



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 9, September 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com

Literature Review on Template-Based Reverse Engineering of Parametric CAD Models from Point Clouds

Suraj Khillare, Asst. Prof. Vaibhav Bankar

P.G. Student, Department of Mechanical Engineering, Vidarbha Institute of Technology Nagpur, Maharashtra, India

Assistant Professor, Department of Mechanical Engineering, Vidarbha Institute of Technology Nagpur,
Maharashtra, India

ABSTRACT: Reverse Engineering (RE) is generally utilized on the perspectives about planning of cutting edge items, programming or pictures. The 3D Mathematical displaying technique is made out of estimation gear and RE programming. The three-layered advanced estimation hardware is utilized to gather the model's point cloud information and reproduce computer aided design model. Geomagic Studio is generally used to process information and fix models, while Geomagic Qualify is broadly utilized in testing of reproduction model. The point cloud information of a turbine cutting edge is gathered and handled, a few innovations and steps counting pre-handling of point cloud information, polygon handling, surface fitting, three-sided network, model smoothing and polygon network enhancement are directed. At long last, it is being illustrated that 3D Mathematical displaying technique in Figuring out is fruitful.

KEYWORDS: Geomagic, Point cloud, CAD, Reverse Engineering.

I. INTRODUCTION

Reverse Engineering is the most common way of acquiring the computer aided design (PC helped plan) model of an article as indicated by its actual substance. From the beginning, it is frequently applied to displaying without drawings, by estimating the surface pieces of information of the genuine item and fitting standard highlights backward to acquire the computer aided design model of the article. With the advancement of land also, geological displaying and the shrewd city, figuring out has been applied to a more extensive scope of utilization situations, for example, human body structure remaking [1], old social relics reproduction [2], farming [3], producing [4,5], etc [6,7]. In the field of modern assembling, the utilization of picking apart without drawings has been bit by bit supplanted by displaying with drawings. For instance, in the field of modern computerized twins, picking apart is applied to the model development of genuine workpieces with a slight disfigurement in the computerized space, in view of plan drawings. The disfigurement of these workpieces might come from their assembling, transportation, or then again different cycles, which is inescapable. This distortion doesn't influence the typical work of the workpiece yet may influence some accuracy get together connections. A computerized twin developed by utilizing the high accuracy developed model in view of a genuine disfigurement workpiece can all the more precisely reflect different cycles in the actual space. The conventional converse designing strategy utilizes 3D (3-aspect) estimating hardware to gather the surface point information of the item, and the administrators select the surface focuses having a place with something similar qualities and utilize a proper defined surface to fit the model surface or fit it to a standard figure. The exactness and time for switch displaying rely upon the intricacy of the demonstrated article and the capability of the administrator, yet in any event, for talented administrators, it requires around a couple of hours to finish high-accuracy switch demonstrating of a typical part.

This displaying technique is tedious and depends totally on manual activity, and the precision of the model isn't steady a direct result of the utilization of manual judgment. For instance, Lukáš Jančar et al. utilized Geomagic to reconduct a differential stuff case, and the greatest deviation of the made model was ± 0.1 mm [8]. Feng Li et al. reconstruct a part in the SolidWorks 2013 climate, and the RMS (root mean square) of the converse model with a solitary wellspring of information is 0.5 mm [9]. With the improvement of the precision of 3D estimation sensors and estimation techniques, the time cost and exactness misfortune brought by the picking apart interaction influences the worth of high-accuracy 3D information. In the writing [9], creators utilized a material test to make up for information from a laser line scanner

to get to the next level the speed and exactness of acquiring 3D information. The information assortment speed expanded by 90%, what's more, the root implies square mistake of the ordinary element model is diminished from 0.53 mm to 0.07 mm. Zhaohui Geng proposed a calculation to produce the mean setup based on the information mists gathered from a few outputs and numerous parts. A Bayesian model with earlier information on creation cycles and scanners is indicated to display the measurable properties of the mean design, which could give a more exact outcome [10]. In any case, because of the impediment of displaying techniques, this high accuracy of 3D checking gear and point cloud information is challenging to be reflected in picking apart [11], particularly while fitting sporadic highlights.

II. RELATED WORK

Benko et al., 2002; Werghi et al., 1999

Obligated fitting strategies go for the gold significant reproduction by presenting a bunch of mathematical limitations that are characterized among the recognized mathematical highlights and upheld during the "Surface Fitting" step (Fig. 1) by figuring out an obliged streamlining issue. With this methodology, palatable outcomes are conceivable, however it takes a great deal of work to track down a decent arrangement of limitations, whether by using a programmed acknowledgment framework or depending on client input. The meaning of a feasible, non-inconsistent, and commonsense requirement set is a difficult endeavor that fundamentally affects the strategy's viability. Besides, the imperatives are regularly simply applied up to a specific resistance in most compelled fitting definitions (Buonamici and Carfagni, 2016).

Wang et al., 2013

All things considered, procedures in light of beautification fit surfaces freely to make a first-pass model. The first 3D information is overlooked during this stage, incredibly diminishing the numerical intricacy of the cycle yet in addition restricting its viability. Following this, a bunch of limitations and relations that are straightforwardly construed from the remade model are implemented by changing the surface boundary values.

Au and Yuen, 1999

The sort of model created at the finish of the remaking system and its convenience are extra pivotal variables that should be considered while assessing a RE technique's exhibition. Figures out regularly hold back nothing portrayal that is viable with somewhere around one significant, notable computer aided design/CAE programming bundle. They may likewise require a critical component tree and a particular record design, which are ordinarily gained through a difficult post-handling stage.

Durupt, Remy, Ducellier, and Pouille, 2014

In this present circumstance, an information-based worldview may make it conceivable to work on the RE of mechanical parts. As indicated by Fisher (2002), the types of average mechanical Parts "keep customary guidelines got from utility and custom" or designing plan," subsequently it very well may be commonsense to contribute the article's past information at the cycle's start. In fact, the fashioner is well educated about the part, which goes past the conceivable utilization of straightforward mathematical examination in light of the information gathered via programmed calculations. As a matter of fact, a figure out approaches an assortment of data sources and clues that could support remaking a precise computer aided design model, like the underlying reason for the part's plan, the subtleties of its assembling methodology, and the connections it should have with different parts. The pick apart can utilize this data to decide the right geography of the computer aided design model, the elements that make up the model, and even to pinpoint mathematical restrictions and exact aspects.

Bosché, 2010; Erdos, Nakano, and Vánca, 2014; Fayolle and Pasko, 2015; Robertson, Fisher, Werghi, and Ashbrook, 2000

Layout based remaking is one of the most effective information-based methods; in this class of procedures, some sort of computer aided design format is characterized toward the start of the RE cycle and used to direct the reproduction. By setting the deduced wanted caps for the pursuit cycle, the layout gives a model depiction of the shape that should be found among the assembled information.

Robertson et al., 2000

In a layout based remaking is utilized to manage low quality 3D information pre-handled utilizing a RANSAC approach (Fischler and Bolles, 1981); a progression of models which are known in geography (for example barrel

shaped opened part, square opened part, and so forth), characterized with deduced known mathematical limitations, are looked for and fitted through a hereditary calculation (Michalewicz, 1997) to the crude information. While managing boisterous information, which would somehow be trying to break down utilizing customary procedures, fulfilling results are introduced; yet, the remade models are as yet recognized by inexactly forced limitations, with a resistance controlling the requirements' severness.

Bey, Chaine, Marc, Thibault, and Akkouche, 2012; Bosché, 2010; Erdos et al., 2014

For structural designing goals, for example, checking the situation with business and modern designs, layout-based remaking has likewise been explored and utilized. In Bey et al. (2012), the creators focus on the remaking of round and hollow segments utilizing a probabilistic procedure. The format is used to assist with recognizing plumbing parts in the assembled information. The originator's aptitude is utilized to ensure the consistency of the remade model, for example, the precision of the channeling framework, which should stick as far as possible. The methodology is extended to torus and cuboids in Erdos et al. (2014).

Bespalov et al.

Our technique is unmistakable and involves examining the part to help the consideration of qualities and sort out them in a computer aided design tree. A type of "part's information extraction" is what this investigation is. Two "sorts of information" can be tracked down in the logical writing: producing information and useful detail. For example, give various extraordinary benchmarked datasets for surveying strategies for recovering computer aided design models and robotized arrangements. Two datasets of modern computer aided design models are remembered for these datasets, and they are classified by the creation interaction and article capability. The main class is partitioned into (1) cast machined parts and (2) kaleidoscopic machined parts. In the second, the capability is partitioned into seven divisions in light of seven different model sorts: linkage arms, lodging, sections, nuts, pinion wheels, screws, and springs.

Bernard et al.

In their proposition, endeavor to address the subject of "how to delay life span of the specialized data of assortment, files, and legacies destinations." The creators contend that information from the APTE technique's Utilitarian Chart Block should be promoted in this procedure. There are two unmistakable classes of information: outside information (socio-specialized setting climate, and so forth) and practical and mechanical elements (inside stream plan as it were: useful and underlying).

Han et al.

In this cycle, data about the part is separated while thinking about its current circumstance and lifecycle. According to our viewpoint, information can be separated into two classes: fabricating information (foundry, machining, and so forth) and utilitarian information, as made sense of in, the principal reference in segment B.2. We simply think about these information useful information and cycle information as a speculation. We presume both are notable. With regards to utilitarian information, no less than one individual — the individual upgrading the part knows about somewhere around one-use case for the part that was digitized prior to being update.

As was noted in the presentation, MATLAB and Siemens NX were utilized to carry out the proposed RE approach for the advancement cycle and the computer aided design climate, separately. The previous offers a prepared to-utilize climate for making and is outfitted with the Worldwide Streamlining Tool compartment and the Improvement Tool kit, which permit speedy and trustworthy admittance to various notable enhancement methodology. Moreover, it gives tasks between network information and computer aided design highlights, for example, the estimation of distance between a lattice surface and a computer aided design surface. The last option is a computer aided design programming bundle provided with language-nonpartisan Programming interface to give full admittance to computer aided design center application capacities. Microsoft's.NET System and Part Article Model (COM) have been utilized to make it feasible for MATLAB and NX to speak with each other.

Gao et al., 2004; Langbein et al., 2001; Langbein et al., 2004)

Concerning layered rightness of the remade objects, it has been shown that the proposed strategy performs imperceptibly better compared to SoA business RE programming arrangements. Moreover, contrasted with the traditional confined fitting strategies, it empowers the recovery of "great" computer aided design models, that is to say, models with perfectly applied hard requirements. This component is a drawn out objective of RE procedures (see Beautification draws near), and it is one of the vital achievements of the system that is being examined. Moreover,

Wang, Gu, Yu, Tan, and Zhou (2012) noticed that recovering a cooperative parametric demonstrating history has various advantages in computer aided design applications.

Khalfaoui et al.

A clear and speedy HPR administrator can be utilized from different points to mirror different securing perspectives. An assortment of nbVWPs perspectives are browsed a predetermined rundown of areas around the thing to be practically figured out, as per system [7]. The technique for Katz et al. [6] is utilized to eliminate stowed away focuses. The picked HPR administrator decides the fact of the matter cloud's detectable focuses from a specific vantage position (Figs. 5.b and 5.c). The discovery of stowed away spots utilizing an octree-based deterioration has been sped up using an enhanced variant of this methodology.

Dorigo, Di, and Gambardella, 1999; Karaboga and Basturk, 2007

It has been shown that utilizing the PSO technique and picking a strange blunder metric (Eq. (3)) instead of the more well known mean Euclidean distance (Eq. (2)) function admirably for the application viable. It is essential to remember that the recommended approach doesn't rely upon a particular class of enhancement calculations; thusly, future tests will zero in on the execution of elective populace based methods (which, as we would like to think, address the class of calculations the most ideal to resolve the depicted issue) or the making of impromptu methodologies and measurements.

Fischler et al.

Numerous strategies that endeavor to fit key mathematical natives in point mists utilize the mathematical crude earlier. fostered the notable arbitrary examining agreement (RANSAC) technique to separate shapes from the point cloud by haphazardly recognizing negligible sets and making related shape natives [5]. A programmed strategy to find central shapes in scattered point mists has been proposed by Schnabel et al. [6]. They utilize an irregular examining method in light of the RANSAC worldview to track down planes, circles, chambers, cones, and torii. The subsequent portrayal just comprises of shape intermediaries for models whose surfaces are made up just of these essential shapes, for example, computer aided design models.

Wang et al.

A framework has been created by Wang et al. to create 3D models from limit surface lattices of modern parts. It fabricates all essential parts highlights by utilizing a gap and-vanquish strategy. To make the last model, certain displaying processes are done as per the mathematical and topological connections between the elements. Once more, the result is a dead B-Rep model that is hardly modifiable in the PDP's later stages. Distinct et al. [20] depict another semi-computerized strategy for reproducing 3D gathering models through the division, part recognizable proof, and design ID processes. To find parts in a data set and reproduce a gathering model, point cloud information gathered from examining is utilized.

Bénire et al.

A computerized technique for making models from 3D cross sections has been created by Bénire et al. The procedure, notwithstanding, just applies to networks delivered through mechanical article discretization. At last, Xu et al's. demonstrating way to deal with reproducing a cycle from multi-view pictures is introduced in. The pieces are drafted utilizing an intelligent part displaying stage and afterward fitted to the instrument point cloud. A pre-recorded video clasp of the system's movement can be utilized to foresee the movement boundaries once the parts are adjusted utilizing a streamlining step.

Yang Jin et al.

Studies and examinations have shown that the SA setting factors, like introductory temperature, beginning area, and greatest cycles, obviously impact the fitting nature of the outcomes. By changing its setting settings, the SA calculation has gone through various endeavors to be streamlined. For example, Yang Jin et al. examined what boundary choice meant for the exhibition of the SA calculation to address the ceaseless organization plan issue, however their outcomes and consideration were principally centered around the temperature decline rate and emphasis number, without considering different elements that likewise impact the viability of their SA-based streamlining.

Shi-hua Zhan et al.

To take care of the Mobile Sales rep Issue (TSP), recommended another Rundown Based Reproduced Strengthening strategy (LBSA), which requires a clever rundown based cooling timetable to control the decrease in temperature. Their methodology takes on the temperature list iteratively as per the geography of the issue's answer space. On the TSP

benchmark issue, the proficiency and awareness of the boundary of the rundown based cooling plan are illustrated. This approach creates and tests a rundown of starting temperatures, however again, it improves the SA activity by considering temperature.

Bellio et al.

The Educational plan Based Course Timetabling (CB-CTT) issue was tackled by Bellio et al. utilizing a solitary stage SA streamlining. To depict the connections between the main solver boundaries and the properties of the occurrence under assessment, they gave an exhaustive and measurably sound system for the boundaries tuning activity. The method moves toward the choice of the boundaries as a grouping issue and fosters a standard for choosing the arrangement of boundaries probably going to perform well for a specific example in view of given highlights. To enhance the previous discoveries, their examination was in any case confined to less models, and just 10 out of the 21 occurrences moved along.

Atiqullah et al.

They have zeroed in on exceptional concentrate on working on the union and related conduct of tempering calculations by changing its boundaries, otherwise called the cooling plan. They formulated a procedure that consolidates algorithmic and parametric expansions to tweak the SA calculation. Rather than the muddled timetables they used to construct a welded shaft using their adjusted SA, they used a less complex cooling calculation. Once more, a couple of elements are viewed as for this situation to further develop the SA calculation, most quiet the cooling plan.

Azernikov et al.

A catalyst strategy for surface recreation from muddled focuses was created by Azernikov et al. Their methodology depends on feature recreation and the extraction of a network diagram from the Various leveled Space Deterioration Model (HSDM). Continuous recreation is performed utilizing octree. Because of the way that the produced network doesn't contain exact data on the constituent elements (like filets or chamfers), this portrayal is suitable for handling huge scope 3D information. The created models, be that as it may, are frozen cross sections absent any and all parametric attributes and gathering data, making them basically futile in the PDP's last option stages.

III. METHODOLOGY

The examination and handling of mathematical models involving man-made consciousness techniques has as of late acquired fame in the PC sciences. This is particularly legitimate while pondering 4D point cloud division and order [5][9]. Notwithstanding, while utilizing directed learning draws near, colossal datasets that may likewise should be labeled are required for these procedures. Consequently, having the option to depend on promptly accessible and solid enormous datasets is one of the significant worries while making such a learning method. It can require a long investment to create and handle every one of the information, subsequently this is certainly not a simple errand. Truly, the procurement and handling time for the Figuring out process [8] could fluctuate from a couple of moments to a few hours [1]. This is vigorously affected by the innovation utilized (like LIDAR, laser scanner, organized light scanner, RGB-D sensor), the obtaining system utilized by the administrator, and the intricacy of the item that should be figured out. For example, filtering a direct sonotrode from different points (Fig. 4.1) and handling the created point mists (for example cleaning, separating, enlistment, improvement, fitting) can require up to a several minutes. Accordingly, attempting to physically make huge number of point mists utilizing conventional figuring out approaches on more convoluted true actual things or environmental factors is unrealistic.

The computer aided design models of the parts or gatherings are utilized to consequently make point mists as a feature of the proposed virtual Figuring out strategy. In this manner, our technique can use promptly accessible data sets that contain countless computer aided design models (like GrabCAD, TraceParts, and 4DModelSpace). Different sensible relics that would appear assuming the fitting genuine things were digitalized with a genuine obtaining gadget are integrated into the last point mists. The produced point mists could promptly acquire from the accessible data assuming that the computer aided design models are marked or improved with semantic data. In this review, which centers around the sensible age of point mists, the legacy system isn't created. Because of the methodology's finished definition, elective point mists might be created for a given computer aided design model to mimic different filtering settings (like the sort of procurement gadget and related control boundaries, ecological variables, and the obtaining grouping utilized). Therefore, an assortment of as-examined point mists can be delivered rapidly.



Figure 4.1: Real sonotrode (a1) scanned to get point clouds that have been post-treated (a2). CAD model of a sonotrode (b1) virtually reverse engineered following three parameterizations of the proposed framework (b2-b4).

Understanding the numerous curios that can arise during a genuine figuring out meeting is urgent for delivering sensible as-checked point mists. Truly ancient rarities can be brought about by pretty much confounded peculiarities that emerge from, and additionally between, the obtaining gadget (for example type, control boundaries), the digitalized object (for example material, variety, shape, and size), the administrator (for example securing procedure, experience), and the climate (for example light, temperature, vibration). Despite the fact that there might be different causes, there are five essential classifications in which the consequences for the subsequent point mists can be ordered (Fig. 4.2): non-uniform examining, missing information, skewed point mists, uproarious information, and exceptions.

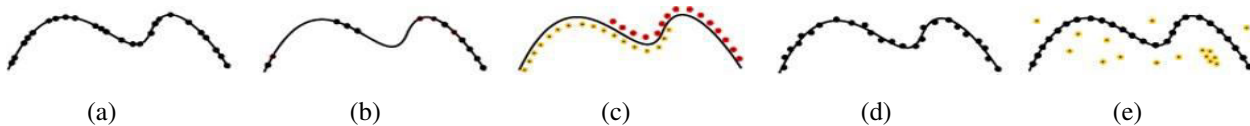


Figure 4.2: Different artifacts: (a) non-uniform sampling, (b) missing data, (c) misaligned scans, (d) noisy data and (e) outliers[2].

The proposed approach is made out of a few modules (Fig. 4). It begins by creating a triangle network wrapping the computer aided design model to be figured out. The computer aided design model can either be a solitary part or a get together of a few sections. The subsequent watertight cross section is then examined to get a more reasonable dissemination of focuses. The impediment peculiarity is then mimicked utilizing a secret point removal calculation sent off from a few perspectives. Subsequently, the subsequent point cloud is fragmented and a few information are absent. Then, a misalignment method can alternatively be utilized to take into ac-include the way that, all things considered, figuring out the item is obtained from a few perspectives. Consequently, this technique can alter the position and direction of the fact of the matter mists' reference outlines with respect to the reference casing of the first computer aided design model. The virtual Picking apart interaction closes by producing commotion and by embedding exceptions.

Table 1 describes the various modules as for their capacity to consolidate the previously mentioned relics. It plainly shows the complementarity of the various modules to accomplish the ideal outcomes, for example having the option to produce as-checked point mists consolidating curios seeming while filtering genuine actual items. The methodology is secluded and every module is constrained by boundaries which are itemized in the following segment.

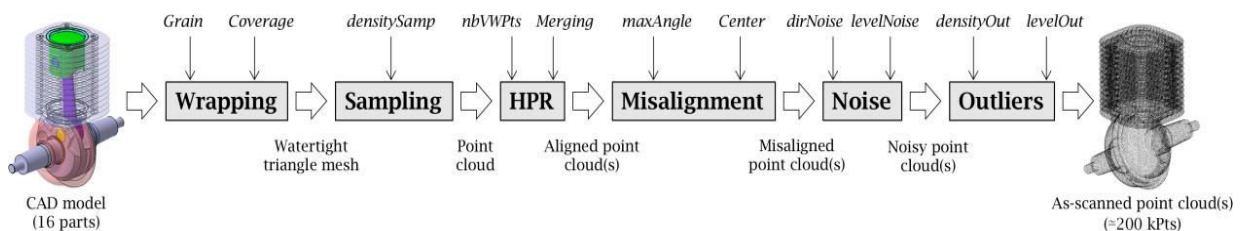


Figure 4.3: Virtual Reverse Engineering modular framework generating as-scanned point clouds from CAD assembly models.

IV. CONCLUSION

We In this paper, a computer aided design model as an earlier data of figuring out strategy is introduced. Through the enrollment of the computer aided design model and direct cloud information toward complete the consistency transformation of the two model direction frameworks, the computer aided design model gives the position data of each

component and the association and limitation data between highlights as an earlier state of the displaying system. Workpiece point cloud information is sectioned by various element locales, and a NURBS surface is utilized to recreate a solitary component surface and reproduce numerous element surfaces. Contrasted and the ordinary manual demonstrating relying upon manual activity and the traditional normal include demonstrating relying upon highlight acknowledgment, the technique is appropriate for turn around designing with drawings of workpieces with slight sporadic disfigurement contrasted and a computer aided design configuration model, which is especially reasonable for building a bunch result of genuine models of similar sort of workpieces and can incredibly further develop the displaying effectiveness what's more, the displaying accuracy security. The strategy introduced in this paper actually has certain constraints, and the consensus of items with complex blend relationship and complex demonstrating surfaces includes should still up in the air through tests. The impact of the cross-section size characterized by the computer aided design model on the model development still should be explored different avenues regarding 3D information of different scenes. In the subsequent stage, we will change the boundaries of the 3D information obtaining hardware and the exploratory climate to confirm the strength of this technique in various conditions, models and gear boundaries, and further explain the use situations of the technique proposed in this paper what's more, the choice strategy for explicit boundaries.

REFERENCES

- [1] Turek, P.; Filip, D.; Przesłowski, Ł.; Łazorko, A.; Budzik, G.; Snela, S.; Oleksy, M.; Jabłoński, J.; Ślep, J.; Bulanda, K.; et al. Manufacturing Polymer Model of Anatomical Structures with Increased Accuracy Using CAx and AM Systems for Planning Orthopedic Procedures. *Polymers* 2022, 14, 2236. [CrossRef] [PubMed]
- [2] Ullah, A.S.; Watanabe, M.; Kubo, A. Analytical point-cloud based geometric modeling for additive manufacturing and its application to cultural heritage preservation. *Appl. Sci.* 2018, 8, 656.
- [3] Kwon, K.; Mun, D. Iterative offset-based method for reconstructing a mesh model from the point cloud of a pig. *Comput. Electron. Agric.* 2022, 198, 106996. [CrossRef]
- [4] Popis,ter, F.; Popescu, D.; Păcurar, A. Mathematical Approach in Complex Surfaces Toolpaths. *Mathematics* 2021, 9, 1360. [CrossRef]
- [5] Wang, Z.; Shi, Y.; Wang, X. NURBS Function Closed-Loop Mapping Trajectory Planning of Serial Robotic Plasma Cladding for Complex Surface Coatings. *Int. J. Adv. Manuf. Technol.* 2022. [CrossRef]
- [6] Geng, Z.; Bidanda, B. Review of reverse engineering systems—current state of the art. *Virtual Phys. Prototyp.* 2017, 12, 161–172. [CrossRef]
- [7] Vitali, A.; Rizzi, C. Acquisition of customer's tailor measurements for 3D clothing design using virtual reality devices. *Virtual Phys. Prototyp.* 2018, 13, 131–145. [CrossRef]
- [8] Jančar, L.; Začal, J.; Folta, Z. Reverse Engineering of the Gearbox Case. In *Current Methods of Construction Design*; Springer: Berlin/Heidelberg, Germany, 2020; pp. 79–87.
- [9] Li, F.; Longstaff, A.P.; Fletcher, S.; Myers, A. Rapid and accurate reverse engineering of geometry based on a multi-sensor system. *Int. J. Adv. Manuf. Technol.* 2014, 74, 369–382. [CrossRef]
- [10] Geng, Z.; Sabbaghi, A.; Bidanda, B. Reconstructing original design: process planning for reverse engineering. *IJSE Trans.* 2022, 1–14. [CrossRef]
- [11] Helle, R.H.; Lemu, H.G. A case study on use of 3D scanning for reverse engineering and quality control. *Mater. Today: Proc.* 2021, 45, 5255–5262. [CrossRef]
- [12] Zhang, K.; Qiao, S.; Wang, X.; Yang, Y.; Zhang, Y. Feature-preserved point cloud simplification based on natural quadric shape models. *Appl. Sci.* 2019, 9, 2130. [CrossRef]
- [13] Sarawit, A.; Kim, Y.; Bakker, M.; Peköz, T. The finite element method for thin-walled members-applications. *Thin-Walled Struct.* 2003, 41, 191–206. [CrossRef]
- [14] Hannaby, S. A mapping method for mesh generation. *Comput. Math. Appl.* 1988, 16, 727–735. [CrossRef]



Impact Factor: 8.423



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details