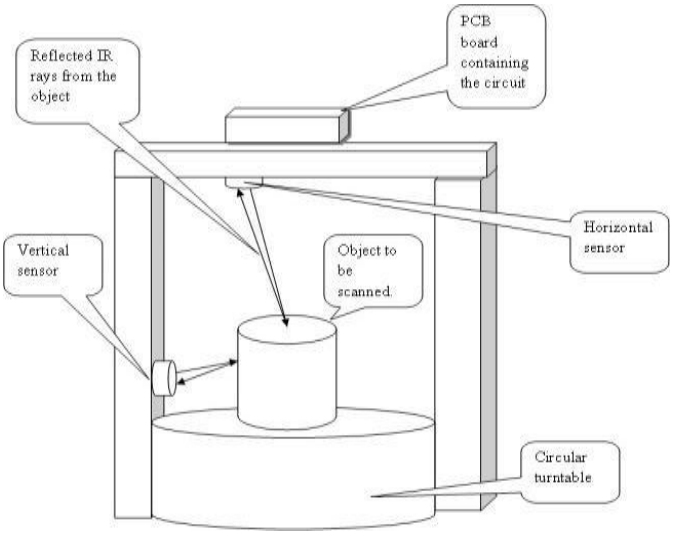

Fig. 2: Mechanical arrangement of 3D scanner

Initially, the sensor is at the bottom portion of the vertical threaded rod. The distance sensor gives the distance information to the microcontroller, which sends this data to the MATLAB application running in the PC which will plot the data graphically. Now the turntable starts rotating slowly. At every step of rotation distance

measurement is done and plotting is done accordingly. After 360 degree rotation is complete, the vertical rod rotates to move the distance sensor upward. The process of turntable rotation and distance measurement is continued. The entire process is repeated, till the top end of the object under scanning is reached. Now the PC will be having the 3 Dimensional information of the object and this will be plotted by MATLAB, using 3D rendering toolkits.

The microcontroller is programmed in embedded c; and the controller is programmed for controlling the motorcontroller and to obtain the data sensed by the IR sensors at each point of time. The obtained data from sensors are analog in nature which is converted into digital values by the microcontroller and the data is transmitted serially into the MATLAB software by converting it into ASCII values.

To reconstruct the 3D image of the object we use MATLAB software, here the data which are serially transmitted by the microcontroller are stored as a matrix and are plotted using 3D rendering tools. This process takes place without any delay as the data is transmitted continuously and image is constructed as soon as the data is received by the MATLAB software. Thus, if any interruption occurs in between if have to restart the scanning process. The stepper motor rotates at a fixed angle and rotates till 360 degree for each n degree rotation the sensors obtain distance variation and sends continuously to the microcontroller and on the other hand both the sensors will also initiate movement to obtain various points of the image and thus to make the plotted image accurate and relevant.

5.RESULTS AND DISCUSSION

The following figure shows the 3D scanned image of a bottle in MATLAB. The scanned data when saved can be used for 3D printing, which is also a future application of this paper. Hence the result of this paper is a low cost prototype of 3D scanner using low cost IR sensors and receivers and PIC microcontroller which can scan the object from every angle and hence generate a 3D image which can be plotted on the computer screen using the MATLAB software. However, accuracy may be increased in the same design using more fine threads, better motors and high precision distance sensors. The advantages of the system is that small businesses are starting to benefit from the low-cost versions of these scanners and also it is very easy to use and very much accurate.

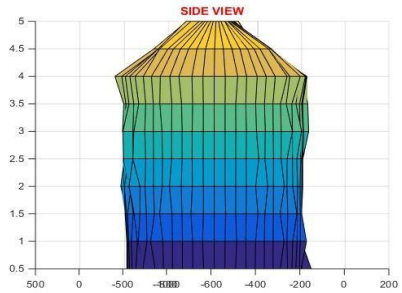

Fig. 3: 3D image obtained in MATLAB

The image shown above is the side view of the object formed from the distance by the IR sensor that is sent to the MATLAB application running on the PC serial plotting of the 3D image and the data transmission happens simultaneously .With more no of sensors we can improve the performance of the system. This paper can find applications in manufacturing fields, biomedical fields etc.

6 .CONCLUSION

3D object scanner is a very useful paper for developing 3D images of objects in design as well as manufacturing industries. We used the 3D rendering tool kits to develop 3D images. The MATLAB software has been used to plot the image on computer screen. The main advantage of the system is that here we are using low cost components. The system is designed for manufacturing areas, reverse engineering fields etc. The IR proximity sensors provide complete scanning. A procedural flow is proposed to manipulate the best position allocation. In the experimental result, the emphasized problems of the worst case really occur when the object is set at the infeasible position. And the criteria of best position of object are demonstrated by the scanned result after the object is re-allocated by the method. A high-performance 3D scanning system is constructed according to low-occlusion approach. In future, we will focus on the development of the automatic procedures to combine the NBV solution to find a more efficient scanning for any complicated model. Proposed system can be extended for the use in different fields such as medical, design, research areas etc.

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