CSSE1001: Assignment 3 – Design Document

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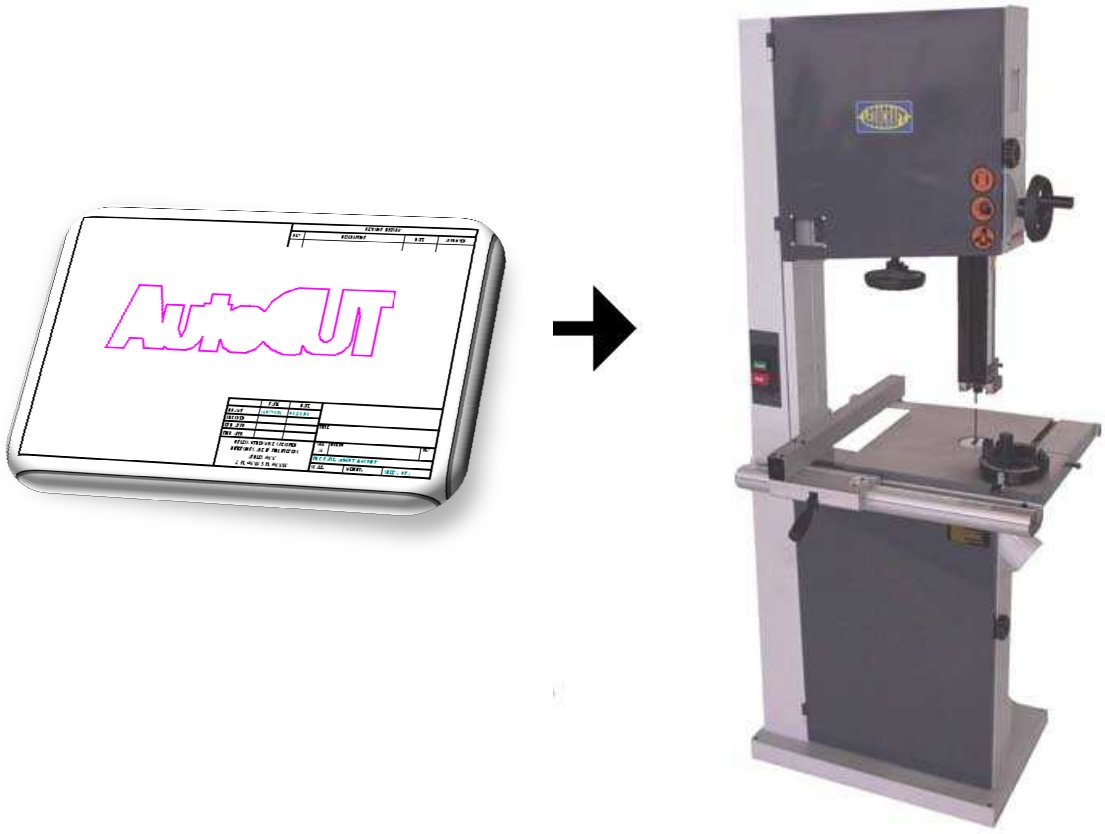
Project Title: CAM software…
AutoCUT 1.0: An Automated Bandsaw Software Package



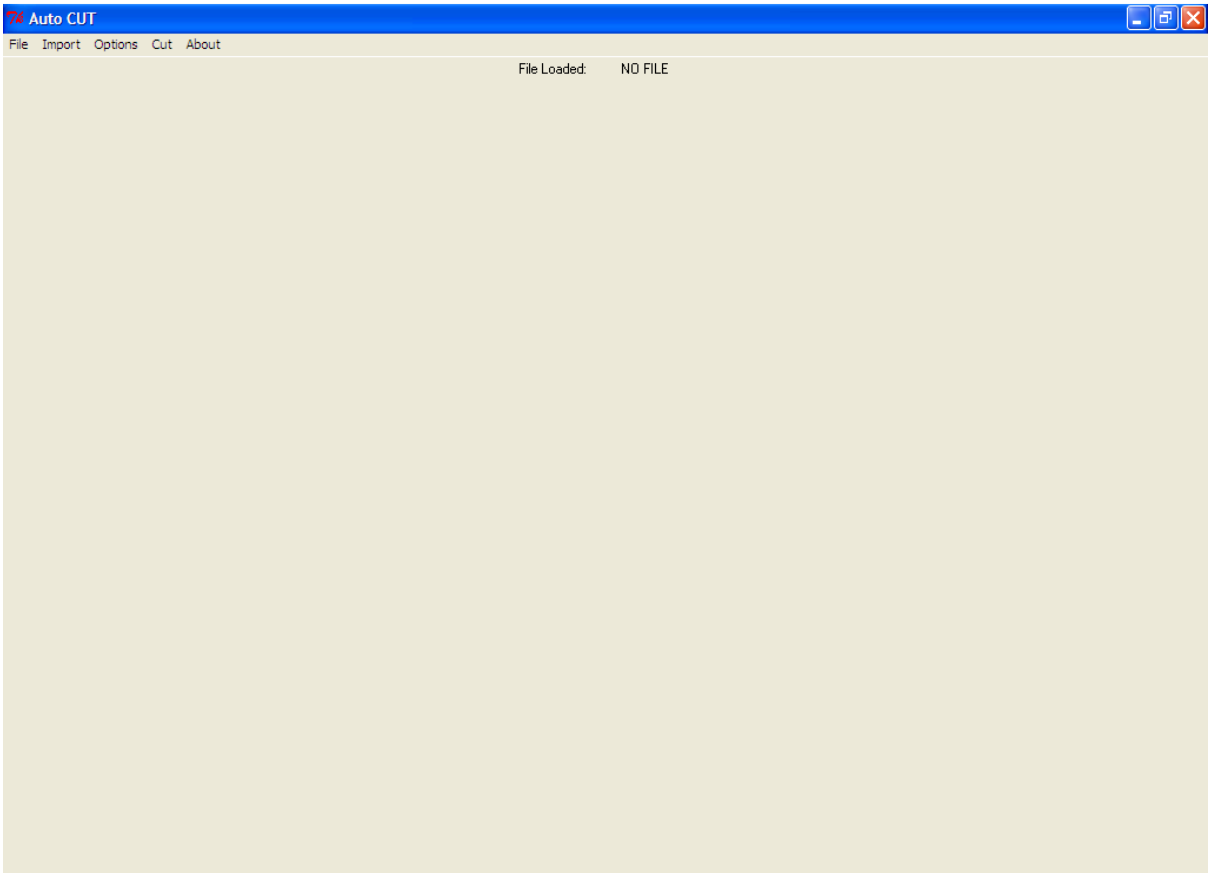
1. Description

Computer Aided Modelling (CAM) plays a vital role in industry today. CAM software systems link computer aided design (CAD) models to real machines, automating machining processes to increase production, increase precision and cut labour costs. The first step in the automated bandsaw development cycle is the development of the software system that provides the link between the CAD model and the machine responsible for feeding the material past the saw blade. To be useful this software must be able to read in data from CAD models and must output/write this data as a series of translations and rotations to be inputted to the feeder machine.

AutoCUT 1.0 is the first installation of this software package.

2. Getting Started with AutoCUT 1.0

2.1 AutoCUT 1.0



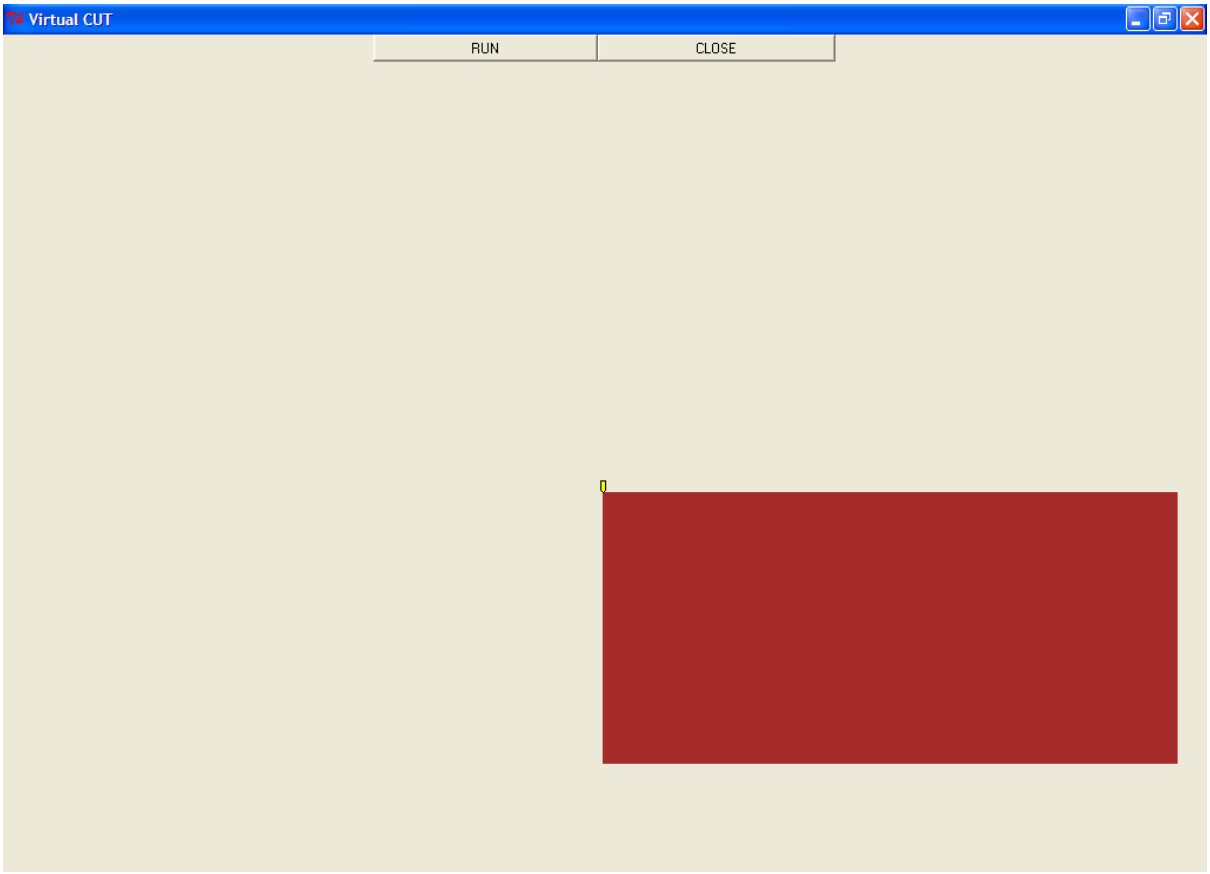
The Main Program Window

The first thing you will want to do is input the file you want to cut. AutoCUT 1.0 has two options to do this. *File -> Open JCode* opens a .jcd file containing the translations and rotations needed to cut your shape, or if you have not already calculated JCode for the shape and have it ready in an IGES file *Import -> Import IGES File* allows you to find the file directory and open it, inputting it into the program.

If you open a JCode file, your shape is ready to cut. Physical machine output is not supported in AutoCUT 1.0 but you can check your calculated JCode toolpath with a virtual run courtesy of VirtualCUT. *Cut -> Cut with VirtualCUT* brings up another program window titled VirtualCUT (see 2.2).

If you open an IGES file you must first calculate the JCode for your shape before you can cut your shape. *Options -> Options* opens a popup box with some parameters to use in calculating JCode (see 2.3). You may want to change these from their default settings before proceeding. *Options -> Calculate JCode* calculates the JCode for your current shape displayed on the AutoCUT canvas. Once you have calculated your JCode you can proceed to cutting it, *Cut -> Cut with VirtualCUT*. Why not go ahead and save it now for later use, *File -> Save JCode*.

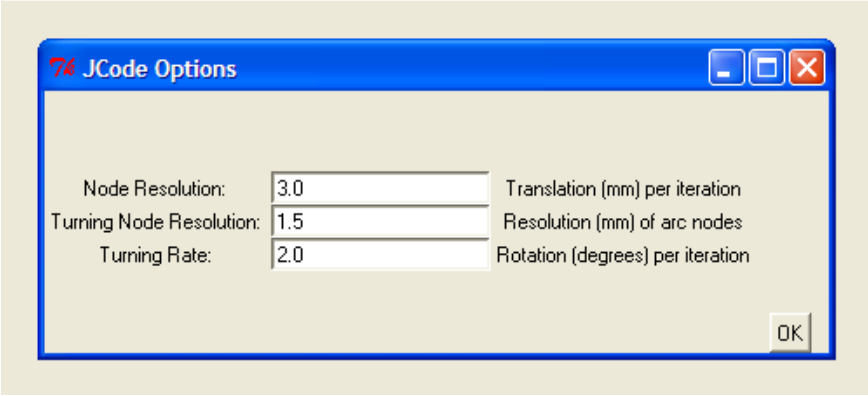
2.2 VirtualCUT



The VirtualCUT window

VirtualCUT is for demonstrating the toolpath calculated for your shape. The RUN button starts the animation, which continues until the VirtualCUT function reaches the end of the JCode. CLOSE closes the VirtualCUT window and returns to the main program window.

2.3 Options Dialog Box



JCode Calculation Options

The three options for calculating JCode in AutoCUT 1.0 are Node resolution, Turning Node resolution and Turn Rate. The Node resolution is how many millimetres the program goes before making another node on straight lines. Turning Node resolution is now many millimetres the program goes along an Arc before creating another node and rotating. The Turning rate is how many degrees the program rotates per iteration when changing orientation.

3. Design

In order for the software package to be truly usable it must be able to communicate with major CAD programs. This is achieved through the use of an international graphics exchange format (IGES). There are several CAD interchange formats in existence but IGES files seem to be the most widely accepted as standard. AutoCUT 1.0 only supports the importation of IGES files. These files consist of 5 sections of data that fully describe a CAD model. AutoCUT 1.0 only supports 2D drawings made up of line and arc entities represented in IGES format. 3D support will be a relatively simple patch for the future but as bandsaw's typically cut in 2 dimensions the program patch may have to be a standalone program named AutoROUTER.

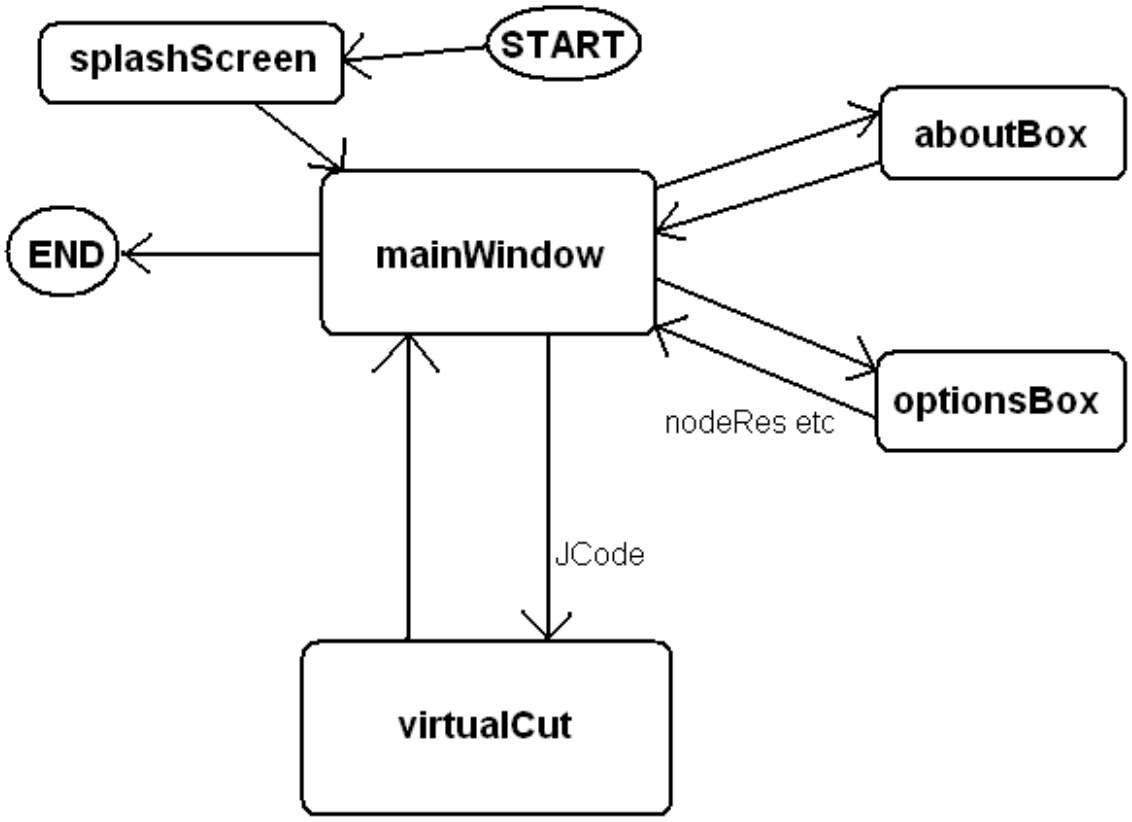


Figure 1 - Basic Class Interaction

The AutoCUT 1.0 software package consists of two main parts, a main window titled AutoCUT which handles almost the entire user interface including displaying the imported shape, and a popup window titled Virtual Cut to show a virtual demonstration of a machine feeding some material through the calculated toolpath. A class was designed for each main window, class mainWindow for

the AutoCUT application and class virtualCut for the virtual demonstration popup window. Some smaller classes handle things like the AutoCUT splash screen, the options dialog box (see 2.3) and the about box.

Class mainWindow:

Main Function Definitions:

openJCodeFile:
Uses tkFileDialog to get user to specify JCode file name and location. If a valid JCode file is selected, it opens file and reads contents to program variable JCode.

saveJCodeFile:
Uses tkFileDialog to get user to specify JCode save name and location. If program variable JCode is not empty, opens file and writes contents of JCode to it.

importIGES:
Uses tkFileDialog to get user to specify IGES file name and location. If a valid IGES file is selected, opens file, saves as string and sends to stand-alone function *readIGESFile*.

d*rawDesign:*
Clears main canvas ready for drawing. Sets pixel amount of whitespace on either axis of drawing then finds how much the shape has to be scaled by to fit in the current canvas. Scales each drawing coordinate and flips the y ordinates about the middle y point then draws each parameter using create_line and create_arc.

optionsDialog:
Displays a popup window with JCode calculation options.

cutWithVCut:
Sends current JCode variable to virtualCut class so that a demonstration of the calculated JCode can we seen.

calcJCode:
Calculates JCode from current imported IGES file according to options set in the Options box. Line entities become an initial rotation, then a series of translations. Arc entities become an initial rotation, then a series of translations and rotations.

Class virtualCut:

Main Function Definitions:

run:
Iterates through the list of data points in the variable JCode and sends each tuple to *self.draw.* Displays the trail as a filled polygon once the demonstration has finished.

drawTrail:
Draws trail list using create_line.

The virtual cut application follows the JCode directions explicitly without any logic of its own, it follows the software's output, just like an automated machine would.

A number of function definitions exist outside of the 2 main class definitions. The most important functions are:

readIGESFile:

Opens an IGES file and stores it's data in list variables. Extracts the files units out of the Global Parameters section and stores each line of the Parameter file data in an element of a list variable. Sends the Parameters to *filterPPars* then returns the filtered parameters and the file's units.

readPPars:

Converts the parameter data list into a list of lists of floating point numbers with the first entry an integer describing the entity. This function includes parsing each parameter line and joining lines if they are longer than one line in the IGES file.

filterPPars:

Filters out drafting lines from 2D drawings and any line that is not joined to another (ie. Dimensions and unjoined lines). Alternatively a click and destroy system could be used for filtering unwanted lines off of potential shapes. Eventually, which filtering option is used will be a selectable option.

findStretch:

Returns the required stretching factor to fit the current shape on the main canvas best.

rotateTrail:

Rotates every set of coordinated in the variable trail about the position of the saw blade using trigonometry.

drawMaterial:

Draws block of material as a polygon from the coordinates passed in for all four corners

4. Support Modules

Tkinter – Tkinter is used for the main application window GUI, the VirtualCUT GUI as well as the options and about popup boxes. Tkinter's canvas tools are used to display the shape on the main canvas and to draw the VirtualCUT demonstration.

tkFileDialog – tkFileDialog is used for the open and save JCut file menu buttons as well as the import menu buttons.

PIL – Python Imaging Library (PIL) is used to display the JPG splash screen image. If PIL is not available, AutoCUT defaults to loading the GIF version of the image.

Math – The inbuilt python module math is used extensively in various function algorithms. The trigonometry functions are extensively used to find angles and positions and the hypotenuse function is used to find lengths between points.

Time – The inbuilt python module time is used to delay the redrawing of the material, saw blade and cut trail to animate the demonstration.