

Theme:

Title: **Intelligent CAD Checker For Building Plan Approval**

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Abstract: *In construction industry, architects need to have a deep knowledge of the uniform building by law and the local council requirements before designing a building or a house. The process of applying his or her knowledge in terms of building by law interpretation is critical during the design stage. Due to enormous amount of by-laws involved, architects may design with some non-compliance to the by-laws. This mistake will be costly especially if it causes the building plan to be rejected by the municipal council or the fire department. The mistake will probably cause a significant delay in the completion of project thus leading to penalty and other costs. Viewing from the point of the approval authority, the personnel involved in approving building plans is also prone to make mistake in approving building plans that have non-compliance to the by-laws. Such mistake may cause great harm to occupants of the building and the responsible authority may be accountable for any mishap caused by the non-compliance. Hence the proposed system discussed in this paper intends to eliminate any errors in interpreting as well as checking for by-laws non-compliance directly from a CAD file submitted by an architect. This system directly reads in the building design CAD file before checking it's attributes and specifications against the building by-laws and will report any non-compliance to the user.*

Keywords: *Computer-Aided Design, Uniform Building By-laws, web-based system, CAD data extraction, building plan approval, object-oriented, knowledge based system, client-server system, electronic submission, building element*

Introduction

The current practice of a construction project, which involves submission of building plans to the local or municipal authority for approval is a very tedious and time-consuming process. The time involved can range from weeks to months. The submission process of the building plans to the relevant authorities will require the authorities involved to check in details on the building design for building by-laws non-compliance. The checking process consumes time and is error prone. The checking process has added significant increment in cost to the overall project and posed a major problem in project management. It poses a major problem because the project manager has difficulty to estimate the actual time required for a building project due to the uncertainty of the time taken for building plan approval. Thus, there is a need for architects to have the ability to check their design prior to submission. The requirements to comply with the uniform building by-laws as well as the local council requirements may amount up to a few hundreds [1] regulations and the system should be able to check compliance to these requirements automatically.

The proposed system should also be of significant important to local council, which is involved in the building plan approving process. Hence, local councils can use such system to expedite their approval process. The importance of such system is also being recognised, as there is currently an on-going project in developing such system in the region [2, 3]. However the on-going project uses IFC based data [4] and will involve development of a product model server. Hence the user will have to design under a code of practice.



Intelligent CAD Checker System For Building Plan Approval

The proposed system will be a web-based client-server system, which enables users to check the CAD files online as well as submit to the relevant local authorities online. Their CAD files submission will only be allowed to proceed if their plan has complied with the uniform building by-laws.

The system will consist of 3 modules. The modules will be as below:

- a). CAD extraction module
- b). Knowledge-based information processing
- c). Non Compliance Report Module

CAD Information Extraction Module

The proposed system can only accept a three dimensional model of CAD for it's by-laws checking in order to reduce the complexity of extracting geometric information from the CAD file. The CAD extraction module function is to retrieve geometric information from the CAD model. The information extracted will be insufficient to cater the requirement for by-laws checking. In order to check compliance on by-laws, additional information such as materials used, purposed group (type of building i.e. residential, industrial, etc.) is needed. In view of this, the proposed system will prompt the user to input additional information required for the by-laws checking. Information regarding type of doors, wall, etc are critical as the by-laws have different requirement for fire door, etc. The geometric data, which is required in order to calculate information (areas, height, width, etc) for the uniform building (UBBL) by-law checking will be extracted from the CAD file. The graphic interface showing the process of extracting geometric information is shown in Figure 1.

The extraction model will be specially designed to cater the CAD system that were chosen for the system as different CAD has different interface protocol and product model architecture. However the extraction module architecture will be independent from the rest of the system to enable future enhancement to cater different CAD system.

Hence, basically the output of the extraction module will be in a standard format which, will be the input for the checking module. Currently the output format of the extraction module will be in text format. Depending on the CAD system chosen, the CAD geometric information deferred from one to another. The CAD system selected identifies wall, beam, column, and most of the standard building elements. However a number of building elements may not be defined and will exist as mass element and these elements required feedback from the user to obtain it's identity. The user will be prompted with pre-determined list of element names that has link to the uniform by-laws. The user will also be allowed to input other element names if he or she chooses to but these names will not be of significance since it is not needed by the uniform by-laws.

The extraction model will be extracting geometric information to cater checking on dimensional requirements of the uniform by-laws. The model will also be extracting information on relationship between elements to enable checking on by-laws that requires relationship conditions such as lighting requirements (determined by the number of windows (standard size) based upon the area of the room). The final feature of the extraction model is extracting links between input information from the user to the geometric elements. The model also is enhanced further in the future, by adding more extraction features such as information on landscaping, etc.

The process extraction used for this CAD system will be dependent to the CAD database structure. The architecture of the CAD database and the actual data that the CAD database stored are vital factors in designing the CAD extraction module. Dimensional data on the CAD file is extracted directly from its database and additional inputs from the user will also be stored into the extended data attributes of the CAD file. This is to ensure that when the extraction module is run, any information inputs from the user will be added into the CAD file (CAD database). Hence, the CAD file can be reprocessed again by the extraction module without seeking similar inputs from the user that he or she has previously provided.

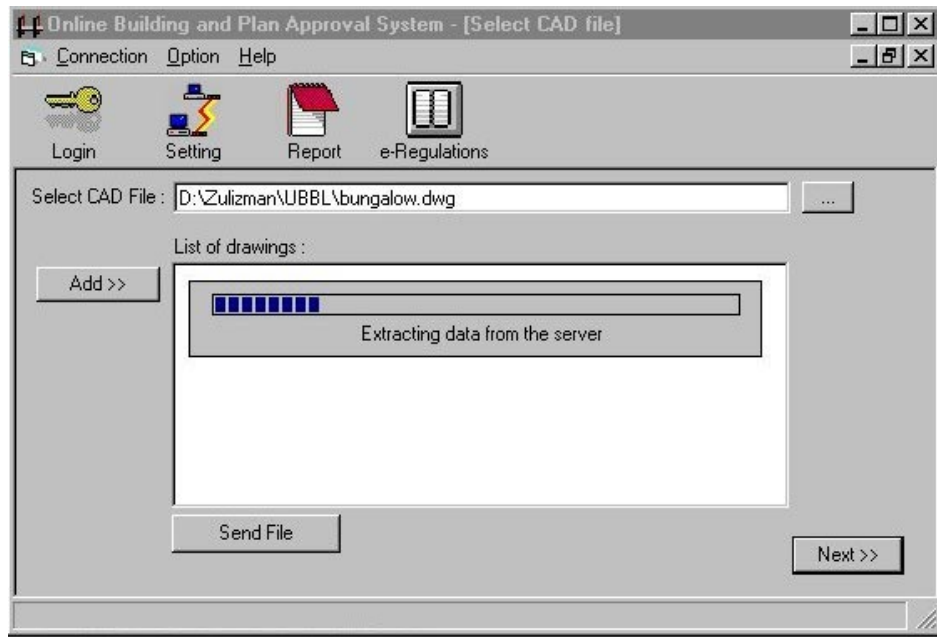


Figure 1 : The process of extracting geometric information is shown.

Design of Knowledge-based Model for Uniform Building By-Laws Checking

The knowledge-based model for uniform building by-laws checking will be one of the most important models for the system. The model will be created in an object-oriented environment, in which, the information required for uniform by-laws checking is the core architecture of the model. All attributes including geometric information will be modelled if it has any links to the requirements of the uniform building by-laws. Some of the information such as areas, volume, etc. which, are not directly obtainable from the CAD file but is required by the uniform building by-laws checking will be calculated by the knowledge-based engine from the basic geometric data. The relationships between building elements will also be modelled, as these information are required to enable the system to check certain building by-laws requirements.

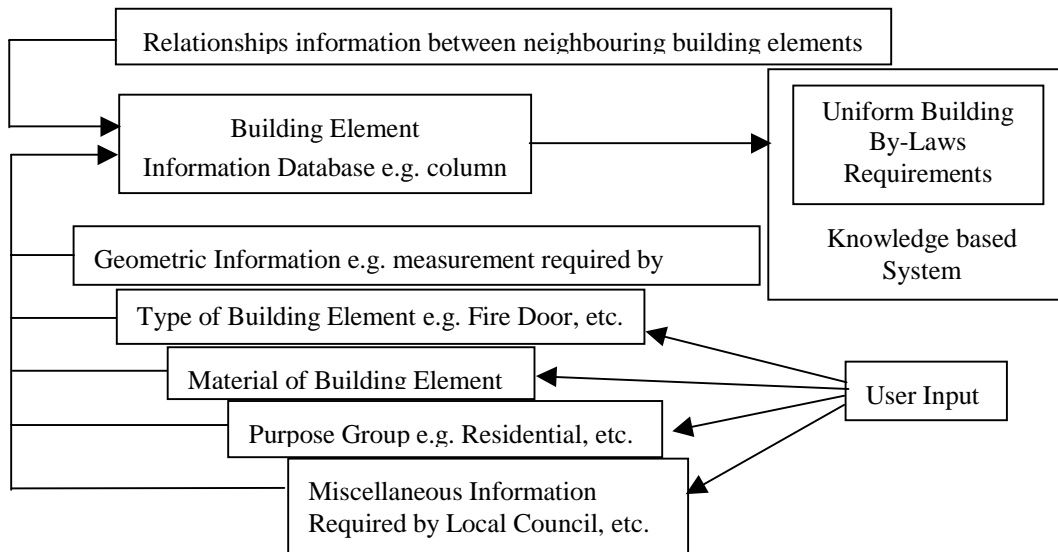


Figure 2 : Model for Knowledge-Based System for One Building Element

Design of Web-Based System Architecture

The proposed system will have a graphic user interface that allows user to submit the building plan CAD files to the approving authorities. The web-based system architecture can be illustrated as shown in Figure 3.

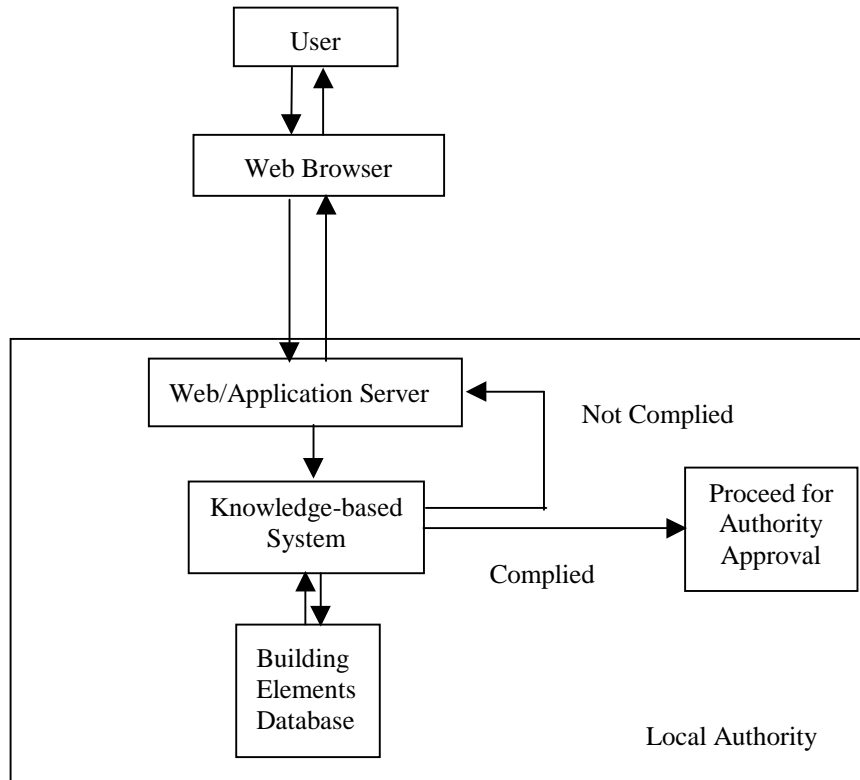


Figure 3 : A simplified model of the web-based system

Report of Uniform By-Laws Non-Compliance

The reporting of non-compliance for the proposed system will be in text and graphical representations as illustrated in Figure 4. The building plan that has non-compliance item will be highlighted in the design and shown to the user for ease of editing and correction purposes. There will be a “NCR” (non-compliance) message on the building plans. At the same time, a text-based report that lists down the items checked and highlights the non-compliance items in red.

Conclusions

The proposed system is very important in enhancing the construction sector, as building plans checking is a critical stage in a construction project. The speed of building plans approval and eradication of non-compliance elements will greatly influence the duration of any project. In addition to that, it also eliminates human errors on failure to detect non-compliance which, in return, ensure the design submitted by architect is safer and building built will be more comfortable to its occupants.

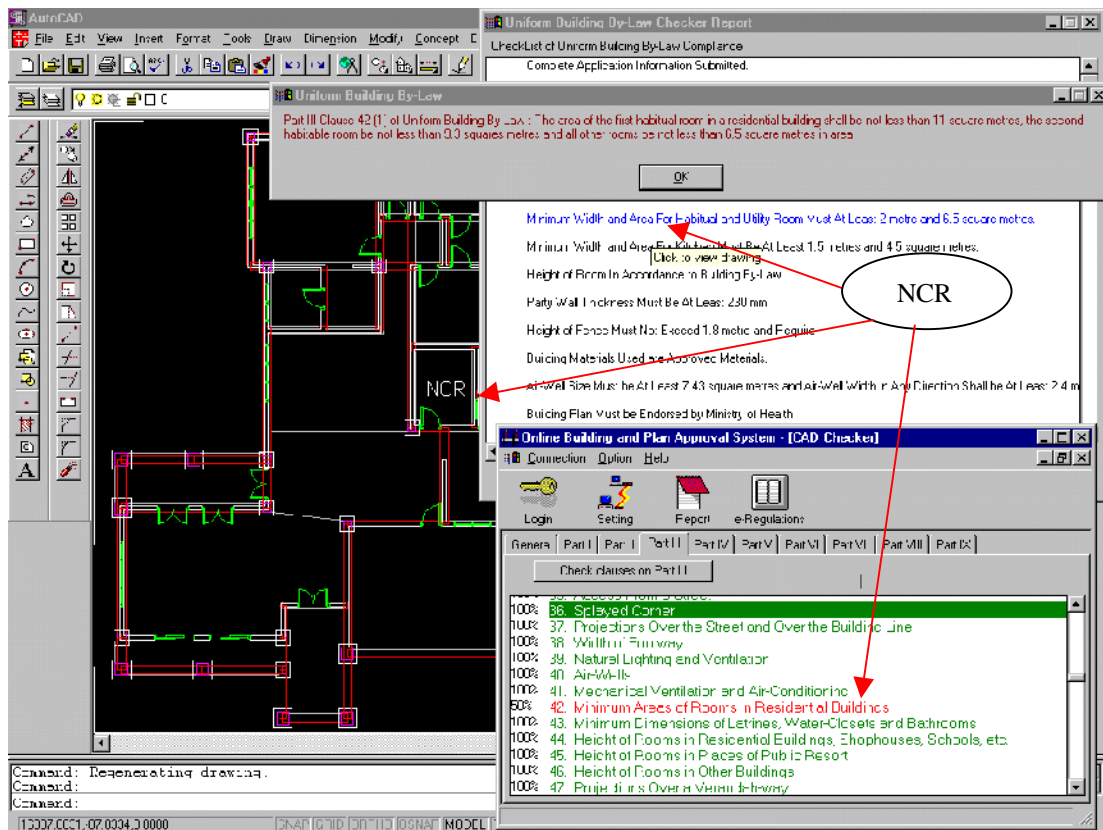


Figure 4 : Reports and display of non-compliance for the proposed system. Note : the “NCR” is in blinking mode.

References:

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