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WEB APPLICATION FOR 3D SOFTWARE COMPARISON CONSIDERING PLM SYSTEM

3D-S SZOFTVER WEB ALKALMAZÁSÁNAK ÖSSZEHASONLÍTÁSA A PLM RENDSZER ASPEKTUSÁBÓL

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Abstract

3D product software has a huge market in various fields like Engineering, Medicine, Entertainment, Gaming, Tourism and many more. There are different kinds of applications modeled in 3D environments for example CAD, CAM applications, 3D printing applications in the engineering field, applications for analysis of human body parts in the medical field, (Visual Effects) VFX based applications in the movie industry, virtual tour based applications in Tourism, 3D Games applications, etc. But, it is difficult to compare and choose the appropriate 3D product modelling application in a relevant field according to the requirements. This article introduces the concept to store the relevant information of the 3D software. Further, a database is created to store the information of 3D software for the (Product Lifecycle management) PLM system. Here, statistical study is conducted first to compare the best possible 3D software of same category in terms of features and operation performed on the product model. Finally, a web application is proposed based on the database which compares existing 3D product modelling software in the market.

Keywords: *Web Application, Database Management, 3D Software, CAD Software, CAM Software, 3D Printing Software*

Absztrakt

A 3D-s szoftverek hatalmas piaccal rendelkeznek a legkülönbözőbb szakterületeken, például a mérnöki és orvostudományokban, szórakoztató- és játékiparban, a turizmusban és így tovább. Eltérő típusú alkalmazásokat fejlesztettek 3D-s környezetre, vegyük példaképp a CAD- és CAM-alkalmazásokat a műszaki tudományok területén, az emberi test részeinek analizálására alkalmas orvosi programokat, a filmipar vizuális effektjeit életre hívó alkalmazásokat, az idegenforgalmi célokat szolgáló virtuális séta programokat, a 3D-nyomtatást, 3D-s játékokat stb. Meglehetősen nehéz egymással összehasonlítani és kiválasztani a szakterület által támasztott követelményeknek leginkább megfelelő 3D modellező alkalmazásokat. Jelen tanulmány egy, a 3D-s szoftverek lényeges információinak tárolására alkalmas koncepciót mutat be. Mindemellett a (Product Lifecycle management) PLM rendszer3D-s szoftverek információit rögzítő adatbázis elkészül. Először egy statisztikai elemzés hasonlítja össze egymással az azonos kategóriába tartozó legjobb szoftvereket tulajdonságaik és működésük tekintetében. Végül webalkalmazás születik a piac által kínált 3D modellező szoftvereket összehasonlító adatbázis alapján.

Kulcsszavak: *Webalkalmazás, Adatbázis-kezelés, 3D szoftver, CAD szoftver, CAM szoftver, 3D* nyomtatásra szolgáló *szoftver*

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INTRODUCTION

The advancement of the present world is the outcome of technology evolution. In this era, the virtual world is a popular way to explain the thought processes of a human. It can be applicable to any profession like engineering, medicine, tourism, hotel management, entertainment, etc. The virtual world is constructed using 3D software. Further, the three dimensional product designed in the virtual world undergoes various analyses and optimization processes according to the requirements. There is plenty of 3D software present in the market so it is difficult for a user to search the best possible option as per the specialization. This paper provides the solution by proposing a web application named, "My 3D Software" to choose the 3D software based on the specialization. Here, a database is constructed by creating various types of tables and stores the relevant information of the 3D software. As, virtual world has vast areas of application, author focused on the mechanical engineering domain. Further, PLM (Product Lifecycle Management) system is considered to explain the concept where CAD (Computer Aided Design), CAM (Computer Aided Manufacturing), CAE (Computer Aided Engineering) & 3D Printing is explained. CAD software has made complex machines with multi-millions of connected components possible, and with an absent of any other options these software are a must for designing functional objects that need to work mechanically in a real world device. Intuitively to build these complex architectures the software itself is going to be sophisticated, Therefore the decision of choosing one brand out of the many brands in the market require a broad range of knowledge, for instance some products may not give direct control over a design priority vs another, artistic work vs industrial mechanical parts. For a printable 3D models a much different aspects and priorities requires than for designing a real functioning nanometer integrated circuits in silicon chips or even a much larger construction of an airplane where the initial design needs to be backed up with strong analysis, inspection, testing, simulation and measure of each the integrated parts over the life cycle of a product. Therefore, choosing CAD, CAM, CAE and 3D printing software is a challenging task. From that perspective, the approach in this paper is comparing some elements of professional software packages, so the ability to create an advanced complex engineering mechanism from the basic components and compose mathematically the vertices, edges, and faces. The work starts with a general concept to store the information of any 3D software in form of a table. Then, a CAD software based table is created with CAE, CAM, 3D printing software as a depending software. Further CAD software information is stored in the table in descending order according to the ranking and a database is created based on the table. The ranking is based on the survey. Finally, a web application using MySQL database is proposed.

PRELIMINARY SURVEY

PLM has a holistic approach to the management of a product [2]. It addresses five phases of product lifecycle and nine components where CAD, CAM, CAE and 3D Printing are the part of different component layers and phases. Our research work is focused on the product modeling where 3D products are designed using CAD software, analysed, optimized using CAE software, manufactured using CAM software and printed using 3D Printing software .Overall, 3D Product modeling is a step by step process and all of them (CAM, CAE, 3D Printing) require CAD files for their operations. It starts with the design phase where a 3D product is designed and stored in a file format (IGES, STEP, CATPRODUCT, NEU, SLDASM, etc). The next step is the testing and correction phase, where the 3D product undergoes analysis, optimization and value of parameters in CAD file can change according to the physical world situation. The final step is the manufacturing or printing phase where the corrected 3D product file is ready for manufacturing or printing. All the CAD software

companies can a file format support package for CAE and CAM. For CAE & CAM, the most common CAD file format are STEP and IGES as they are a neutral format. In the case of CAM, the neutral file format is translated into manufacturing directives for CNC (Computer Numerical Control). Of course, it doesn't mean that it is the only format used by CAE and CAM. As 3D printing is emerging technology, most common CAD file formats are STL and VRML. The CAD software based companies like Dassault Systèmes, Autodesk, PTC, Siemens, etc. provide the above mentioned file format support with their own CAD file formats. Our research work starts with the market survey of CAD, CAE, CAM and 3D Printing software. According to the market share survey of CAD software [17] in 2016, SolidWorks software has the maximum market share. Moreover, the top 15 CAD software companies have 82.6% of the total market share.

Similarly, a market survey of high-end CAM software in 2016 [18] mentioned that Mastercam software has the maximum market share. Also, the market share of CAE software in 2013 [22] mentioned that ANSYS software has a maximum market share. In the proposed work, the ranking of CAD, CAM and CAE software is based on the market share. The 3D printing software is ranked in the survey [23] based on the social media score, website score and 3D printing community where Blender software scores the most. Based on the survey, information of some of the best software of the CAD, CAM, CAE, and 3D printing software has been gathered. Features are considered as an information type in the context of our research. According to the survey data, the information gathered for the features of some of the best CAD software are in the reference: SOLIDWORKS [3], Fusion360 [6], AutoCAD [7]. Similarly, information on features gathered from some of the best CAE software are in the reference: ANSYS [10], MathWorks [11], Abaqus [12]. Information on features gathered from some of the best CAM software are in the reference: MasterCAM [14], HSMWorks [15], Powermill [16]. Information on features gathered from some of the best 3D printing software are in the reference: Blender [21], SketchUp [22] and SolidWorks [23]. Tables are created based on the feature as the information types obtained from the references. These tables will be discussed in the next section. Then after, a database is created based on the tables. Finally, a web application [1] is created based on the database. The details of the web application will be discussed in the practical approach section.

RESEARCH CONCEPTS

In this research work, the general model is proposed that can be applicable to compare 3D softwares in any field. It can be Engineering, Medical, Tourism, Entertainment, etc. According to the proposed concepts, the 3D application is divided into two categories, Dependent Application and Depending Application. The 3D software application to be compared is called *Dependent Application*. The application which depends on the outcome of the Dependent application is called *Depending Application*. Based on the categories, a table is created as shown in Table 1. The Dependent Application column stores the information of software that generate the application. Here, Software N is the last software of the table. The software are arranged in the table according to the ranking in the Rank column. The ranking is based on market shares, satisfied customers, number of features available etc. The Dependent Application Feature stores the feature of software in the same order of ranking. The Dependent Application package stores the package corresponding to the feature/s of the software. Here, the term Package is equivalent to a folder that stores files. Of course, files are equivalent to features here. Also the term Feature defines the technical specification of the software. The Dependent Application Domain stores the domain information of the package. It can be software, mechanical, electrical, electronics, etc. The Depending Application Support column stores the boolean value as it can be possible that the outcome file format of some of the Dependent Application is not supported by the application.

Further, if the Dependent Application is supported, the next step is to figure out which features and packages are supported by the Depending software. It may also possible that the user wants the best software option for the Depending software. Considering this scenario, a separate table for the Depending Application has been created with the same rules of the Dependent software as shown in Table 2.

Dependent App	Rank	Dependent App Features	Dependent App Package	Dependent App Domain	Depending App Support	Depending App Features	Depending App Package
Software A	1	Feature A1, Feature A2	Package A1	Domain M, Domain N	Yes	Feature X1,	Package X1
						Feature X2, Feature X3	Package X2
Software B	2	Feature B1, Feature B2,	Package B1	Domain M, Domain O	No	N.A.	N.A.
		Feature B3	Package B2	Domain P			
Software C	3	Feature C1,	Package B1	Domain N, Domain O,	Yes	Feature Z1, Feature Z2	Package Z1
		Feature C2,	Package B2	Domain P, Domain Q			
		Feature C3	Package B3	Domain T			
Software N	N	Feature N1 Feature N2	Package N1	Domain Y	Boolean Value	Feature K1 Feature K2	Package K1

Table 1 Table for 3D software comparison

Depending App	Rank	Depending App Features	Depending App Domain
Software K	1	Feature K1, Feature K2,	Domain M,
		Feature K3, Feature K4	Domain P
Software L	2	Feature L1, Feature L2	Domain O, Domain Q
Software J	3	Feature J1,	Domain T, Domain S,
		Feature J2, Feature J3	Domain Q, Domain M

Table 2 Table for Depending software comparison

Taking the general model into account, the PLM system based model is created with a CAD application as the Dependent Application, CAE, CAM and 3D printing as the Depending Application. Based on the market survey for CAD software, we have created a table for the CAD software comparison as shown in the table 3. Further, softwares are ranked according to the market share percentage. The table stores the information of the CAD application like Software name, Rank, CAD features, CAM support, CAE support, 3D Printing support, CAM features, CAE features, 3D Printing features and the domain where CAD software is used. This table shows various primitive types stored in different columns. Here, each row in the CAD Application, CAD Package, CAD Domain, CAM Package, CAM Domain, 3D Printing Package, 3D printing Domain column stores the information as a string value, the Rank column stores the integer value, CAD Features, CAM Features and 3D Printing Features cloumn stores the information as collection of string value depending on the related package.

CAD Application	Rank	CAD Features	CAD Package	CAD Domain	CAM Support	CAM Feature	CAM Package	CAM Domain
String value	Integer value	String values	String value	String value	Boolean value	String values	String value	String value

CAE support	CAE feature	CAE Package	CAE Domain	3D Printing support	3D Printing feature	3D Printing Package	3D Printing Domain
Boolean value	String values	String value	String value	Boolean value	String values	String values	String value

Table 3 Table for CAD software comparison

Similarly, tables are created for the Depending software like CAM, CAE and 3D printing as shown in the table 4, 5 and 6. Every row in the CAM Application, CAM Package, CAE Application, CAE Application, 3D Printing Application and 3D Printing package stores the information as a string value, the Rank column stores the integer value and CAD Features, CAM Features and 3D Printing Features stores the information as collection of string value depending on the related package.

CAM Application	Rank	CAM Features	CAM Package
String value	Integer value	String values	String value

Table 4 Table for CAM software comparison

CAE Application	Rank	CAE Features	CAE Package
String value	Integer value	String values	String value

Table 5 Table for CAE software comparison

3D Printing Application	Rank	3D printing Features	3D Printing Package
String value	Integer value	String values	String value

Table 6 Table for 3D Printing software comparison

It is important to note that Features and Packages in Table 4, 5 and 6 are not the same as in table 1 because the later case is related to the feature and package supported by the CAD software.

PRACTICAL APPROACH

Based on the tables from PLM system based model, a database is created and a web application is proposed. The specification of technology used is as follows:

Web Server: Glassfish
Database Server: MySQL
Technology/Language: Java Servlets,JSP (JavaServer Pages),JDBC (Java Database Connectivity), JSTL (JavaServer Pages Standard Tag Library), HTML, CSS, MySQL

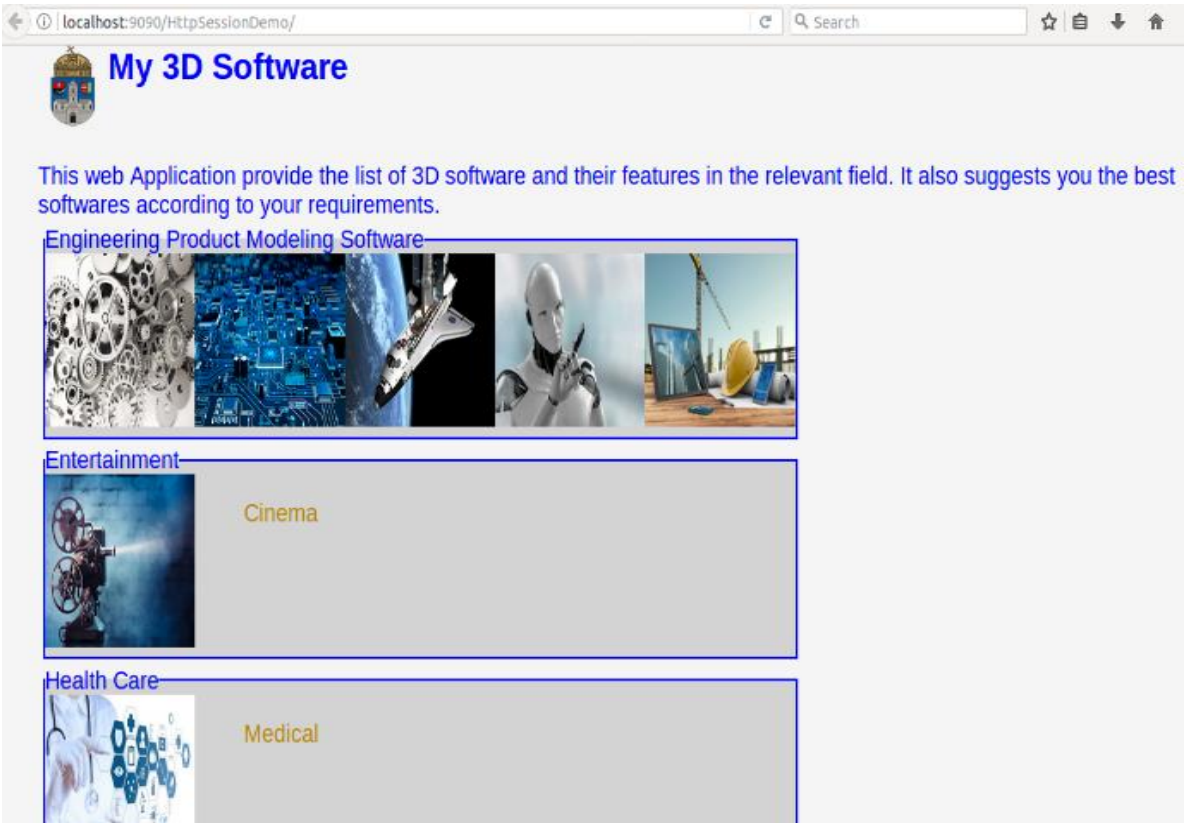


Figure 1 My 3D software welcome page

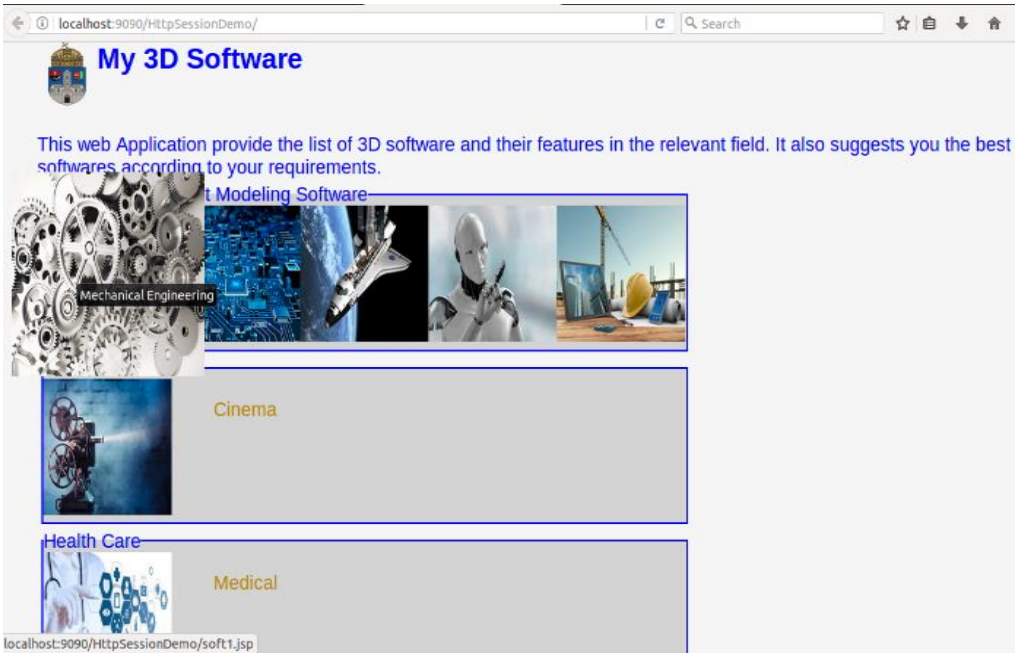


Figure 2 My 3D software welcome page when Mechanical Engineering selected

The proposed application name is "*My 3D Software* ". For the welcome screen, the web page is divided into sections named Engineering field, Entertainment field, Medical field, Tourism field, and Interior decoration field as shown in figure 1. In the engineering field section, subsections are created as mechanical engineering, electronics engineering, aeronautical engineering, robotics engineering and civil engineering (ordering is from left to right) as shown in the figure 2. When the user clicks on the mechanical engineering subsection, it will navigate to the CAD system page as shown in Figure 3. This page provides the choice to the user for choosing the best CAD software. CAD software and CAD features are the mandatory boxes and the rest of them are optional boxes. The Check box next to CAD software, CAE software, CAM software indicate that if the user choose this option, the corresponding Features option is disabled automatically. It means the user can choose one out of the Software box and Features box. The scenario of user activities are explained in Table 7.

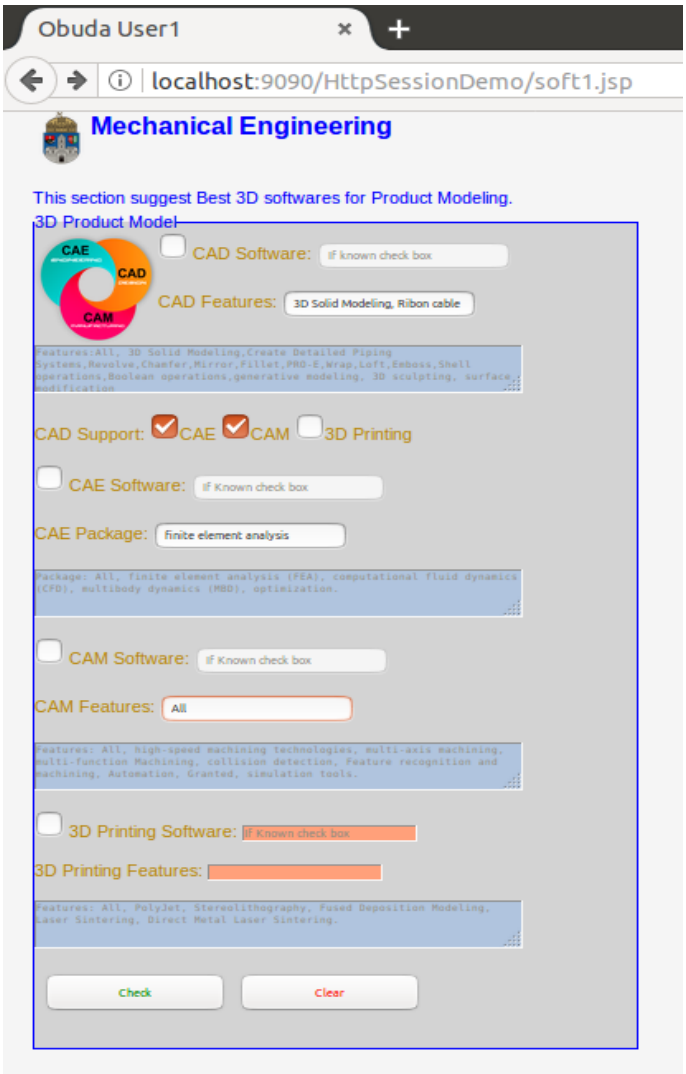


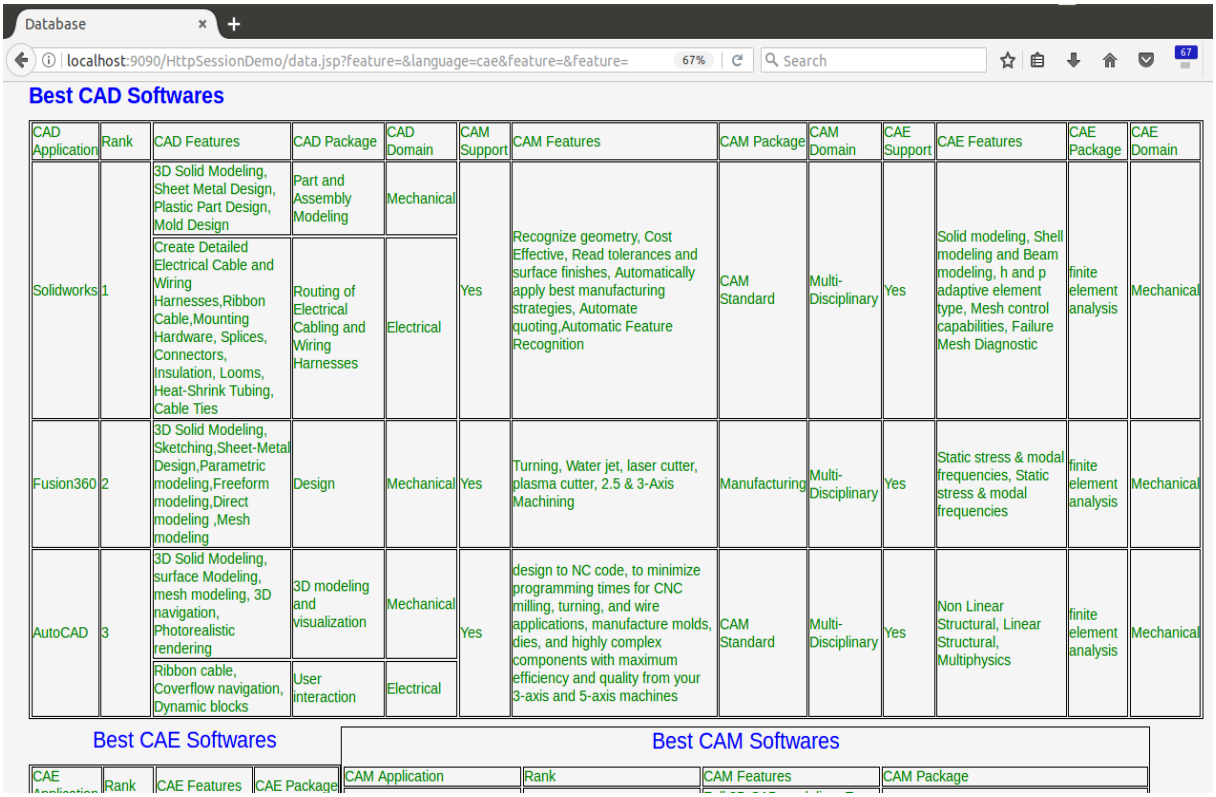
Figure 3 My 3D Software CAD system page

After choosing the option, when the user clicks to the Check button, it will navigate to the CAD table page as shown in the figure 4 and 5.

User Knowledge	User Requirement	Mandatory box		Optional box		Output Table
		Box	Value	Box	Value	
No information	user want to know best CAD software	CAD Feature	All	N.A.	N.A.	CAD Table
No information	user want to know best CAD, CAM, CAE, 3D Printing software	CAD Feature	All	CAM Features, CAE Features, 3D Printing Features	N.A.	CAD Table, CAM Table, CAE Table, 3D Printing Table
Features information	user want to know best CAD software with mention features	CAD Feature	Choose features from the box (grey color)	N.A.	N.A	CAD Table with mention features
Features information	user want to know best CAD, CAM, CAE, 3D Printing software with mention features	CAD Feature	Choose features from the box (grey color)	CAM Features, CAE Features, 3D Printing Features	Choose features from the box (grey color)	CAD Table, CAM Table, CAE Table, 3D Printing Table with mention features
Software information	user want to know CAD software features and rank	CAD software	software Name	N.A.	N.A	CAD Table with mention software
Software information	user want to know CAD, CAM, CAE, 3D Printing software features and rank	CAD Feature	software Name	CAM Features, CAE Features, 3D Printing Features	software Name	CAD Table, CAM Table, CAE Table, 3D Printing Table with mention software

Table 7 Table for User Activities

This table explains some of the main user activities. The user may have different requirements for example the user may want to know about best CAD software, CAM and CAE software. In this case, expected tables can be evaluated from the table of user activities. Let us the consider an example using figure 3 where user has CAD Features information as shown in the figure 3. Of course, the user chooses this information from the Feature box (grey color). In this case, CAD Software box is disabled and the box next to it is unchecked. Also, the user may want to check best CAM and CAE software. Hence, the CAM and CAE check boxes are checked but the 3D printing check box is unchecked. As a result, the 3D printing Software box and 3D Printing Features box both are disabled. Further, the user has CAE Features information but no information of CAM. In case of CAM, the user can write "All" in the CAM feature box. Here, CAE Software box and the CAM Software box is disabled. When the user clicks on the check button, it will navigate to "My 3D Software" CAD table page as shown in figure 4 and 5. It should be noted that both figures belongs to the same page. In figure 4, it displays the information of CAD table according to the chosen parameters, whereas, In figure 5, it displays the information of the CAE and CAM table. If 3D printing table option is checked, then it will display the information of the 3D printing table according to the chosen parameters. Also, if the user can reset all default value using Reset button in the "My 3D Software" CAD system page.



CAD Application	Rank	CAD Features	CAD Package	CAD Domain	CAM Support	CAM Features	CAM Package	CAM Domain	CAE Support	CAE Features	CAE Package	CAE Domain
Solidworks	1	3D Solid Modeling, Sheet Metal Design, Plastic Part Design, Mold Design	Part and Assembly Modeling	Mechanical	Yes	Recognize geometry, Cost Effective, Read tolerances and surface finishes, Automatically apply best manufacturing strategies, Automate quoting,Automatic Feature Recognition	CAM Standard	Multi-Disciplinary	Yes	Solid modeling, Shell modeling and Beam modeling, h and p adaptive element type, Mesh control capabilities, Failure Mesh Diagnostic	finite element analysis	Mechanical
		Create Detailed Electrical Cable and Wiring Harnesses,Ribbon Cable,Mounting Hardware, Splices, Connectors, Insulation, Looms, Heat-Shrink Tubing, Cable Ties	Routing of Electrical Cabling and Wiring Harnesses	Electrical								
Fusion360	2	3D Solid Modeling, Sketching,Sheet-Metal Design,Parametric modeling,Freeform modeling,Direct modeling ,Mesh modeling	Design	Mechanical	Yes	Turning, Water jet, laser cutter, plasma cutter, 2.5 & 3-Axis Machining	Manufacturing	Multi-Disciplinary	Yes	Static stress & modal frequencies, Static stress & modal frequencies	finite element analysis	Mechanical
AutoCAD	3	3D Solid Modeling, surface Modeling, mesh modeling, 3D navigation, Photorealistic rendering	3D modeling and visualization	Mechanical	Yes	design to NC code, to minimize programming times for CNC milling, turning, and wire applications, manufacture molds, dies, and highly complex components with maximum efficiency and quality from your 3-axis and 5-axis machines	CAM Standard	Multi-Disciplinary	Yes	Non Linear Structural, Linear Structural, Multiphysics	finite element analysis	Mechanical
		Ribbon cable, Coverflow navigation, Dynamic blocks	User interaction	Electrical								

CAE	Rank	CAE Features	CAE Package

CAM Application	Rank	CAM Features	CAM Package

Figure 4 My 3D Software CAD table page

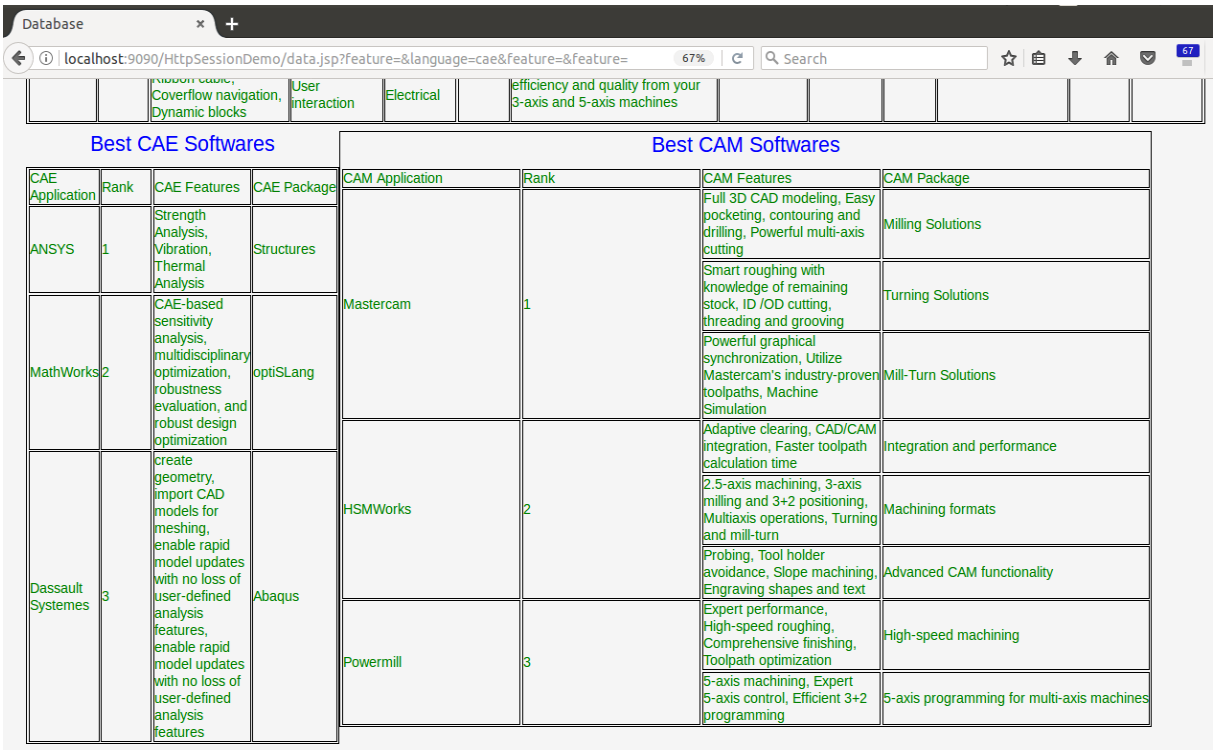


Figure 5 My3D Software CAD table page with CAE & CAM

CONCLUSION

This work starts with the survey of 3D software used in the PLM system. Here, the author focused on the CAD software, CAM software, CAE software and 3D printing software. Then tables were created based on the survey. Further, a database was created based on the proposed table. Finally, a web application is designed to extract the content of the database. The web application is targeted to the user who wants to design 3D based applications and don't have sufficient knowledge of existing software in the market. As 3D Software is dominating in all the fields, this web application is the possible solution for choosing the best 3D software.

FUTURE WORK

In the context of research, a database is created considering the PLM system. It is possible to create a database for other domains like Healthcare, Tourism, Interior Decoration Construction and many more, where there is an application of 3D software. Therefore, The scope of the web application will be extended to other domains. It is also possible to rank the 3D software other than Market survey and Media score. Further, The concepts from this work could also be used to create web application for comparison of any type of software.

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