A Proposed Information Extraction Technique in Engineering Drawing for Reuse Design

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Abstract—The extensive number of engineering drawing will be referred for planning process and the changes will produce a good engineering design to meet the demand in producing a new model. The advantage in reuse of engineering designs is to allow continuous product development to further improve the quality of product development, thus reduce the development costs. However, to retrieve the existing engineering drawing, it is time consuming, a complex process and are expose to errors. Engineering drawing file searching system will be proposed to solve this problem. It is essential for engineer and designer to have some sort of medium to enable them to search for drawing in the most effective way. This paper lays out the proposed research project under the area of information extraction in engineering drawing.

Keywords—computer aided design; information extraction; engineering drawing; reuse design

I. INTRODUCTION

ENGINEERING drawing have become somehow essentials to most organization be it consultants, contractors or even government sectors. With few numbers of computer aided software (CAD) getting through the market each year, these software have played a significant part especially in a developed nation. Due to its efficiency, effectiveness and reliability, this software has taken the world by storm. Nowadays, CAD software is widely used in automotive, construction and even electronic sector. Even certification from a renowned organization has also been offered to those who manage to master the art of using CAD software. One of the major advantages of CAD is the ability to store a file or drawing in a softcopy. This depends solely on the CAD user itself on how to manage and store files. Imagine, in order to design an automobile, about 500 drawings have to be produced which include design for engines, tires, interior and exterior part. These drawings have to be filed accordingly in order to enable other CAD user to retrieve it in future times.

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Normally, engineering drawing must be store either in a computer as a softcopy or in a 'library rack' as a hardcopy for a minimum of five years before it can be removed. Store using hardcopy definitely requires organizations to allocate unnecessary budget for storage space, therefore most organizations insist on storing engineering drawing as softcopy and uses server to centralize it. However, most company cannot afford to purchase server since it costly to setup this type of network environment. Most company prefers to use peer to peer as their choice of network type. By using peer to peer, storage space is divided into various sources. Although peer to peer managed to reduce storage cost, it does create havoc in other parts of storage. Since every person have its own method of doing filing, it will be almost impossible to find these files. Another problem of managing CAD files includes naming convention. Basically, most engineering drawings come with a revision number which allows CAD user to retrieve the files easier in future times. [1], [2] found out that engineers spent time up till 30% from their working hours looking and accessing designing information. It is essential for CAD user to have some sort of medium to enable them to search for drawing in the most effective way. This paper lays out the proposed research project under the area of information extraction in engineering drawing.

II. OBJECTIVE

The main objective of this research is to propose an information extraction technique on engineering drawing. The second objective is to test the usage of the proposed algorithm by developing engineering drawing searching system.

III. SCOPE OF RESEARCH

The aim of this research is to produce the technique for reuse design purpose by extracting information available in the engineering drawing. In general, engineering drawings are illustrations of a designed product which can be saved in raster or vector formats. The technique will works only on vector format and the file format that will be studied is Drawing Interchange Format (DXF). The scope of engineering drawing information in this research is constrained to information extraction by identifying and retrieve the required information from the engineers, not the entire information that exist in engineering drawing. The required information will be determined after the interview data has been analyzed. In terms of body of knowledge, this research is focused on the information extraction by identifying and extracting the required information.

IV. MATERIAL AND METHODS

The proposed for data collection method for this research is interview which the respondents are among engineers and designers who works in engineering drawing environment, which used any software of 2D CAD drawing. The purpose of interview in this preliminary stage is to seek information regarding engineering drawing searching process. The information is valuable to this research as it will determine whether there is a problem in the process of finding the right drawing.

The research outcome will be an engineering drawing searching system which able to search information in the engineering drawing regardless of fields. Therefore, the respondent will be chosen from different engineering fields such as manufacturing, construction, electrical, architecture, civil, structure, mechanical and so on. The number of respondents will depend on data saturation, the point which there is no new information coming from each new participant and redundant information keeps coming up.

In order to achieve the research objectives, this research requires findings on how the engineers manage the engineering drawing files, how they find and retrieve old drawing, what the important information they seeks in the engineering drawing when they searching for old drawing, problems in searching process, sharing the engineering drawing between colleagues and different companies and how long the retention period of the engineering drawing. From these findings, it will help the researcher in identify the required information by engineer in doing searching on the engineering drawing. Information available in the engineering drawing is divided into two categories which are geometry and non-geometry information. Technique will be produced based on what the important information the engineer seeks in the engineering drawing when they searching for old drawing.

This research will require some knowledge and skill in software development. The development of the system in this research will be using Visual Studio C# meanwhile for the database, SQL server is chosen in storing the searching result.

V. RELATED WORK

According to [3] the process of extraction is the process of extracting of CAD data in order to obtain details of products and processes that contribute to the production of the product. Basically, CAD data contains data on geometry and non geometry. Geometry data is a collection of objects described by CAD drawing of lines, arcs and circles. While non-geometry data are related to object attributes such as length, thickness, radius, diameter and label [4]. Geometry and non geometry data is closely related to information products [3]. [5] classify the automatic recognition of engineering drawings problems into three levels at which the first is the identification of low-level graphics primitives, the second stage of identification of high-level graphical objects, and the third level of high-level intelligence interpretation and analysis.

A. Reuse Design

Information and reuse of knowledge identified as key issues in engineering design [6]. Production of the latest products such as cars are considered as a new product because the features, functionality and performance to differ significantly from the previous and this leads to a different physical structure. However, most of the components and parts in new product are not necessarily new. Malaysian's car maker, Proton used the same body chassis of old model to produce a new car with different variant of engine. In this case, a minor modification took placed to suit with the manufacturing requirement of new model where the engineering drawing of old model will be referred. The extensive number of engineering drawing will be referred for planning process and the changes that will be made will produce a good engineering design to meet the demand in producing a new model.

Studies by [1] and [7] indicate that 40-50% of component in the new product is similar to the existing components in previous products. While 40% of the components require some changes to the existing components and only 10% -20% of the components are new.The advantage in reuse of engineering designs is to allows continuous product development to further improve the quality of product development, thus reduce the development costs. Furthermore, it gives more time for the designer to create innovative designs [8].

Meanwhile Crabb [9] in his study indicates most employers will lose more than 50% of the workers which are consist of designers and engineers due to retirement and retrenchment. In addition, there are possibility for the workers to resign when they got a new job which offer a good deal and remuneration. It is one of the factors that contributed to the loss of workers. This certainly complicates the situation and will create problem if the resigned worker failed to inform the employer about the processes related with the document storage and drawing management.

Survey of strategies being used in the automotive industry for product data retention has been carried out by Bsharah [1]. In this study, original engineering drawings were identified as one of document for data retention. The retention period for engineering drawing is 20 years after the last use of the record. This long period of retention will produce thousands of engineering drawing in an organization, As time goes, organization will get a new project that required engineering drawing to be made thus the process of searching the engineering drawing are much needed. The searching process must be fast and will give the accurate and correct result as it crucial for the designer to get the desired engineering drawing.

When designer designing a new engineering drawing, they will refer to the previous valid design document that same or nearly match with their new design specification. Previous design have been reviewed, analyzed and proven to be successful. By using the previous design, it likely saves significant resources and manpower [10].

Due to the frequent use of old components in new products, it is essential to develop an engineering drawing search system to facilitate the retrieval process of engineering design.

According to engineering perspectives, the term 'reuse' is related to the same information being used repeatedly to the same work or nearly the same work [11]. Whilst, the term

reuse in engineering scope by [12] is divided into 3 sections, where one part of it is physical artifact (component, sub-assembly). In casting, engineering drawing also being reuse in term to produce a better product. In manufacturing, engineering drawings also are being reused for betterment purposes in producing a better product. During designing phase, an engineer will ponder in finding a similar design or nearly similar designs in developing a new product [13]. An engineer will only make the necessary changes in making the product better, and consequently could reduce time, energy and idea in producing a new product.

In manufacturing, the design of products and the components are being reused in producing new products such as bottling products [14], washing machine components [15] and car components [16, 17]. For example, Wahab et al [16] has done a research in advancing a design of a car door for reuse purposes. The modification had been done to the design by making changes to the original drawing.

Engineers keep on referring to engineering drawings to design a mechanical product efficiently by changing some of the existing components [18]. However, to retrieve the original engineering drawing, it is time consuming, a complex process and are expose to errors [19]. Previous researches shown that the reuse of information in engineering design specializes to engineering data distribution model between CAD system [20]. The reuse of knowledge in engineering design is usually to prepare one's individual or the organization's experience regarding the previous designing activities in frame to deliver more information and ease the designing activities in future. In preparing the shared knowledge regarding old engineering drawings, an system that could reach and search efficiently has to be developed to assist the designing activities of a new product.

Engineers rarely begin with blank papers in designing for a certain project [21]. In a research being done by [22], nearly 28% of a new design from a construction company begin from reused designs while [23] estimated up till 80% of a new design are reused. In designing engineering designs, most designs involve whether redesigning, geometrical changing or reusing, techniques or solving [24]. When an individual is being elected as an engineer at the beginning his career, they are advised to prepare a personal log book in term to record a good design. Hence, when they are good in designing, they would have a lot of good designs and could be reused [25] and act as references in producing recent or future designs. The ability in repossessing engineering designs is crucial for reuse purposes. According to Song et al, [26], the access in getting engineering designs among numbers of designs effectively are really adventurous. In a traditional method, when an engineer caught a task to draw, they had to start from a scratch by designing on blank papers. It is a tiring and time consuming process. By reusing existing drawings, time is cut short and consequently, allowing engineers to concentrate their time, energy and focus to more interesting and innovative designs [26]. Thus, by preparing a system that could search existing engineering drawings, allowing the concept of reusing and sharing drawings be done where it enhances the designing

process, producing better designs and ultimately save time and cost. One of the advantages in CAD is the ability to create new and update existing drawing files, where necessary. However, with the rise of numbers of projects and engineering designs, it causes problems when the organization has not prepare a mechanism in retrieving the reuse engineering designs which support a reuse method [27]. [10] and [27] found out that engineers reuse their engineering designs once getting a new project where the design is used as references in getting new ideas and basically the solution is succeed. A research being done by [28] found out that project files are critical in helping engineers identify relevant characteristics to be used and to hinder from making the same mistakes in producing engineering designs. More than 75% of designing activities are case based designs which applied an old design in solving problems of a new design [29].

B. Information in Engineering Drawing

Engineering processes require creativity and intensive knowledge and comprise activities such as designing, engineering analysis, fabricating and achievement evaluation. In detailed designing phase and engineering analysis, engineers are mostly depending on information such as reports, drawings, model and manual [30], [31]. These days, an effective use of information and knowledge are needs in assuring organizations operated efficiently and pasturing competitive advantages [32], [33], [34]. According to [35], searching for digital documents stored in a personal computer is much more complicated compares to personal rack. Reliability of a company towards its information is crucial in engineering sectors [36].Information is vital in designing activities, manufacturing and life cycle of a product [38], [39], [40]. Research [41] shows that by increasing the information management and knowledge, it could increase the quality of the product, increase the achievement and cut the time to market the product. The importance of information in engineering organizations also being mentioned in a survey done by [37] which involves around 300 organizations. The survey exposes that engineers usually spend nearly one third of their working time in activities involving information especially in retrieving information.An international level survey had been done by [42] which involve contents and the use of engineers log books towards 50 respondents among engineers and involves 16 log book concerning 2000 pages had been analyzed in detail. Basically, a log book is being used to record information that pictured outcomes of activities and tasks, which might be required in future activities or may be valuable to be used in future. One of the information records is CAD drawings. Based on the survey, engineers print and paste engineering drawings in log books for future references. This method has weaknesses where the log book is being used as a personal working record and is not concentrate in information sharing between colleagues. Besides, this research found out that nearly 31 respondents said that they gain information by flipping the pages of the log book. Difficulties in searching for entries by flipping each pages show that it is a complicated process and time consuming.

Engineering documents should be made as a standard structure so that the consistency level could be maintained in a good organization. In increasing the time and the quality of work, archive and retrace of documents are vital functions that could assist in increasing daily working productivity.

VI. CONCLUSION

This paper lays out the proposed research project under the area of information extraction in engineering drawing. The scope of engineering drawing information in this research is constrained to information extraction by identifying and retrieve the required information from the engineers, not the entire information that exist in engineering drawing. The required information will be determined after the interview data has been analyzed.

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