Converter for CAD and FEM

Project Synopsis

Submitted In Partial Fulfillment Of The Requirement For Six Month Training
at
Testing and Consultancy Cell, GNDEC
Batch:2011-2015

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Contents

List of Figures

1 Introduction To Organisation

Figure 1: Guru Nanak Dev Engineering College

I am having my Six Months Industrial Training at TCC-Testing And Consultancy Cell, GNDEC Ludhiana. Guru Nanak Dev Engineering College was established by the Nankana Sahib Education Trust Ludhiana. The Nankana Sahib Education Trust i.e NSET was founded in memory of the most sacred temple of Sri Nankana Sahib, birth place of Sri Guru Nanak Dev Ji. With the mission of Removal of Economic Backwardness through Technology Shiromani Gurudwara Parbandhak Committee i.e SGPC started a Poly technical was started in 1953 and Guru Nanak Dev Engineering College was established in 1956.

NSET resolved to uplift Rural areas by admitting 70of students from these rural areas ever year. This commitment was made to nation on 8th April, 1956, the day foundation stone of the college building was laid by Dr. Rajendra Prasad Ji, the First President of India. The College is now ISO 9001:2000 certified.

Guru Nanak Dev Engineering College campus is spread over 88 acres of prime land about 5 Km s from Bus Stand and 8 Km s from Ludhiana Railway Station on Ludhiana-Malerkotla Road. The college campus is well planned with beautifully laid out tree plantation, pathways, flowerbeds besides the well maintained sprawling lawns all around. It has beautiful building for College,Hostels,Swimming Pool,Sports and Gymnasium Hall Complex, Gurudwara Sahib, Bank, Dispensary, Post Office etc. There are two hostels for boys and one for girls with total accommodation of about 550 students. The main goal of this institute is:

- To build and promote teams of experts in the upcoming specialisations.
- To promote quality research and undertake research projects keeping in view their relevance to needs and requirements of technology in local industry.
- To achieve total financial independence.
- To start online transfer of knowledge in appropriate technology by means of establishing multipurpose resource centres.

1.1 Testing and Consutancy Cell

My Six Months Institutional Training was done by me at TCC i.e Testing And Consultancy Cell, GNDEC Ludhiana under the guidance of Dr. H.S.Rai Dean Testing and Consultancy Cell. Testing and Consultancy Cell was established in the year 1979 with a basic aim to produce quality service for technical problems at reasonable and affordable rates as a service to society in general and Engineering fraternity in particular.
Consultancy Services are being rendered by various Departments of the College to the industry,

Figure 2: Testing and Consultancy Cell

Sate Government Departments and Entrepreneurs and are extended in the form o5 expert advice in design, testing of materials & equipment, technical surveys, technical audit, calibration of instruments, preparation of technical feasibility reports etc. This consultancy cell of the college has given a new dimension to the development programmers of the College. Consultancy projects of over Rs. one crore are completed by the Consultancy cell during financial year 2009-10.

Ours is a pioneer institute providing Consultancy Services in the States of Punjab, Haryana, Himachal, J&K and Rajasthan. Various Major Clients of the Consultancy Cell are as under:

- Larson & Turbo.
- Multi National Companies like AFCON & PAULINGS.
- Power Grid Corporation of India.
- National Building Construction Co.
- Punjab State Electricity Board.
- Punjab Mandi Board.
- Punjab Police Housing Corporation.
- National Fertilizers Ltd.

2 Introduction

Figure 3: CAD

Computer-aided design (CAD) is the use of computer programs to create two- or three-dimensional (2D or 3D) graphical representations of physical objects. CAD software may be specialized for specific applications. CAD is widely used for computer animation and special effects in movies, advertising, and other applications where the graphic design itself is the finished product. CAD is also used to design physical products in a wide range of industries, where the software performs calculations for determining an optimum shape and size for a variety of product and industrial design applications.

Hundreds of thousands of professionals in (take a deep breath) architecture, construction, engineering, commercial interiors, light construction, landscape architecture, kitchen and bath design, urban planning, game design, film and stage, woodworking, and plenty of other fields use CAD softwares all the time, every day.

GDCAD is a such application that can tackle with 2-D and 3-D graphics. GDCAD is like a pencil with superpowers. Start by drawing lines and shapes. Push and pull surfaces to turn them into 3D forms. Stretch, copy, rotate and paint to make anything you like. GDCAD is as simple and as powerful as you want it to be.

GDCAD uses set of toolbuttons and menu options to capture the CAD functionality. It has various toolbuttons to capture the implementation of various entities such as line, circle. point, ellipse etc. It has a drawing area with in which the entities are painted. The click of any toolbutton such as point button or other captures and stores the mouse positions, such that along that points things get painted. Also the mouse movements in the drawing area are captured and shown in the status bar. We can repaint the same entity again without having the need to click that button again. The signal from the same button remains active until and unless another button is clicked. Along with toolbuttons the menu also has the options to provide the painting of things. The shortcuts for each action are also implemented.

GDCAD also provides with the functionality of zooming in and out with the mouse scroll and same is also provided in the menu options. It can also open, load and display an image with .jpg and .png format as sometimes the architectures and other need to have an idea by looking into the image. So no need to load it externally, GDCAD exhibits this feature. You can even select the entities or the area you want.

GDCAD is also designed to play nice with other software. So if you need to send your work to someone who needs a CAD file, you can use it to export pages as DWG and DXF files. It also exports multi-page PDFs also.

Every document you create has a physical paper size that you specify at the very beginning of your project. Because of this, all you need to do to print a plan view of your model at an exact scale is insert and set up a model viewport, and choose File then Print. Its literally a two minute process.
Also, this project is completely open source and is made using Qt as IDE, that uses the Qt libraries and the Qtwidgets with C++ and with openGl functionality, the entire code is available to the user as and when required. The project is governed by the GNU General Public License v3.0 i.e GNU-GPLv3.0.

Various tools used to develop the project are:

- Qt version 4.7 or higher
- C++

3 Introduction to FEM

In mathematics, the finite element method (FEM) is a numerical technique for finding approximate solutions to boundary value problems for differential equations. It uses variational methods (the calculus of variations) to minimize an error function and produce a stable solution. Analogous to the idea that connecting many tiny straight lines can approximate a larger circle, FEM encompasses all the methods for connecting many simple element equations over many small subdomains, named finite elements, to approximate a more complex equation over a larger domain.

3.1 Finite Element Analysis

Finite element analysis (FEA) is a computerized method for predicting how a product reacts to real-world forces, vibration, heat, fluid flow, and other physical effects. Finite element analysis shows whether a product will break, wear out, or work the way it was designed. It is called analysis, but in the product development process, it is used to predict what is going to happen when the product is used.
FEA works by breaking down a real object into a large number of finite elements, such as little cubes. Mathematical equations help predict the behavior of each element. A computer then adds up all the individual behaviors to predict the behavior of the actual object.

3.2 FEM Software-Calculix

CalculiX is a package designed to solve field problems. The method used is the finite element method. With Calculix Finite Element Models can be build, calculated and post-processed. The pre- and post-processor is an interactive 3D-tool using the openGL API. The solver is able to do linear and non-linear calculations. Static, dynamic and thermal solutions are available. Both programs can be used independently. Because the solver makes use of the input format it is

possible to use commercial pre-processors as well. In turn the pre-processor is able to write mesh related data for nastran, abaqus, ansys, code-aster and for the free-cfd codes duns, ISAAC and OpenFOAM. A CAD interface is available. The program is designed to run on Unix platforms like Linux and Irix computers but also on MS-Windows.
Calculix is a very powerful tool of analysis, highly configurable allowing the user to have complete control over the analysis, with more than 18 types of analysis covering most fields of study finite element Calculix's user can modify any variable on the analysis at discretion, the huge amount of information and documentation on the web make calculix a great alternative for the development of research projects where computer tools must accommodate the needs of the study.

4 Introduction to DXF

DXF stands for Drawing Exchange Format. Files that contain the .dxf file extension contain CAD vector image files. The DXF file format is similar to the DWG file format, but DXF files are ASCII based and are therefore more compatible with other computer applications.The DXF file format was developed as an exchange format for the CAD files that are created by computer aided drafting software applications. The file format was initially introduced in December of 1982 as a part of AutoCAD 1.0. The file format was meant to provide an exact representation of the data in the standard AutoCAD file format.

4.1 General File Structure

A Drawing Interchange File is simply an ASCII text file with a file type of .dxf and specially formatted text. The overall organization of a DXF file is as follows:

- HEADER section–General information about the drawing is found in this section of the DXF file. Each parameter has a variable name and an associated value.
- TABLES section–This section contains definitions of named items.
  * Linetype table (LTYPE)
  * Layer table (LAYER)
  * Text Style table (STYLE)
  * View table (VIEW) * User Coordinate System table (UCS)
  * Viewport configuration table (VPORT)
  * Dimension Style table (DIMSTYLE)
  * Application Identification table (APPID)
- BLOCKS section–This section contains Block Definition entities describing the entities that make up each Block in the drawing.
- ENTITIES section–This section contains the drawing entities, including any Block References.
- END OF FILE

5 Problem Formulation

We are trying to build a general purpose converter for CAD and FEM softwares, to convert one file format to another file format.

5.1 Scope and Objectives

- To import and export any file format in CAD softwares.
- To allow user to give inputs through text file with flexible format.
- To implement the DXF library for importing them into .dxf file.

6 Project Work

6.1 Feasibility Study

- Technical Feasibility As this whole project is based on C and C++ as programming language, technical feasibility of this project revolves around the technical boundaries of the C++. As we need parser for our project, so we are also using Flex and Bison for this. These languages are perfect to design the software under this project.

- Economic Feasibility Almost all the softwares used in this project are Open source and the software released under this project are Open source too and are released under GNU GPLv3 (General Public Licence). So this project is fully economic feasible.

- Operational Feasibility This project is also operationalally feasible which not only saves time but also saves money as mast the work done by this software.

6.2 System Design

Based on the user requirements and the detailed analysis of a new system, the new system must be designed. This is the phase of system designing normally, the design proceeds in two stages:-

- Preliminary or general design.
- Structure or detailed design.

Preliminary or general design
In the preliminary or general design, the features of the new system are specified.

Structure or Detailed design
In the detailed design stage, computer oriented work begins in earnest. Input, output and processing specifications are drawn up in detail.

There are several tools and techniques used for designing

- Data flow diagram (DFDs).
- ER Diagram.

Design is the first step into the development phase for any engineered product or system. Design is a creative process. A good design is the key to effective system. The term "design" is defined as "the process of applying various techniques and principles for the purpose of defining a process or a system in sufficient detail to permit its physical realization". It may be defined as a process of applying various techniques and principles for the purpose of defining a device, a process or a system in sufficient detail to permit its physical realization. Software design is the technical kernel of the software engineering process and is applied regardless of the development paradigm that is used. The system design develops the architectural detail required to build a system or product. As in the case of any systematic approach, this software too has undergone the best possible design phase fine tuning all efficiency, performance and accuracy levels.

7 Methodology/Planning of Working

- Researching the needs of the students and organisations and finding out the facilities required to develop project.
- Documenting the needs and then preparing the layout for the project, and deciding the various modules to be included in the software.
- DFDs will be prepared showing various interactions between users and the system.
- Selecting the technology for developing the project and installing the required tools for developing the project. We will install Flex, Bison and C and C++ compiler.
- Developing the Parser. The program whch will actually conert the file formats.
- Testing the system by running it

8 Facilities for Proposed Work

8.1 Software Requirements

- Operating System: Linux/Windows
- Parser Generator: Flex and Bison
- Programming Language: C++

8.2 Hardware Requirements

Hardware requirement of this project is any Desktop or Laptop machine for local use or a Server with minimum available configuration to make Project globally available. Hardware specifications of the machine used depends upon the hardware requirements of the Operating System installed on it. As such there are no special hardware requirements of this project.

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