

Use of Open Source Software in Engineering

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Abstract - The term Open Source Software (OSS) is widely described with the software that is available with its source code and a licensed to redevelop and redistributes it. Today's open source softwares are widely used for every field of computer, business and management because of its many features over proprietary software. This research paper describes the use of open source software instead of proprietary software in the field of engineering because open source software is cheaper than proprietary software and they also have ability to modify by user according to their need for maximization of performance.

Keywords - Internet, Open Source, Proprietary, redistribution, Software.

I. INTRODUCTION

Open Source Software is described as a software and its source code that is distributed in a wide geographical area over the internet. OSS is licensed under various open source licenses model like GNU General Public License or Berkeley's free software foundation, which allow the user to modify software according to their requirements and redistribute to others. The source code of open source software is a collaborative effort of number of programmers for providing flexibility to use and share. While OSS is freely provided over the internet but a programmer or distributor may charge it from end user for their services like special programming, maintains and installation. The use of open source software over proprietary software is due to its modification and redistribution.

II. FEATURES OF OPEN SOURCE SOFTWARE

Open source software is widely used because it has various features. Some of these are listed below:

- A. OSS has the ability to distribute the software freely.
- B. The source code of software is also provided under open source.
- C. OSS with its source code can be easily downloaded from internet.
- D. OSS is a collaborative effort by a group of developers over the internet that provides it large flexibility to use it in a wide geographical area.
- E. Every user has right to create derived works through modification under OSS.
- F. The license must not be specific to a product, but apply to all sub-parts within the licensed product.

- G. No discrimination against persons or groups both for providing contributions and for using the software.
- H. OSS increase user involvement in implementation. They are viewed as co-developer of Software.

III. WHY OSS FOR ENGINEERING

Engineering is the application of scientific, economic, social, and practical knowledge, in order to design, build, and maintain structures, machines, devices, systems, materials and processes. The American Engineers' Council for Professional Development (ECPD, the predecessor of ABET) has defined "engineering" as:

The creative application of scientific principles to design or develop structures, machines, apparatus, or manufacturing processes, or works utilizing them singly or in combination; or to construct or operate the same with full cognizance of their design; or to forecast their behavior under specific operating conditions; all as respects an intended function, economics of operation or safety to life and property.

Engineers use their knowledge and skills for developing engineering applications and find the solutions for other related fields. Because of modernization in the field of engineering, computer and software also plays a big role. Today's Open source software in engineering is the best choice over proprietary software because of various reasons which are described below:

- A. OSS provides consultation for planning and design.
- B. Implements networks including commercial Wi-Fi networks.
- C. Develops customized solutions to meet business needs when necessary.
- D. Primarily work is subcontracted by other vendors and they provide support.

IV. SOME MOST POPULAR OSS FOR ENGINEERING

- A. There are some Open source softwares used in civil engineering are listed below:
 - 1) *DYSSOLVE* - Dyssolve usually pronounced as dissolve is an open source software which is used to solve structural dynamic problems. A platform independent programming language Matlab is used to write it. The architecture of Dyssolve is such that more modules can be easily integrated. It is designed as a lightweight, classroom instruction and learning tool. Various problems like single and multi-degree of freedom spring mass damper system, String Vibration, Visualization of beam, Dynamic Analysis of Frame Structure and Spring-connected pendulum can also be solved using Dyssolve.
 - 2) *ruBeam* - ruBeam is an open source 2D structural analysis tool. It is used to generate 2D structure

- model. It also shows deformation and reaction force results. It is used as a plug-in on CADEMIA. The advantage of plug-in is the utilization of existing CAD functionality for pre- and post-processing. Structure analysis is the main objective of reBeam plug-in.
- 3) *FERMA* - Ferma is an open source educational CAD software used for truss units analysis. It is basically designed for the optimization of 2D truss structural units and for finite element calculation.
 - 4) *Frame 3DD* - Frame 3DD is open source software used for static and dynamic structural analysis of 2D and 3D frames and trusses with elastic and geometric stiffness. It use direct stiffness and mass assembly for computing the static deflections, reactions, natural frequencies, internal element forces, modal participation factors of 2D and 3D elastic structures and mode shapes. It is licensed under GNU General Public License. Frame 3DD is written in plain ANSI C. It's source code includes: frame analysis, LDL' decomposition, LU decomposition, Newton-Raphson iteration, sub-space iteration, Stodola iteration, Sturm eigenvalue check, static condensation, Guyan reduction, and dynamic condensation. The file format for Frame3DD is .3dd and it also supports matlab(.m) and spreadsheet(.csv) file formats.
 - 5) *Microstran Viewer* - Microstran Viewer is an open source parser and viewer that reads Microstran ".ARC" files and display them into 3D view. This software is useful for basic interoperability between structural analysis programs and Frame 3DD.
 - 6) *IDARC2D* - IDARC2D is open source software or a computer program for Seismic Inelastic Structural Analysis. It is developed at the University of Buffalo-the State University of New York. It was first introduced in 1987 for analyzing earthquake damage in multistory, reinforced concrete building. After that various new features has been added to IDARC for analyzing a wide variety of structures, structural materials, and for structural dumping devices. And also 3D and bridge specific versions are currently being developed.
 - 7) *OpenSees* - OpenSees is an open source framework for developing applications to simulate the performance of structural and geotechnical systems subjected to earthquakes. OpenSees framework was developed by Frank McKenna and Gregory L. Fenves with significant contributions from Michael H. Scott, Terje Haukaas, Armen Der Kiureghian, Remo M. de Souza, Filip C. Filippou, Silvia Mazzoni, and Boris Jeremic. OpenSees framework is developed at the NSF-sponsored Pacific Earthquake Engineering (PEER) Center. One can create OpenSees application by writing scripts in TCL programming language. They can access the source code using Apache Subversion(SVN)
- B. There are some Open source softwares used for Electronic Engineering are listed below:
- 1) *Quite Universal Circuit Simulator* - Quite Universal Circuit Simulator (Qucs) is an open source electronics circuit simulator software and graphical interface for schematic capture. It is licensed under GNU General Public License. It provides the ability to set up a circuit with a graphical user interface and simulate the large-signal, small-signal and noise behavior of the circuit. It also support Pure digital simulations. It is easy to use and handle than other circuit simulators. It also provides various features like transmission line calculator, Smith-Chart tool for power and noise matching, Optimizer for analog designs, Filter synthesis, Support for multiple languages, Powerful data processing and it can also represent the simulation in various type of diagrams, including Smith-Chart, Cartesian, Tabular, Polar, Smith-Polar combination, 3D-Cartesian, Locus Curve, Timing Diagram and Truth Table.
 - 2) *TinyCAD* - TinyCAD is an open source program which helps to draw circuit diagrams. It also use a front end to a number of PCB layout programs. We can use TinyCAD to publish our drawings by copying and pasting into a word document or saving as a PNG bitmap for the web. Various other features of TinyCAD are Drawing Overview, Create PCB's, Simulate with Spice, creating circuit diagrams for display on the web and in word and convert drawings in to .pdf format files.
 - 3) *FidoCadJ* - FidoCadJ is an open source multiplatform vector drawing program with a complete library of electronic symbols. It is the best tool for exchange sketches in forum and newsgroup discussion. It allows a great graphical flexibility without netlist concept. The Schematics and drawings are stored in a very compact text format. It has ability to export the drawings into several graphic formats, such as pdf.
 - 4) *SVEditor* - SVEditor is an open source Eclipse-based Integrated Development Enviornment. It is used for Verilog and SystemVerilog development. It also provides colorizing editor for SystemVerilog that support content assist and cross-linking between SysemVerilog files. Various features of SVEditor are Open class diagram, Open Declaration, Open type Hierarchy, New class/interface/module wizard and doc hover.
 - 5) *PIC sim* - PIC sim is an open source microcontroller simulator that emulates a microcontroller PIC and peripheries such as USART. It provides a way to easy implementation of external elements in c language.

- 6) *MC34063 Universal Calculator* - It is an open source universal calculator use to calculate any standard application, such as step-up, step-down, inverting and step-up-down.
 - 7) *Gputils* - Gputils is a open source software and a collection of tools for Microchip PIC microcontrollers. It was created by Craig Franklin and James Bowman. It includes gpasm, gplink, gplib and fully compatible with Microchip's tools; mpasm, mplink, mplib. It is licensed under GNU General Public License. Gputils is supported with Linux, Mac OS X and with MS- Windows.
 - 8) *Icarus Verilog* - Icarus Verilog is an open source Verilog simulation and synthesis tool that works as complier and compiling the source code of Verilog into some target format. Icarus Verilog can generate an intermediate code known as 'vvp assembly' for batch simulation. 'vvp' command is used to execute that intermediate code. That complier can also generate netlists for desire format.
 - 9) *Fritzing* - Fritzing is an open source hardware initiative for supporting the designers to convert physical prototype to actual product. We can also be seen it as an EDA (Electronic Design Automation) for non-engineers.
 - 10) *RapidSmith* - RapidSmith is an open source FPGA CAD tool for modern Xilinx FPGAs. Its objective is to serve as a rapid prototyping platform for research ideas and algorithms relating to low level FPGA CAD tools.
- C. These are some Open source softwares used in mechanical engineering are listed below:
- 1) *CalculiX* - CalculiX is an open source package to solve field problems. It takes input as Abaqus and used the finite element method for calculations. Both linear and non-linear calculations have been performed using CalculiX. It has both pre-processor and post-processor 3D tools that use openGPL API. The pre-processor is able to write mesh related data for nastran, abaqus, ansys, code-aster and for ISAAC and OpenFOAM. The original software is only compatible with Linux OS but Convergent Mechanical has ported it also for Windows OS.
 - 2) *Code Aster* - Code Aster is an open source package developed for numeric simulation in structural mechanics. The most of LOC of Code_Aster is written using FORTRAN and Python languages. It was released under GNU General Public License. Code_Aster is based on the theory of Finite elements. It covers a wide range of applications like 3D thermal analyses and mechanical analyses in linear and non-linear statics and dynamics, for machines, pressure vessels and civil engineering structures.
 - 3) *Deal.II* - Deal.II is an open source library that solves partial differential equations using finite element method. It allow parallelization using multithreading through Intel Threading Building Blocks and massively parallel using MPI. It also provides interfaces to several libraries including PETSc, Trilinos, METIS, VTK, p4est, BLAS, NetCDF and LAPACK.
 - 4) *Elmer FEM Solver* - Elmer is an open source computational tool for multi-physics problems that includes physical models of fluid dynamics, structural mechanics, electromagnetic, heat transfer and acoustics. These models are described by PDEs that is solved by Elmer using FEM (Finite Element Method). Elmer is the combination of several different parts: ElmerGUI, ELmerSolver, ElmerPost, ElmerGrid. These parts may also be used independently. Elmer is written in FORTRAN, C and C++. It is licensed under GNU General Public License and runs on Unix and Windows operating system.
 - 5) *FEAppv* - EAPpv known as Finite Element Analysis Program: Personal Version is an open source general purpose finite element analysis program that is designed for research and educational use. It is compatible with Unix, Linux and Windows OS environment.
 - 6) *FEBio* - FEBio, Finite Elements for biomechanics is an open source software package designed for finite element analysis and biomechanics applications. It also offers modeling scenarios, constitutive models and boundary conditions. It is also used to solve 3D large deformation solid mechanics and solid-fluid problems. It supports both dynamic and static analysis. It is developed to compatible with Linux, UNIX and Windows OS.
 - 7) *FEMM* - FEMM is an open source set of programs developed for solving low-frequency electromagnetic problems on two-dimensional planar and axi symmetric domains. It currently addresses linear/nonlinear magneto static problems, linear/nonlinear time harmonic magnetic problems, linear electrostatic problems, and steady-state heat flow problems.
 - 8) *FRANC2D and FRANC3D* - FRANC2D and FRANC3D is an open source two/three dimensional, finite element based program for simulating curvilinear crack propagation in planar (plane stress, plane strain, and axisymmetric) structures. It is developed by Cornell Fracture Group US. It is developed to support for Windows and Linux/UNIX OS.
 - 9) *Z88* - Z88 is an open source finite element software package. Z88 is coded in ANSI-C and licensed under GNU General Public License. It provides static

calculations in mechanical engineering and building & construction industries. Z88 is supported with Microsoft Windows, Mac OS X and UNIX/Linux Operating Systems.

IV. CONCLUSION

Engineering is the field where a particular solution for all other fields can be found. Engineers use their knowledge of science, mathematics, logic, economics, and appropriate experience or tacit knowledge to find suitable solutions to a problem. As with all modern scientific and technological endeavors, computers and software play an increasingly important role. If the software and techniques used in engineering are costly then it also produce costly solutions for other fields. The use of open source software is an efficient approach towards cheap solutions, for lower budget fields, easy to update and free distribution. In this research paper, we describe various open source software that are used in engineering and its branches.

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