

Documentation for GCodeMapper

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Abstract

GCodeMapper is a program which maps a g-code program's movements from one surface to another.

1 Introduction

This program was created, because I have only a three axis CAM software package <http://www.cambam.info> but a milling machine with an additional rotatory axis – as shown in figure 1. I use the machine controller software LinuxCNC <http://www.linuxcnc.org>. You can have a look at <http://wiki.linuxcnc.org/cgi-bin/wiki.pl?Rot4thaxiskins> for further information on how to set up the kinematics for such a kind of machine in LinuxCNC.

For a lot of problems it is sufficient to map the program cutting on the surface of a planar stock – as generated by a three axis CAM software – around a cylindrical stock. This is exactly what this program does – see figure 2. The mapping relation of coordinates $[X_p, Y_p, Z_p]^T$ in the planar program to coordinates $[X_c, Y_c, Z_c, A_c]^T$ in the resulting cylindrical program is

$$\alpha = \frac{Y_p}{r_c} \quad (1)$$

$$r = Z_p + r_c \quad (2)$$

$$\begin{bmatrix} X_c \\ Y_c \\ Z_c \\ A_c \end{bmatrix} = \begin{bmatrix} \mathbf{r}_o \\ 0 \end{bmatrix} + \begin{bmatrix} X_p \\ \sin(\alpha)r \\ \cos(\alpha)r \\ -\alpha \frac{180}{\pi} \end{bmatrix} \quad (3)$$

where \mathbf{r}_o denotes the origin of the cylinder and r_c the cylinder's radius. The cylinder's axis is parallel to the X -axis. A_c is the rotation of the tool's tip around an axis which is parallel to the X -axis and goes through the point $[X_c, Y_c, Z_c]^T$.

Straight motions (G0 and G1) in the planar program with a constant Z -coordinate are mapped to a helix (G2 or G3) in the cylindrical program. Straight motions in the planar program with a constant Y -coordinate are mapped to a straight motion (G1) in the cylindrical program. Straight motions violating these constraints and arcs (G2 and G3) are approximated by short line segments (G1). Note that a rapid movement (G0) is never mapped to a G0, that's why you have to pass a feed rate for mapped G0 movements. All other motions are not implemented, so only G0, G1, G2 and G3 movements are supported.

2 Installation

Only a source package is provided at <http://www.lederhilger.co.at/GCodeMapper/gcodemapper-1.1.tar.gz>. That means you have to compile this C++ program by yourself. This program has the following prerequisites:

- C++98 compiler
- CMake <http://www.cmake.org>
- Boost library <http://www.boost.org>



Figure 1: Machine with three cartesian and one rotatory axes

- Eigen3 library <http://eigen.tuxfamily.org>

To configure the program, create a build directory, change to it, and run

```
cmake <path to source directory>
```

or

```
cmake -DCMAKE_INSTALL_PREFIX=<path to install directory> <path to source
  directory>
```

and then run

```
make
make install
```

to compile and install the program. I have tested this with GCC on Linux.

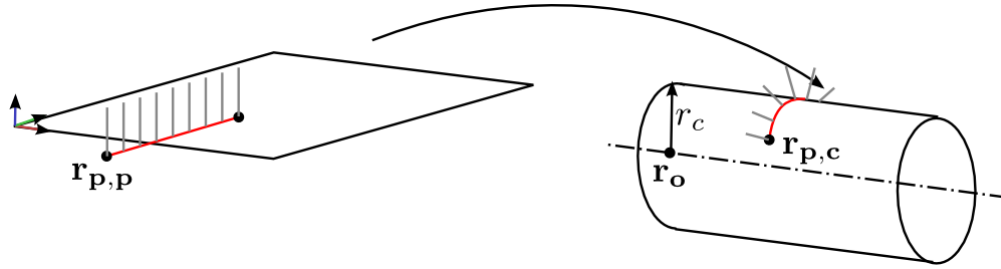


Figure 2: Mapping of a straight line from a plane onto a cylinder. Gray lines represent the tool.

3 Usage

Please note that I have used this program several times on my own machine, but it could still contain some bugs. So please take a look on the transformed program before running it on your machine!

The program has a command line interface. When running

```
gcodemapper --help
```

you get a general help, and when running

```
gcodemapper --help --mapper CylinderGCodeMapper
```

you get the help for the command line parameters of the CylinderGCodeMapper – no other mapper type¹ is implemented at the moment. Most of the parameters have reasonable defaults², only mapper, cylinder-diameter, rapid-feed-rate and input and output files are required. A hyphen is also accepted as the input and output file parameter. This means that the file is read from standard input or written to standard output. You can also specify parameters which are always the same in “gcodemapper.conf”. It is searched in the current working directory. In the following listing you can see an example.

Listing 1: gcodemapper.conf

```
mapper=CylinderGCodeMapper
rapid-feed-rate=900
```

3.1 Example

This section shows how to apply this program on an example g-code program which was generated by CAMBam. The example is shown in figure 3 and in listing 2.

Listing 2: example_planar.ngc

```
( example 8/22/2013 7:00:33 PM )
( T3 : 3.0 )
(STOCK/BLOCK,100.0,157.08,10.0,0.0,0.0,10.0 )
G21 G90 G91.1 G64 G40
( Engrave1 )
G0 Z50.0
( T3 : 3.0 )
( TOOL/MILL,3.0,0.0,0.0,0 )
O<wzw> call [3]
G0 Z50.0
G17
M3 S100
(begin mapping)
G0 X23.0 Y4.0
G0 Z5.0
```

¹In principle mapping to any other surface would be possible.

²for LinuxCNC

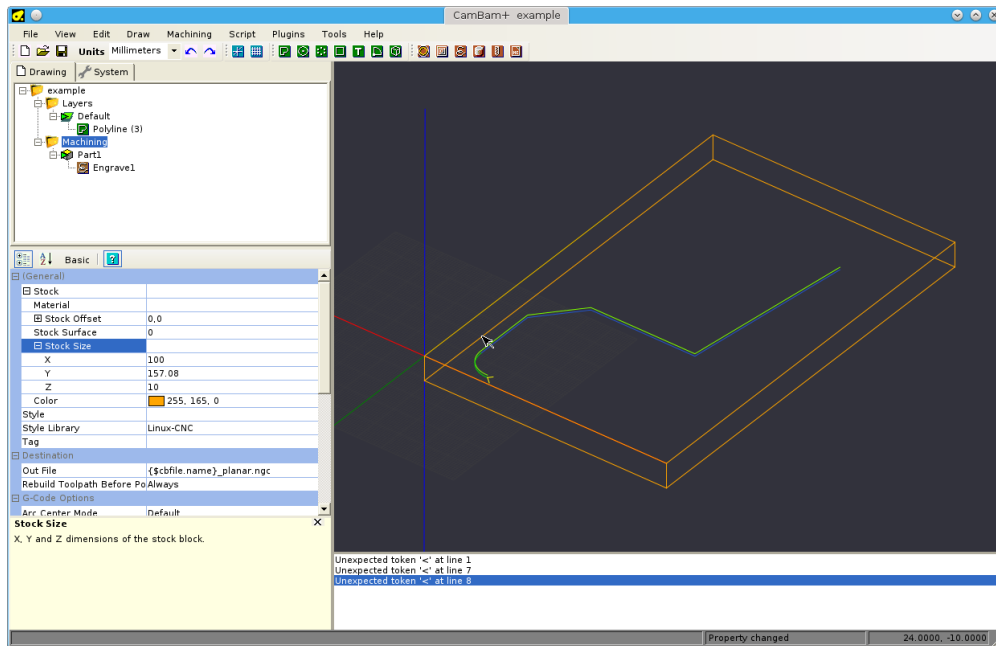


Figure 3: Example visible in CAMBam

```
G1 F30.0 Z-1.0
G2 F120.0 X13.0 Y14.0 I-0.487548322 J9.512451678
G1 Y39.0
G1 X27.0 Y55.0
G1 X70.0
G1 Y134.0 Z-11.0
(end mapping)
G0 Z50.0
M5
M30
```

When the command

```
gcodemapper --mapper CylinderGCodeMapper --cylinder-diameter 50
example_planar.ngc example_cylindrical.ngc
```

is executed, then everything between the begin and end mapping comment is mapped around the cylinder. The mapped output is shown in figure 4 and in listing 3.

Listing 3: example_cylindrical.ngc

```
( example 8/22/2013 7:00:33 PM )
( T3 : 3.0 )
(STOCK/BLOCK,100.0,157.08,10.0,0.0,0.0,10.0 )
G21 G90 G91.1 G64 G40
( Engrave1 )
G0 Z50.0
( T3 : 3.0 )
( TOOL/MILL,3.0,0.0,0.0,0 )
O<wzw> call [3]
G0 Z50.0
G17
M3 S100
G90 G90.1 G19
G0 Z50
G0 Y0
G2 F900 X23 Y7.96591 Z49.3614 A-9.16733 J0 K0 P1
```

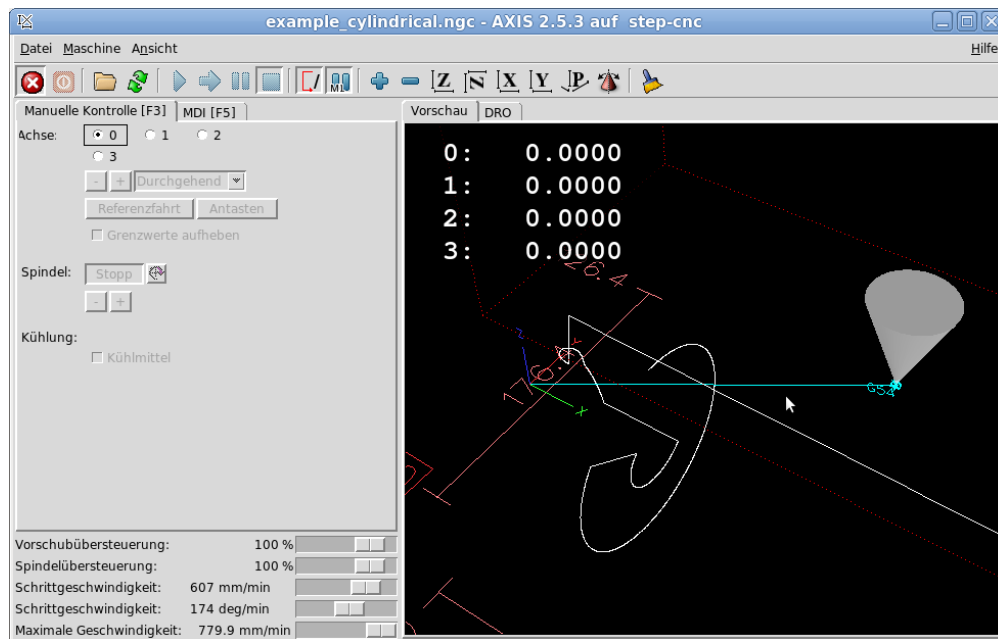


Figure 4: Example visible in Axis

```

G1 F900 X23 Y4.77955 Z29.6168 A-9.16733
G1 F30.0 X23 Y3.82364 Z23.6935 A-9.16733
G1 F120.0 X21.9381 Y3.82823 Z23.6927 A-9.17843
G1 X20.8833 Y3.94478 Z23.6736 A-9.46039
G1 X19.8488 Y4.17155 Z23.6347 A-10.0097
G1 X18.8473 Y4.50518 Z23.5734 A-10.8195
G1 X17.8915 Y4.94061 Z23.486 A-11.8798
G1 X16.993 Y5.47116 Z23.3681 A-13.1773
G1 X16.1632 Y6.08856 Z23.2149 A-14.696
G1 X15.4123 Y6.78299 Z23.0215 A-16.4169
G1 X14.7497 Y7.54326 Z22.7837 A-18.3187
G1 X14.1835 Y8.357 Z22.498 A-20.3778
G1 X13.7209 Y9.21088 Z22.1621 A-22.5684
G1 X13.3675 Y10.091 Z21.7755 A-24.8635
G1 X13.1279 Y10.9832 Z21.3394 A-27.2345
G1 X13.0048 Y11.8735 Z20.8571 A-29.6519
G1 X13 Y12.7485 Z20.3341 A-32.0856
G2 X13 Y23.9986 Z0.259107 A-89.3814 J0 K0 P1
G2 X27 Y19.4039 Z-14.124 A-126.051 J0 K0 P1
G1 X70 Y19.4039 Z-14.124 A-126.051
G1 X70 Y18.7243 Z-14.8102 A-128.343
G1 X70 Y18.021 Z-15.4646 A-130.634
G1 X70 Y17.2955 Z-16.0867 A-132.926
G1 X70 Y16.5492 Z-16.6756 A-135.218
G1 X70 Y15.7836 Z-17.2307 A-137.51
G1 X70 Y15.0002 Z-17.7515 A-139.802
G1 X70 Y14.2006 Z-18.2372 A-142.094
G1 X70 Y13.3862 Z-18.6876 A-144.385
G1 X70 Y12.5587 Z-19.1022 A-146.677
G1 X70 Y11.7195 Z-19.4807 A-148.969
G1 X70 Y10.8702 Z-19.8227 A-151.261
G1 X70 Y10.0125 Z-20.1282 A-153.553
G1 X70 Y9.14775 Z-20.397 A-155.845
G1 X70 Y8.27763 Z-20.6291 A-158.136
G1 X70 Y7.40366 Z-20.8243 A-160.428

```

G1 X70 Y6.52739 Z-20.9828 A-162.72
 G1 X70 Y5.65034 Z-21.1048 A-165.012
 G1 X70 Y4.77403 Z-21.1904 A-167.304
 G1 X70 Y3.89997 Z-21.2399 A-169.596
 G1 X70 Y3.02961 Z-21.2535 A-171.887
 G1 X70 Y2.16444 Z-21.2317 A-174.179
 G1 X70 Y1.30587 Z-21.175 A-176.471
 G1 X70 Y0.455324 Z-21.0837 A-178.763
 G1 X70 Y-0.385833 Z-20.9585 A-181.055
 G1 X70 Y-1.21625 Z-20.7999 A-183.346
 G1 X70 Y-2.03462 Z-20.6087 A-185.638
 G1 X70 Y-2.83965 Z-20.3855 A-187.93
 G1 X70 Y-3.63012 Z-20.131 A-190.222
 G1 X70 Y-4.40481 Z-19.8462 A-192.514
 G1 X70 Y-5.16258 Z-19.5318 A-194.806
 G1 X70 Y-5.9023 Z-19.1887 A-197.097
 G1 X70 Y-6.62289 Z-18.8179 A-199.389
 G1 X70 Y-7.32335 Z-18.4204 A-201.681
 G1 X70 Y-8.00268 Z-17.9972 A-203.973
 G1 X70 Y-8.65996 Z-17.5492 A-206.265
 G1 X70 Y-9.2943 Z-17.0777 A-208.557
 G1 X70 Y-9.90489 Z-16.5837 A-210.848
 G1 X70 Y-10.4909 Z-16.0683 A-213.14
 G1 X70 Y-11.0517 Z-15.5328 A-215.432
 G1 X70 Y-11.5866 Z-14.9783 A-217.724
 G1 X70 Y-12.0949 Z-14.4061 A-220.016
 G1 X70 Y-12.5761 Z-13.8173 A-222.308
 G1 X70 Y-13.0297 Z-13.2132 A-224.599
 G1 X70 Y-13.4553 Z-12.595 A-226.891
 G1 X70 Y-13.8524 Z-11.9642 A-229.183
 G1 X70 Y-14.2207 Z-11.3218 A-231.475
 G1 X70 Y-14.56 Z-10.6692 A-233.767
 G1 X70 Y-14.87 Z-10.0078 A-236.059
 G1 X70 Y-15.1505 Z-9.33873 A-238.35
 G1 X70 Y-15.4015 Z-8.66334 A-240.642
 G1 X70 Y-15.6229 Z-7.98292 A-242.934
 G1 X70 Y-15.8147 Z-7.29874 A-245.226
 G1 X70 Y-15.977 Z-6.61208 A-247.518
 G1 X70 Y-16.1098 Z-5.92419 A-249.81
 G1 X70 Y-16.2134 Z-5.23633 A-252.101
 G1 X70 Y-16.2879 Z-4.54972 A-254.393
 G1 X70 Y-16.3336 Z-3.86559 A-256.685
 G1 X70 Y-16.3509 Z-3.18513 A-258.977
 G1 X70 Y-16.3401 Z-2.5095 A-261.269
 G1 X70 Y-16.3016 Z-1.83987 A-263.561
 G1 X70 Y-16.2358 Z-1.17735 A-265.852
 G1 X70 Y-16.1434 Z-0.523052 A-268.144
 G1 X70 Y-16.0249 Z0.121968 A-270.436
 G1 X70 Y-15.8807 Z0.756669 A-272.728
 G1 X70 Y-15.7117 Z1.38005 A-275.02
 G1 X70 Y-15.5184 Z1.99113 A-277.312
 G1 X70 Y-15.3015 Z2.58899 A-279.603
 G1 X70 Y-15.0619 Z3.17273 A-281.895
 G1 X70 Y-14.8002 Z3.74148 A-284.187
 G1 X70 Y-14.5174 Z4.29443 A-286.479
 G1 X70 Y-14.2142 Z4.8308 A-288.771
 G1 X70 Y-13.8915 Z5.34986 A-291.063
 G1 X70 Y-13.5503 Z5.85092 A-293.354

```

G1 X70 Y-13.1913 Z6.33332 A-295.646
G1 X70 Y-12.8157 Z6.79646 A-297.938
G1 X70 Y-12.4243 Z7.23978 A-300.23
G1 X70 Y-12.0181 Z7.66278 A-302.522
G1 X70 Y-11.5981 Z8.06497 A-304.814
G1 X70 Y-11.1654 Z8.44596 A-307.105
G1 F900 X70 Y-39.8764 Z30.1641 A-307.105
G3 F900 X70 Y0 Z50 A-0 J0 K0 P1
G90 G91.1 G17
G0 Z50.0
M5
M30

```

4 License

GCodeMapper – maps movements of a g-code program from one surface to another ,
eg. plane to cylinder.

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5 History

You can find the history of the program in table 1.

Version	Date	Remarks
1.0	2013-08-23	Initial release
1.1	2013-08-24	Added tool's orientation in figure 2

Table 1: Changelog