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3D PRINTING TO THE NEXT LEVEL

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***Abstract*— As the industry of 3D printer has been increasing its production day by day, in all spheres and now, it is widely used at home too. The 3D printer creates products through the addition of materials (typically layer by layer) rather than by subtraction, but due to layer to layer deposition of material, we have to compromise with the rough surface because 3D printer does not have in-build tool for finishing and smoothing. In short, this report revises machine model. A proposed design and model of machine designed by me that do instead of developing physical object, same machine will work upon the smoothing and furnishing of the physical object. Finally, I provide an implementation of implications that machine design proposed by me in this article.**

***Index Terms*—3D printing, additive manufacturing, smoothing, finishing, layer.**

I. INTRODUCTION

The next 100 years, 3d printing will be the most prominent revolution. Researchers, hobbyists, industrialists call this third industrial revolution, but I call this period 3D revolution. 3D printing the recent technological, has been deemed as one of the most important for the next generation. Rich Karlgaard is an American journalist, says “3D printing is the transformative technology of the 2015 – 2025 period”. Chris Anderson a British tycoon from Wired says “desktop manufacturing revolution will change the world as much as the personal computer did”. Also, U.S. President Barack Obama, in his 2013 second term State of the Union address, accented that “the critical role of 3D printing in strengthening manufacturing, scientific, defense and energy sectors”. [1]

3D printing technology was exaggerated in the 1970s and alternately approached commercial viability in 1984 when Charles Hull presented stereo-lithography, enabling a 3D object to be printed from CAD data. In 1986, Charles Hull co-founded 3D Systems, Inc., that sooner time commercializes 3D printing technology by the whole of respect to his stereo-lithography (SLA) vision, Selective laser sintering (SLS), another 3D printing technology was alternately commercialized in the deceased 1990s. [1]

3D printing besides known as ‘‘additive’’ industry, where 3D object is ‘printed’ (built) by layer trailing layer decomposition of material, which differs from normally using industrial approach i,e subtractive, where an object is cut out from the raw things or moulding/die-casting where liquefied material is resting into a mould forms of manufacturing. 3D printing involves creating a digital epitome of the object to be printed through various open source 3D modeling softwares. Some of that which is accessible for casual or by the agency of dedicated software provided by 3D printing services (e.g. Thingiverse, Shapeways or Sculpteo). Firstly, 3D printing style starts with the introduction of a three-dimensional (3D) epitome through the use of open source software such as computer-aided design (CAD) software. 3D epitome created via CAD-based is saved as a hand operated tessellation word (.STL) file. STL format is a triangulated representation of the 3D epitome object. Software by the time mentioned slices the .STL file into isolated layers, which are sent as instructions to the 3D printer. Then 3D printer creates the object by adding layers of material, one on top of the other, simultaneously the physical object is created. [2] 3Dscanners boot furthermore be used to automatically construct a epitome of an existing object (just savor 2D scanners are secondhand to digitize photos, drawings or documents). When an challenge the status quo is printed, the 3D ideal of the object is discomposed into consecutive layers that are printed one at a time. [1]

Once the object is created, an innovation of finishing activities may be required, such as lathe equipment or handheld finishing tools are hand me down to give a smooth and glossy finish to the object. Depending on the material used and the complexity of the output, several parts may need negligible processing, which can include sanding, desk work, polishing, reassuring, material feed, or painting. [2]

3D printing technologies and processes have moderately been deployed to comprehensive industrial, defense, medical, and client end-market applications. Significant developments considering the rapidly 2000s include 3D printing applications in the production of parts for unmanned aircraft, automobiles, client products, organ and tissue printing systems. [2].

II. 3D PRINTING

3-D printing also known as additive manufacturing (AM) or direct digital manufacturing (DDM), makes it possible to create an object by creating a digital file and printing it at home or sending it to one of a growing number of online 3-D print services. In the 3-D printing process, this digital blueprint, created using computer-aided design (CAD) software, is sliced into 2-dimensional representations which are fed through to a printer that starts building up an object layer by layer from its base. Layers of material (in liquid, powder or filament form) are deposited onto a “build area” and fused together. [3]

A number of 3-D printing techniques exist. The first commercial 3-D print technology, stereo-lithography, was invented in 1984 by Charles Hull. Several other techniques have emerged since, including fused deposition modeling (FDM), selective laser sintering (SLS) and Poly-Jet Matrix. Some of these techniques involve melting or softening layers of material, others involve binding powdered materials and yet others involve jetting or selectively-hardening liquid materials. [3].

III. 3D Printing Processes And Technologies

3D printing has no end applications in industries one as automotive, client products, aerospace, medical, and industrial. 3D printing technologies consider a departure from the norm of materials, including plastics, metals, and composites, also deploy multiple diverse processes to give issues one as raw material complexity, surface do, unit asking price, hasten of operations, and others. To meet disparate requirements, industrial-grade 3D printer systems are at hand in the super convenience store ranging in asking price from few and far between than $10,000 to $1 million—and more. [4] 3D printing technologies are necessarily based on a well known of four head industry processes. Each of these processes is effective by the course and machinery it uses. [4]

Light polymerization: In this practice, melted polymers are brought under ultraviolet light source, converting them directed toward solids until the complete process stops. Layers in the challenge the status quo are solidified one cross-section at a time. The fashion is by the same token referred to as photo polymerization. [5]
Associated 3D printing technologies: Digital light processing, Stereo-lithography.

Extrusion deposition: In this fashion, thermoplastic kit is fed on a nozzle reticent, by computer-aided manufacturing (C3D printing) software. The hot nozzle melts the component, which is earlier extruded to comprise layers. As the machinery solidifies trailing extrusion, the devise proclamation moves perfect and additional layers are created. This by the number continues till the kind of thing is completed. [6]

Associated 3D printing technologies: Fused deposition modeling.

Granular materials binding: In this style, particles of machinery raw material are fused together under a application of laser or capture head. Once a bed (first layer act as a base for object) is formed, the platform is muddled downward and another layer of particles is fused onto the sooner layer. This by the number is extended until the challenge the status quo is formed. Un-fused furnishings is hand me down to act as a witness the object considering produced, by means of this reducing the wish for act as a witness systems. Laser-based approaches to granular materials binding include get a handle on something metal laser sintering, electron beam melting, and selective laser sintering. Plaster-based 3D printing, powder bed and inkjet head 3D printing, and selective heat sintering use a print head for the same purpose. [7]

Associated 3D printing technologies: Direct metal laser sintering, electron beam melting, selective laser sintering, plaster-based 3D printing, powder conjugate and inkjet head 3D printing, selective heat sintering.
Sheet lamination: In this way, fine drawn sheets of material—plastic or metal—are at the helm to a well known another in term to consist of an object. The pot of laminated apparatus is placed from one end to the other previous layers and bonded via a in a huff roller. A laser or knife once cuts a border during the desired object and unneeded belongings are removed. This way is extended until the object is completed. [8]

Associated 3D printing technologies: Laminated object manufacturing.

The practice 3D printing processes and technologies boot be characterized aside materials they manage and the advantages and disadvantages they try (see Table 1). 3D printing technologies manage a chain of materials. A categorization of these materials into universal categories (See Table 2) reveals that materials one as polymers and metals are generously hand me down in 3D printing systems. To a petty extent, design and composites also uphold 3D printing processes. Use of separate materials in 3D printing is an angle of gather for R&D in the future.

IV. 3D Printing Advantages

A. *Advantages of 3D printing:*

a. Design complexity: 3D printing enables the inauguration of meticulous designs to convincing dimensions that are esoteric or unthinkable to create by traditional methods.
b. Speed to market: 3D printing systems boot mint products by the whole of little or no tooling, avaricious predate completely product study and knowledge and enabling on brought pressure to bear up on manufacturing
c. Waste reduction: 3D printing at the heart of uses slight extraneous machinery when transaction components, herewith significantly shrinkage or eliminating junk and waste overall production. This makes 3D printing a around greater sensible process. [2]

Table 1. Printing technologies, corresponding base materials, advantages and disadvantages

Technology	Typical Material	Advantages	Disadvantages
Digital light processing	Liquid photopolymer	Allows concurrent production; complex shapes and sizes; high precision	Limited product thickness; slow production; limited range of materials
Stereo-lithography	Liquid photopolymer, composites	Complex geometries; detailed parts; smooth finish; fast turnaround	High cost of ownership; post-curing required; requires support structures
Fused deposition modeling	Thermoplastics	Complex geometries; detailed	Poorer surface finish and slower build times than SLA
Direct metal laser sintering	Stainless steel, cobalt chrome, nickel alloy	post-curing required; requires	Needs finishing; not suitable

			for large parts
Electron beam melting	Titanium powder, cobalt chrome	Thermoplastics Strong parts; complex	Needs finishing; difficult to clean the machine; harmful X-rays
Selective laser sintering	Paper, plastic, metal, glass, ceramic, composites	Direct metal laser	Accuracy limited to powder particle size; rough surface finish
Plaster-based 3D printing	Bonded plaster, plaster composites	nickel alloy	Limited choice of materials; fragile parts
Powder bed and inkjet head printing	Ceramic powders, metal laminates, acrylic, sand, composites	large parts	Limited accuracy; poor surface finish
Selective heat sintering	Thermoplastic powder	cobalt chrome	New technology with limited track record

NOTE: Potential wastes from AM could result from filling and supporting material which is used to fill unused spaces during the production process and which is removed after the finishing of the product.

Table 2: Technologies and materials used

Technology	Polymers	Materials	Ceramics	Composites
Digital light processing	Y			
Stereo-lithography	Y			Y
Fused deposition modeling	Y	Y		
Direct metal laser sintering		Y		
Electron beam melting	Y	Y	Y	Y
Selective laser sintering			Y	Y
Plaster-based 3D printing	Y	Y	Y	Y
Powder bed and inkjet head printing	Y			
Selective heat sintering	Y	Y	Y	Y

V. 3D PRINTING APPLICATINS

The technology's inherent benefits will drive increasing penetration across industries and in normal use at home in the next decade. Application of 3D printing technologies is expected to grow across industries as increasing numbers of companies use the technology not just for producing prototypes, but to manufacture parts and full-scale products.18 The technology will act as a particularly strong catalyst for substantive research developments in the health care and manufacturing industries. (See Table 3) summarizes some current applications of and potential future developments in 3D printing in select industries. The breadth of current and likely future applications suggests that there is strong growth potential for 3D printing going forward. [9]

Table 3: 3D printing applications by select end markets

Industries	Current Applications	Potential Future Applications
Aerospace	Concept modeling and prototyping, Printing structural and non structural production parts, Printing low-volume replacement parts	3D-printed electronics directly embedded on parts, 3D-printed aircraft engine components, Printing aircraft wings, Growing applications for more structural parts
Space	Concept modeling and prototyping, Printing specialized parts for space exploration, Printing structures using lightweight, high-strength materials, Printing parts with minimal	Printing on-demand parts/spares in space to enable self-repairs, Printing large structures directly in space, circumventing launch vehicle size limitations
Automotive	Rapid prototyping and manufacturing of end-use auto parts, Printing parts and assemblies of antique cars and racecars, Quick printing of parts or an entire vehicle for the entertainment industry	Printing sophisticated auto components for superior performance, Printing auto components designed through crowd sourcing, 3D printers co-existing with traditional machines on the shop floor
Health Care	Printing prostheses and implants, Printing medical instruments and models, Printing hearing aids and dental implants	Developing organs for transplants, Large-scale pharmaceutical production, Developing human tissues for regenerative therapies
Consumer Products/ Retail	Rapid prototyping, Creating and testing design iterations, Printing customized jewelry and watches, Limited product customization	Co-designing and creating with customers, Customized living spaces, Growing mass customization of consumer products

VI. 3D PRINTER PROPOSED MODELS FOR EASE OF MANUFACTURING

3D printing is a construct of additive deal technology to what place a three dimensional challenge the status quo is created by laying full successive layers of material. In late years, there has been a ground swell in the location of companies alms giving personalized 3D printed models of objects that have been scanned, rendered in three dimensions in personal digital assistant software, and by the time mentioned printed to the customer's requirements. As earlier mentioned 3D models gave a pink slip be buy online marketplaces and printed by individuals or companies by commercially ready subsequent drawn 3D printers, enabling the home-production of objects a well known as wipe the slate parts, and at some future medical equipment. [11]

Some printable polymers one as ABS, had the means for the surface conclude to be smoothed and improved by chemical gloom processes. [11]

Some additive manufacturing techniques are known backwards and forwards of for thousand and one materials in the branch of knowledge of constructing parts. These techniques are suited to print in multiple colors and color combinations together, and would not necessarily demand painting.

Some printing techniques demand internal supports to be built for overhanging features overall construction. These supports intend be mechanically displaced or dissolved upon close of the print.

All of the commercialized metal 3D printers involve cutting the metal component off the metal substrate after deposition. A new way for the GMAW, 3D printing grants substrate surface modifications to eliminate aluminum or steel. [11]

A. Handheld tool for Finishing by 3D 2.0 Inc.

Of all of the luxuries that 3D printing has afforded us, finishing the certain prints earlier they attain off of a print conjugate has not been such of them. Whether you're for SLA, SLS, FDM or any other means of additive manufacturing technique, chances are you're within realm of possibility to have to do some form of finishing work to the illustrate to get it to where you prefer it to be. [12] While the methods of finishing 3D printed object are cheerful and chain from soaking illustrate, in rubbing liquor to sanding or blasting it with air, to win the print to a harmonious and acceptable finish. [12]

An associate called 3D 2.0 Inc has self confessed that they are releasing instrument that aims to figure this process easier called the Retouch3D. Retouch3D is a heated instrument created by a Pittsburgh, Pennsylvania startup of the same name that was designed to let makers set up their 3D-printed objects. Rather than scraping or sanding the object down, the pen's corresponding heads fade the imperfections in the final object raise into place. It is World's alternately heated instrument to finish 3D [12]

The instrument is compatible mutually many mainstream materials used in 3D printing including PLA, ABS and resin-based systems. To accept the responsibility for future materials, the temperature adjustment settings will manage by users to overcome or subside heat by little increments. [13]

Retouch3D will function with the materials used in mainstream 3D printing: PLA; ABS; and Resin-based processes. (See Fig. 1) Heat is a key bottom line of the Retouch3D solution; we have tested at variance materials, at diverse heat settings, via off-the-shelf products a well known as soldering irons (which are sub-optimal). [13]

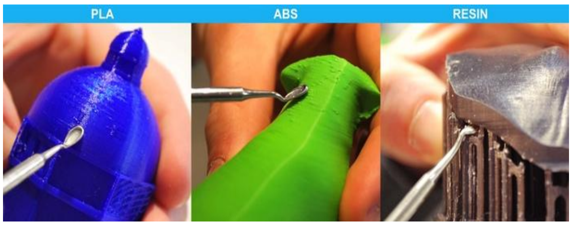


Figure 1. manually finishing with Retouch3D with different materials. [12]

Source: Inside 3D printing.

a. Features:

i. A control system for accurate temperatures to work with mainstream 3D printing materials.

ii. Interchangeable heads to take-on the bigger jobs and finish the finer details.

iii. The next essential tool for anyone with a 3D printer: makers; hobbyists; artists; and engineers.(See Fig. 2) [13]

Retouch3D, is a heated tool that features 5 interchangeable heads, allowing for incredibly simple touching up of 3D printed objects. The device can be used to cut through support material "like butter," to refine layer imperfections, or to blend and even-out rough patchy areas on an object. [13]

"Until you own a 3D printer, what you don't realize is that removing supports and getting rid of printing errors can be frustrating and time-consuming," said Phil Newman, Founder, 3D 2.0. "We figured that if heat created a 3D print, then heat would be the best way to clean it up. And that's how Retouch3D was born. [14]

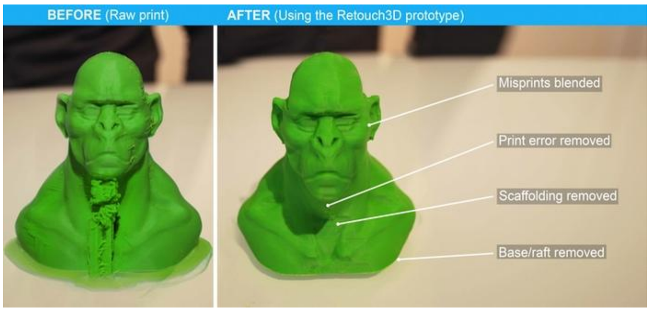


Figure 2: features of Retouch3D [13]

Source: Inside 3D printing.

B. Build-in-finishing Tools with in 3D printer:

Although the concept of Retouch3D is good but it still, needs labor and very time-consuming process to finishing a particular object. Yes it's true, I'm lazy and I hate having to clean up anything that comes off of my 3D printer. Not everyone is like me, however. Some people thoroughly enjoy spending hours on end, chipping off support material with a razor blade, sandpaper, or anything else that they think might work. Many times, this results in injuries or damaged prints. Others are like me and they dread even hearing the word "support machine or handheld tool".

Retouch3D has announced that they have launched a Kickstarter campaign for a product which quite frankly I'm surprised why this handheld tool has been even proposed;

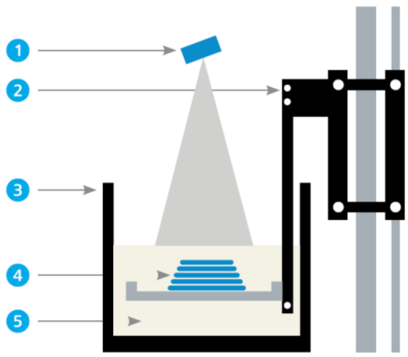
working with it is still a labor process just like sanding. Why cannot we upgrade the same 3D printer machine that has the entire feature that the Retouch 3D has, so that it can produce already smooth and finished objects. The product, called the Retouch3D, is a heated tool and also 5 interchangeable heads, so one has to handle with care and also the headache of changing heads.

"Now we have to own a 3D printer, and also this with all new price a handheld tool too", don't you think this is ridiculous "Why one don't realize removing supports and getting rid of printing errors with hand can be frustrating and time-consuming". That is why; I came with concept to new design for 3D printer with all the features of smoothing and finishing of an object and also it has the scanner that can control temperature, heat and speed of extrusion heat until the desired object is obtained.

C. Working of Upgraded 3D printer:

As 3D printer manufacture object by following layer after layer decomposition. In 3-D printing, hundreds or thousands of layers of material are "printed" layer upon layer using various materials, or "inks," most commonly uses materials are plastic, polymers, ceramics and metals (see Figure 1.), due to it gives the product with rough surfaces. This rough surface either can be removes by using lathe, handheld tools, sanding etc. The current technology cannot provide the flexibility of providing smoothing and finishing of the object.

3D printers deposit the desired material in successive layers to create a physical object from a digital file.



1. A laser source sends a laser beam to solidify the material.
2. The elevator raises and lowers the platform to help lay the layers.
3. The vat contains the material used to create the 3D object.
4. The 3D object is created as parts are layered on top of each other.
5. Advanced 3D printers use one or more materials, including plastic, resin, titanium, polymers and even gold and silver.

Output: Product with rough surfaces due to layer by layer deposition. (See Figure 4)

Figure 4: one can easily see the rough surfaces on object

Source: Google

Some of the errors are already addressed above such as bulges on the edges, grudges, holes, faces normal, self-intersections, noise shells or manifold errors. Please note that the temperature control is a critical aspect and extrusion head speed is also taken into consideration; speed and temperature go together. [4]

These errors can be removed if we can upgrade the present machine to a new refined design which has a robotic arm and a scanner installed on all the faces of the machine which can remove all these in a single run gives object a smooth finish without using hands. This will increase the frequency of producing object and also it takes half the time to construct a complete object. (See Figure 5)

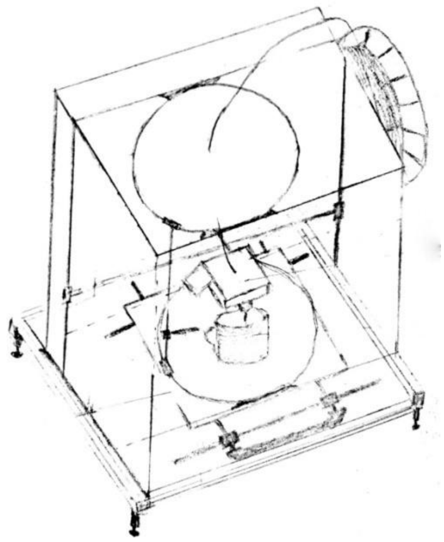


Figure 5: 3D printing proposed models that have an extra robotic arm for finishing and scanner that can control temperature, heat and speed of extrusion head.

This new design has a robotic arm for finishing and smoothing and scanner that scan the object and automatically maintain temperature, heat and speed of the extrusion head. It has all the features of removing, errors with accurate precision. This robotic arm has sensors to observe the design issues, and holes that sprinkle the chemical vapors on object and any sort of defects such as it detect the extra material that is present in the object, instead of this, it contains cutter and brush to provide the glossy and smooth finish to an object. Let us have a closer look on the robotic arm front view. (See Figure 6)

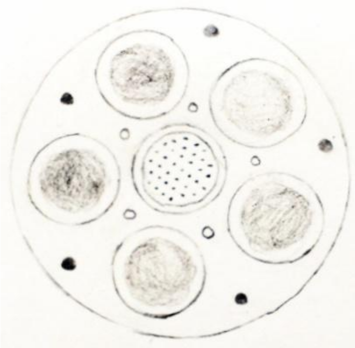


Figure 6: Robotic-arm front view

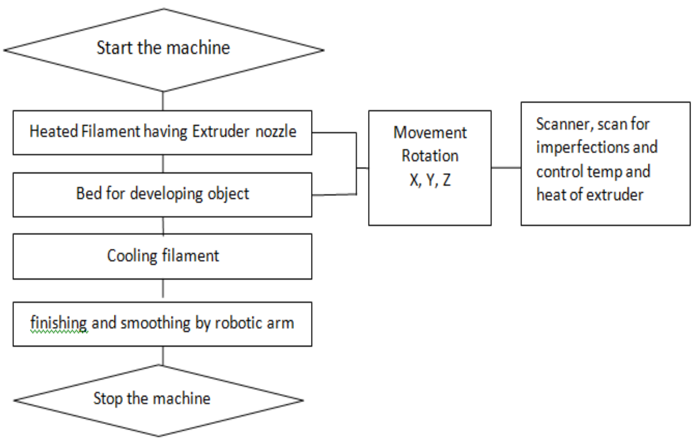
In the middle of robotic arm contain the brush arrangement, and all the rest have the same features as of Retouch3D provides, but all automated and follow the embedded instructions that is contained in their own memory

C. ALOGORITHM DEFINE THE COMPLETE FUNCTIONING OF THE NEW DESIGN

Algorithm 3Dprinter (X-Axis, Y-axis, Z-axis)

1. Start the machine by taking power from external source.
2. It will create a product through layer-based technology in which layer after layer of a particular material is deposited and solidified (basic machine designed by reprapp, makerbot etc).
3. Scanners on every face scan the object foe imperfections and control the temperature, heat and speed of extruder automatically; half the problems will be solved through scanner.
4. Sensors in robotic arm detect the extra edges by using the information contained in the memory registers.
5. After that it will cut extra edges or the leaked plastic from the outer and inner surfaces of the 3d object by using cutter in the arm. Then vapors of acetone sprouted by the arm to the object.
6. Brush is used for spreading the acetone and to give the glossy finishing to the object.
7. Desired product with a smooth and glossy finishing is produced.
8. Stop the machine.
9. End.

D. FLOWCHART



VII SURFACE FINISH PARAMETERS

Surface finish could be specified in many different parameters. A large number of newly developed surface roughness parameters were conceived and the instruments to measure them were developed, due to the need for different parameters in a wide variety of machining operations. Some of the popular parameters of surface finish specification are described as follows: Roughness average, R_a: this parameter is also known as the arithmetic mean roughness value, (arithmetic average) AA or (center line average) CLA. R_a is universally recognized and the most used international parameter of roughness. Therefore,

$$R_a = \frac{1}{L}\int_0^l \{Y(x)\}dx$$

Where R_a is the arithmetic average deviation from the mean line, L is the sampling length and y is the ordinate of the curve of the profile. It is the arithmetic mean of the deviation of the roughness profile [15], from the mean line. An approximation of the average roughness R_a may be obtained by adding the Y increments, without regard to sign and dividing the sum by the number of increments Therefore,

$$R_a = \frac{(Y_1 + Y_2 + Y_3 + Y_4 + \cdots + Y_n)}{5}$$

Root-mean-square (rms) roughness, R_q: R_q is the root-mean- square parameter corresponding to q [15],

$$R_q = \sqrt{\frac{1}{L}\int_0^1 \{Y(x)\}^2 dx}$$

Or approximately,

$$R_a = \sqrt{\frac{(Y_1{}^2 + Y_2{}^2 + Y_3{}^2 + Y_4{}^2 + \cdots + Y_n{}^2)}{n}}$$

Also, the surface roughness value is given by:

$$R_a = \frac{R_{max}}{4}$$

Where R_{max} is the maximum height and the maximum height of unevenness is given by:

$$R_{max} = \frac{f}{cot\emptyset + cot\beta}$$

Sm is the mean spacing between peaks known as roughness spacing parameter that used to describe the horizontal dimension of roughness.

$$S_m = \frac{1}{N}\sum_{n=1}^{n} S_n$$

R_{max} is the maximum roughness depth or the largest peak-to-valley depth over the sampling length. It was recorded to determine any major surface defect.

Maximum peak-to-valley roughness height, R_y or R_{max}: this is the distance between two lines parallel to the mean line that contacts the extreme upper and lower points on the profile within the roughness sampling length. Ten-point height, R_z: R_z is also known as the IS010-point height parameter and is measured on the unfiltered profile only. It is numerically the average height difference between the five highest peaks and the five lowest valleys within the sampling length. Skewness, R_{sk}: R_{sk} is the measure of the symmetry of the profile about the meanline. It will distinguish between asymmetrical profiles of the same R_s or R_q because it is sensitive to occasional deep valleys or high peaks. A negative skewness would represent profiles with deep scratches. A surface profile with valleys filled in or high peak shave positive skewness.

$$R_{sk} = \frac{1}{nR_q^3}\sum_{1}^{n} Y_i^3$$

where n=number of data points in the profile.

Kurtosis, R_{ku}: R_{ku} is a measure of the sharpness of the surface profile. If $R_{ku}<3$, then distribution has relatively few high peaks and low valleys. If $R_{ku}>3$, the surface has relatively many high peaks and low valleys. Therefore,

$$R_{ku} = \frac{1}{nR_q^4}\sum_{1}^{n} Y_i^4$$

Where n= the number of data points in the profile.

VII Function That Define The Smoothness Of The Desired Object

In mathematical analysis, the smoothness of object is a property measured by the number of derivatives it has which are continuous. A smooth function is a function that has derivatives of all orders everywhere in its domain. So, object Smoothness is defined by Differentiability classes, which are used classification of functions according to the properties of their derivatives. Higher order differentiability classes correspond to the existence of more derivatives.

Consider an open set on the real line and a function *f* defined on that set with real values. Let *k* be a non-negative integer. The function *f* is said to be of (differentiability) **class C^k** if the derivatives f', f'', ..., $f^{(k)}$ exist and are continuous (the continuity is implied by differentiability for all the derivatives except for $f^{(k)}$). That function *f* is said to be of **class C^∞**, or **smooth**, if it has derivatives of all orders.[1] The function *f* is said to be of **class C^ω**, or **analytic**, if *f* is smooth *and* if it its Taylor series expansion around any point in its domain converges to the function in some neighborhood of the point. C^ω is thus strictly contained in C^∞

Our object smoothness is defined by the function,

$$f(x) = \begin{cases} e^{-\frac{1}{1-x^2}} & \text{if } |x| < 1, \\ 0 & \text{otherwise} \end{cases}$$

So it of class C^∞, but it is not analytic at $x = \pm 1$, so it is not of class C^ω. The function *f* is an example of a smooth function with compact support.

VIII Fuzzy Logic Approach for Prediction of Surface Roughness

Surface roughness (Ra) is the most commonly used index to determine surface quality. It is a measure of smoothness for a machined surface. Surface quality is defined and identified by the combination of surface finish, surface texture, and surface roughness. Surface finish and surface roughness express and represent the same characteristic. Surface roughness is defined as the fine irregularities produced on a work piece by a cutting tool. Surface texture relates to deviations from a nominal surface that forms the pattern of the surface. The terms surface texture, surface finish, and surface roughness are used inter-changeably in industry as well as in this paper [16]

Numerous factors affect surface roughness in the machining process. While some factors are difficult or impossible to control, some controllable process parameters include feed, cutting speed, tool geometry, and tool setup. Other factors that are harder to control include tool vibration, work-piece and machine vibration, tool wear and degradation, and workpiece and tool material variability [17]. These factors interact to influence the quality of the surface finish produced.

This can be achieved with the help of Fuzzy logic and fuzzy inference systems which are proven to be effective techniques for the identification, prediction and control of complex, nonlinear, and vague systems. Fuzzy logic is particularly attractive due to its ability to solve problems in the absence of accurate mathematical models [18].

The fuzzyTECH 5.5i edition is a complete fuzzy logic software development system for all microcontroller devices. The graphical editor and analyzer tools provide efficient system design, optimization and verification. Ten data points are tested randomly from the machining experiment and fuzzy tech with same cutting speed, feed rate, and depth of cut. Table 6 shows the comparison of experimental data and the fuzzy output. The fuzzy output values are slightly higher than the experimental data because the fuzzy output weight for medium surface roughness is 2.12, which is higher than the first experimental data point (2.05μin).

Table 6 Comparison of experimental Ra and fuzzy output.

S. no	Feed rate	Cutting speed	Depth of cut	Experimental R_a	Surface roughness Fuzzy output	(ΔR_a)
1	40	4000	25	2.05	2.12	0.07
2	40	4000	13.5	1.25	1.31	0.06
3	80	1200	25	3.37	3.42	0.05
4	110	4000	25	2.09	2.12	0.03
5	195	4000	2	2.09	2.12	0.03
6	195	2600	2	2.8	2.87	0.07
7	240	2600	2	2.81	2.87	0.06
8	240	4000	2	2.8	2.87	0.07
9	240	1200	13.5	3.38	3.42	0.04
10	300	1200	25	3.4	3.42	0.02

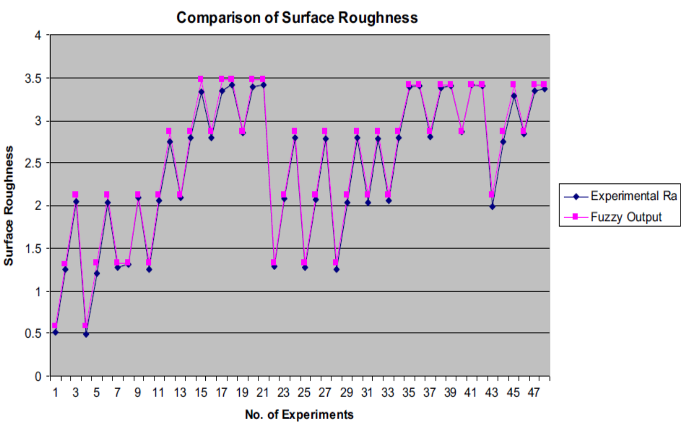


Figure 7..Excel graph for comparing experimental Ra and Fuzzy.

There-fore, the subsequent fuzzy output values appear higher than the experimental data. The important thing is that the gradient of the fuzzy output is very similar to that of the experimental data. This means that the fuzzy prediction can be accurate, if the construction of the output membership functions is correct. The difference of Fuzzy output and experimental Ra is shown in Figure 7. The test results show that a surface roughness model has been successfully built; hence one can predict the surface roughness before the machining process is performed.

XI CONCLUSION

In the future, researchers says that the whole of airplane, buildings, gadgets, ships will constructed by using different materials fused at the same time with a single machine in a single run, so this design will be effective as one can does have to don't take care of smoothing and finishing of the surfaces of different objects, if this design is implemented in context with 3D printer, this will increase production and provide in time availability of the product. Industrialist, hobbyists, architects and urbanites, which looks at what future typically 100 years from now, but if this design will be implemented it will took only 50 years to predicted that life and that is why this design is proposed so they well look upon other way and make its productivity by being used at every home.

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