3DM G-code Laser Path Input Conversion

Introduction

The 3DM model takes a proprietary laser path file as an input to the model. This file is specified in the 3DM input file, under the parameter “Laser Path Input Filename”. Each row of the laser path file represents a time step. If the time step in the laser path file is different from the time step used for the FEM model, the 3DM code will interpolate between the data points listed in the laser path file. Care should be taken to ensure that the laser path file has a sufficiently small timestep to properly resolve the path geometry and the laser on/off pulses, if applicable. The columns of the laser path input file contain the following information in this order:

Time X Coordinate Y Coordinate Laser Power

The units of each are determined by the user. An example of valid units are seconds, meters, meters, and watts for the time, x coodinate, y coordinate, and laser power respectively.

The gcode_to_lasercenter_file Program

The `gcode_to_lasercenter_file` program will create a laser path file from a 2D linear gcode file. This tool allows the user to convert either a simple, hand-written gcode file or a complex computer generated gcode path into a laser path input file compatible with the 3DM model. Gcode is a standardized language to control machine tools. Gcode files contain a series of movement commands to be performed at a specified rate, along with numerous other machine control commands. This program will only interpolate linear G0 and G1 gcode movement commands, as most post-processors for 3D printing will specify all movement using only these linear commands.

The syntax for running the `gcode_to_lasercenter_file` program is as follows, where the “input file” is a gcode file, the “output file” is the laser path file, and “time step” determines the time gap between each line of the laser path file.

```
./gcode_to_lasercenter_file <input_file> <output_file> <time_step>
```

Note that the resulting output laser path file must be specified in the 3DM input file and also placed in the same directory as the 3DM input file.

The Gcode File

Each line of the gcode file contains commands, followed by relevant parameters. The list below explains the meaning of the relevant commands and parameters.

- `G0` is the command for “rapid” linear movement, which is done with the laser turned off, and `G1` is the command for normal linear movement, which is done with the laser turned on. These commands are then followed by an `X` and/or `Y` parameter, which defines the location where the linear movement will go to from the current location. If only the X or Y parameters are specified for a G0 or G1 move, then the movement occurs only in the X or Y directions respectively.
- `F` is a parameter that defines the feedrate, or laser scan speed. This parameter can be placed at the end of a G0 or G1 command line, and will cause the movement defined on that gcode line and all following lines to be performed at this new feedrate. This feedrate will be used on all subsequent lines until another gcode line with an `F` command is reached.
- `S` is the command to specify the laser power. It is adapted from the “spindle speed” command used for conventional machine tools. It can be added to the end of gcode lines the same as the feedrate command.
- Semicolons are used to create comments. Entire lines can be commented out, and comments can also be placed at the end of a command line.

An example of a simple Gcode file is shown below.

```
1  ;U-shaped laser path in the center of a 500x500 micron test piece
2  ;16 cm/s scan speed
3
4  G1 X0.000180 Y0.000475 F0.16 S200
5  G1 Y0.000775
6  G1 X0.000080 S100
7  G1 Y0.000475
```

Lines 1 and 2 are commented out, and do not impact the laser path. Line 4 specifies that the laser spot begins at a position 180 microns in the positive x direction and 475 microns in the positive y direction from the model origin. The laser is turned on and its power is set to 200 watts. The initial feedrate is set to 160 mm per second. Line 5 defines a linear translation of the laser from (x,y) = (180,475) microns to (x,y) = (180,775) microns at a rate of 160mm/s with a laser power of 200W. Line 6 includes an S command, so the laser power is now reduced to 100W. Line 6 then defines a linear translation of the laser from (x,y) = (180,775) microns to (x,y) = (80,775) microns at a rate of 160mm/s and a laser power of 100W. FInally, line 7 defines a linear translation of the laser from (x,y) = (80,775) microns to (x,y) = (80,475) microns at a rate of 160mm/s and a laser power of 100W. Note that the units used in this example are not hard

coded, and the user can choose which units to use. Units, however, must be consistent and compatible for every input to the model.