IMPLEMENTATION OF 3D SCANNER FOR 3D PRINTING

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Abstract : 3D printing technique is an emerging area of research. In the current scenario, people are targeting to use 3D printing process in manufacturing, surgical medicine, architecture and civil designing, molecular science, etc. 3D printing has been used as alternative method to manufacture components for use in experiments, machineries and vacuum components with demonstrated performance comparable to traditionally produced parts. 3D printing is used to manufacture moulds for making jewellery, and even the jewellery itself. It is used for designing models and spare parts by the automobile and many other manufacturing industries.

The versatility of 3D printers is evident in the variety of ways they're used today. The medical field alone has a number of uses for them. Surgeons are increasingly planning their operations by producing and reviewing 3D printed replicas of the physical problem being operated on. Using this method of preparation, surgeons can gather a better idea of what the surgery entails – reducing the likelihood of error. Printed models are also a more cost effective way for medical students to study human anatomy. Prosthetic limbs are increasingly being developed by way of 3D printing – bringing the latest cutting edge technology in functional prosthetics to entire communities of people that would otherwise not be able to afford or access the care they need.

Fashion and interior designers are taking advantage of 3d printing to create remarkable products. The world of fashion, known for embracing the newest trends, has produced stylish high heels and chunky statement jewellery. Interior designers are building everything from ottomans to sets of tables and chairs. The furniture is more artistically inspired than its conventional counterparts, and it's lighter too – one of the benefits of being printed. However, the pieces sacrifice nothing in terms of sturdiness. Because of their exacting structure, they are durable and sleek. Lamps have also found their way into the 3D printing market. Floor lamps, table lamps, ceiling lights, and wall lights have all been designed and printed.

This project aims at developing a low cost prototype which can scan real world objects & plot its 3D model on a computer screen. Further this 3D model can be printed using 3D printer

***IndexTerms* – Surgical Medicine, 3D Printing , 3D model.**

I. INTRODUCTION

A 3D model is a digital representation of a physical object. If you already have an object, and you want it in a digital form, that's what a 3D scanner does. It takes physical objects that you send to it and uses advanced 3D scanning equipment to capture and transform them into 3D digital models.

The 3D printing process builds a three-dimensional object from a 3D model, usually by successively adding material layer by layer (additive manufacturing), unlike conventional machining, casting and forging processes, where material is removed from a stock item (subtractive manufacturing) or poured into a mould and shaped by means of dies, presses and hammers.

One of the key advantages of 3D printing is the ability to produce very complex shapes or geometries, and a prerequisite for producing any 3D printed part is a digital 3D model.

The main purpose is to create items with only minimal material used. 3D printing can offer an unprecedented revolution in terms of usability, comfort, low cost, ease of designing & so on.

II. LITURATURE REVIEW

3D printing starts with the creation of a 3D model in a computer. This digital design plays the key role. A 3D model is either created from the ground up with 3D modelling software or based on data generated with a 3D scanner by means of rendering. With a 3D scanner you're able to create a digital copy of an object.

Erald Piperi used a passive system, such as photogrammetry to acquire 3D geometries, with the use of one DSLR camera, a kit lens and close up lenses the results carried out for three benchmarked small objects (from 15 to 22mm) from photogrammetric 3D scan to 3D printing.[1]

Athira K R worked on 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 which transmits the signal reflected and back after striking the obstacle, the received light signal 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 . [2]

Siva Rama Krishna used CATIA software using different commands for drawing the 3D CAD Model of the building applicable in civil engineering for developing the prototype model of complex Osmania University Arts college building structure. [3]

Morteza Daneshmand provided an overview of 3D scanning methodologies and technologies proposed in the existing scientific and industrial literature. Various types of the related techniques are reviewed, which consist, mainly, of close-range, aerial, structure-from-motion and terrestrial photogrammetry.[4]

Aman Sharma explained advanced technology of 3D printing, their implementation in the respective fields and its significant contribution in the global world of science and medical. In this paper we will deal with the term Additive

Manufacturing or 3D Printing and a little bit of its history. Its various applications along with the type of materials used in the 3-D are also described and numerous opportunities provided by this emerging technology as well as the risks and challenges related to it. Its environmental aspects are also discussed.[5]

III. METHODOLOGY

3.1 Proposed Method (3D Scanner)

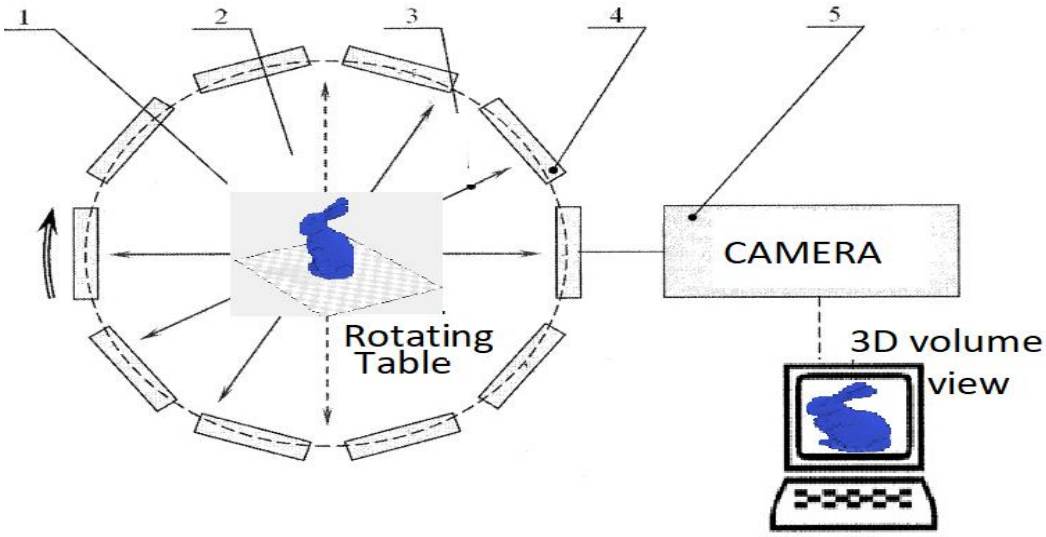

figure 1 : 3D scanner

Step-1 : Setup for 360 degree view and image acquisition (electro-mechanical system)
Step-2: Visualizing and accessing 3D rendering outcome through mesh plot.
Step-3: Feeding 3D rendering outcome to 3D printer
Step-4: Evaluating model and precision for corners, hard edges, sharp creases, transparency, hollows and concave internal geometries.
Step-5: Experimentation with protruding appendages and thickened susceptible sections. Outstretched appendages with thin and puny joints from the core of the model might snap off during or after printing. Hollowing out the 3D model can help you save on the expense of your print.
Step-6: Experimenting with possibility of interlocking separate parts. This step will focus on experimenting with different types of joints and mechanisms so that the finished print can have robust and moveable parts.

3.2 Block Diagram

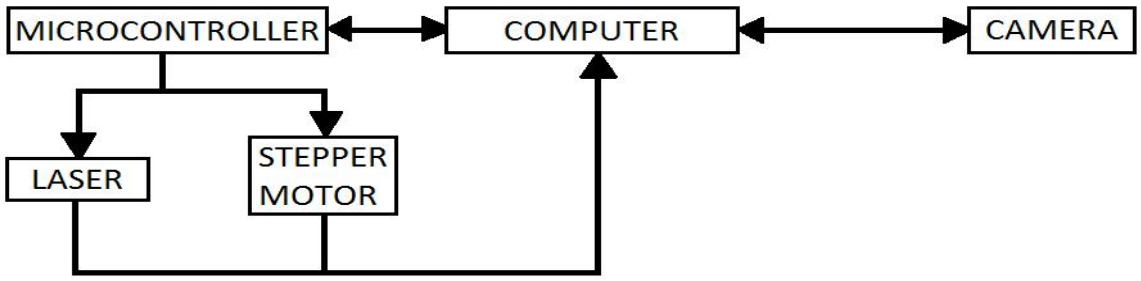

figure 2 : block diagram

3.2.1 Camera The camera acts as the eye of the 3D scanner. It captures the illuminated part of the object as a set of points in the point cloud. It captures the set of points frame by frame. It gets control signals from the computer. It is focused on the object.

3.2.2 Computer The computer contains the scanning software which gives the control signals and also stores the scanned data. It controls the stepper motor and the laser. It can store the completed scan or can import the file to a 3D printer.

3.5.3 Microcontroller The microcontroller connects the laser and the stepper motor to the computer. It acts as a link between the computer and the stepper motor. The micro controller used in this project is the **'**Arduino Uno**'**. It is the heart of the 3D scanner. It controls the operations of the laser and the stepper motor based on the control signals from the computer. It powers the A4988 motor driver which is used to drive the stepper motor.

3.5.4 Laser The laser is used to illuminate a thin strip of the object. The laser is a very important part of the triangulation principle. The laser used in this project is a linear laser. It is controlled by the microcontroller.

3.5.5 Stepper motor The stepper motor is used to rotate the object. It rotates by a predefined angle. It is driven by the A4988 motor driver and the operates as per the control signals from the computer.

3.3 Working Principle

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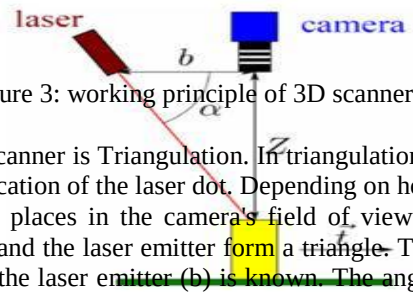

figure 3: working principle of 3D scanner

The working principle of the 3d scanner is Triangulation. In triangulation, the laser is focused on the subject and a camera is used to look for the location of the laser dot. Depending on how far away the laser strikes the surface, the laser dot appears at different places in the camera's field of view. This technique is called triangulation because the laser dot, the camera and the laser emitter form a triangle. The length of one side of the triangle, the distance between the camera and the laser emitter (b) is known. The angle of the laser emitter corner **(α)** is also known. The angle of the camera corner can be determined by looking at the location of the laser dot in the camera's field of view. These three pieces of information fully determine the shape and size of the triangle and give the location of the laser dot corner of the triangle. In most cases, as well as in this project, a laser stripe, instead of a single laser dot, is swept across the object to speed up the acquisition process. In other words, when the laser falls on the object, and when viewed by the camera at an angle, an illuminated edge, in the shape of the object is captured. Many such illuminated edges, put together, will make up the object.

3.4 Experimental Set up

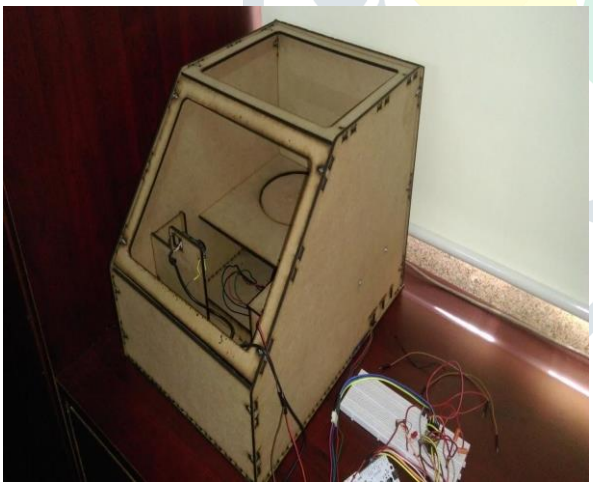

figure 4: experimental set up for 3D scanner

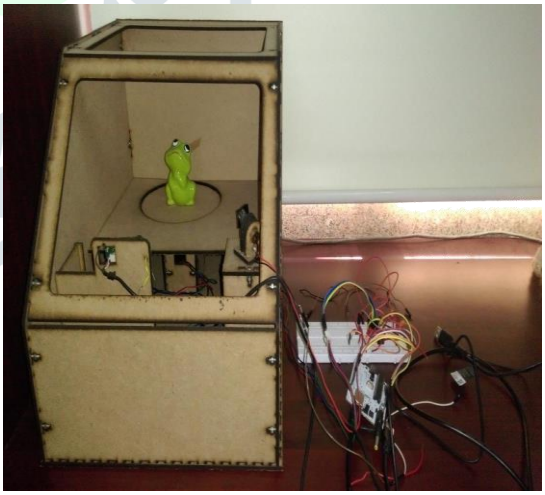

figure 5: 3D scanner with a object to be scanned

3.5 Operation Principle

The camera is calibrated as per the turntable. The laser is aligned with the object. The camera captures the first set of points (linear edge) illuminated by the laser. The scanned data is sent to the computer. Once this data is acquired, the computer sends a signal to the microcontroller to rotate the stepper motor by 1.8 degrees (Full step mode) and off the laser. Once the motor rotates, the laser is turned on and the camera captures the new set of points. Again the motor is rotated and the camera captures the next set of points. This cycle keeps repeating till the entire object is scanned.

All such edges, arranged together in the right pattern forms the point cloud. The point cloud is only a collection of points; hence it does not contain any smooth surface. The point cloud is then cleaned and using mesh reconstruction, the surfaces of the object is created. All this is done in special softwares in the computer. Finally the 3D digital scan of the object is ready. The scan can further be stored for future use or sent to a 3D printer for printing.

3.6 Softwares Used

All the softwares used are open source and are easily available. In total we have used four softwares. The first one is the **Arduino Software (IDE)**. The code for the arduino is written in this software and is uploaded into the arduino through this software. The second one is **Fabscan 100.4**. This software has been developed by Francis Engelmann for his own 3D scanner project. Though there are quite a few 3D scanning softwares available, we have found his software to be most compatible with our scanner. This software controls the working of the entire scanner. It is the main software. It is responsible for capturing the point cloud through the camera. It sends control signals to the arduino through the computer, which in turn controls the stepper motor and the laser. It thus tells the turn table when to turn, the laser when to blink and the camera when to capture. Formation of the point cloud is one of the main aspects of this project. Once the point cloud is obtained, it is sent to the third software, **Blender 3D**. This software is used for cleaning the point cloud. Finally the cleaned point cloud is sent to the fourth software called **MeshLab**. This software is used to render the point cloud into the object. Using certain reconstruction algorithms and filters, it creates a mesh joining all the points of the point cloud. This creates the final 3D scan of the object. MeshLab also allows exporting the scan as a .STL file for 3D printing

IV. RESULTS

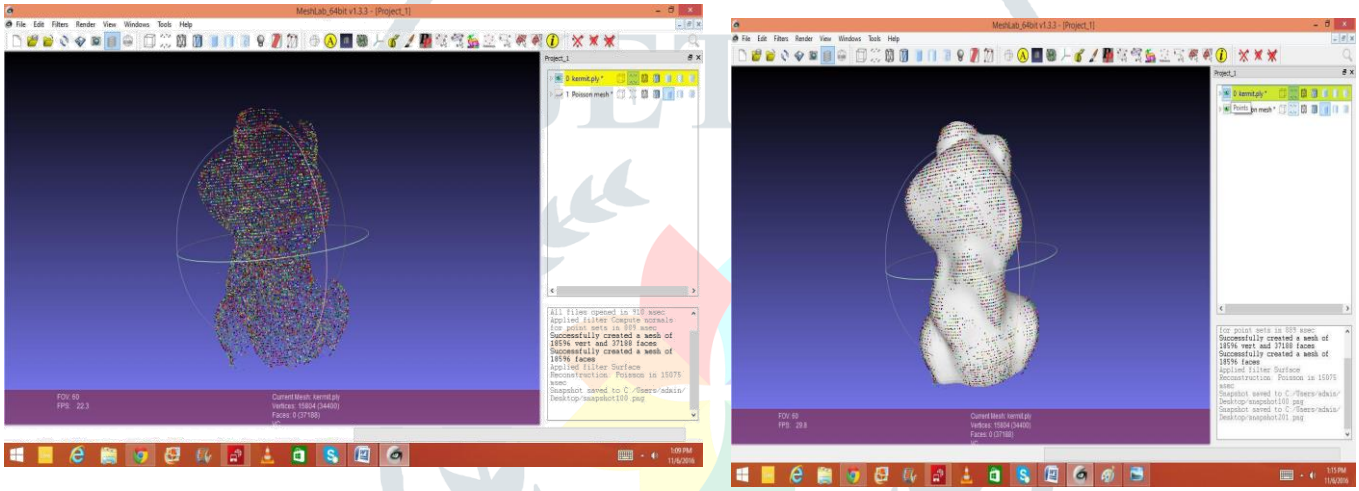

figure 6 : scanned 3D model using FabScan

Fig 7. Object Point Cloud

Fig 8: Rendered 3D model from MeshLab for 3D Printer

V. CONCLUSION

In this paper, a 3D scanner is implemented successfully which is very useful tool to create the 3D shape of the components from the real world into computerised form as three dimensional representations. The 3d scanning is widely used for Reverse engineering Here We have used one linear laser and a camera to build a 3D scanner. This enables users to duplicate 3D shapes as multi-resolution data. A complete analysis to reconstruct 3D points has been discussed.

The results have been really good. The resolution of the scans has been satisfactory. A proper output has been obtained from 3D Scanner and after proper processing the 3D model is printed using 3D Printer.

3-D printing technology's importance and social impact increase gradually day by day and influence the human's life, the economy, and modern society. 3D Printing technology could revolutionize the world. Advances in 3D printing technology can significantly change and improve the way we manufacture products and produce goods worldwide. An object is scanned or designed with Computer Aided Design software, then sliced up into thin layers, which can then be printed out to form a solid three dimensional product. 3D printing can have an application in almost all of the categories of human needs while it may not fill an empty unloved heart, it will provide companies and individuals fast and easy manufacturing in any size or scale limited only by their imagination. 3D printing, on the other hand, can enable fast, reliable, and repeatable means of producing tailor-made products which can still be made inexpensively due to automation of processes and distribution of manufacturing needs.

VI. FUTURE SCOPE

- **Wood and Paper**: NASA has been developing technologies that would 3D print wood using bio-printing technique. This would enable the astronauts to bring wood into space without actually carrying it with them.
- **Metals and building materials**: MIT Media Lab is experimenting on printing large moulds for concrete structures using spray poly-urethane foam. MIT has printed several wall moulds that are about 5-6 feet. Contour Crafting proposes 3D printing an entire house of 2,500 sq. foot within 20 hours with low cost and emergency housing system using a specially formulated concrete .
- **Defense and Aerospace**: Printing an aircraft wing may be possible in near future which may further lead to the development of an entire aircraft by this method. 3D printing on a battleship ground can bring a revolution as there would not be any dependence on the supply of ammos in the battlefield. Also self healing military vehicles can be developed.
- **Automotive**: 3D printed components for vehicles can be used whose models are rarely available in the market. Innovative vehicles enabled by 3D printing can also be manufactured.
- **Healthcare**: Tissue and organ transplant is also possible using 3D printed organs. Nano-Scale medicines can be produced along with complex printed organs.
- **Consumer-Retail**: 3D printing stores can be opened where a customer can express his ideas and accordingly the product can be printed.
- **General Manufacturing**: Printed electronics embedded in parts may be very common in future. Also factories may comprise of 3D printing machines along with or without the traditional manufacturing machines.

VII. ACKNOWLEDGMENT

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