## LAMPIRAN I. PENGOPERASIAN APLIKASI GRBL

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Gambar 1.2 Pengoperasian Aplikasi GRBL untuk pengujian akurasi sistem kontrol dan fungsi laser bentuk segitiga



Gambar 1.4 Impor gambar ke dalam aplikasi GRBL untuk proses grafir

LaserGRBL v3.3.0	🐇 Import Raster Image	
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Gambar 1.5 Setting kecepatan gerak *engraving speed* 1000 mm/min dan daya laser *S-Max* 105

LaserGRBL v3.3.0	🔸 Import Raster Image	
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Gambar 1.6 Setting kecepatan gerak *engraving speed* 1000 mm/min dan daya laser *S-Max* 155

🔸 LaserGRBL v3.3.0	🐇 Import Raster Image	
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Gambar 1.7 Setting kecepatan gerak *engraving speed* 1000 mm/min dan daya laser *S-Max* 205

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Gambar 1.8 Setting kecepatan gerak *engraving speed* 1000 mm/min dan daya laser *S-Max* 255

LaserGRBL v3.3.0	🖕 Import Raster Image	
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Gambar 1.9 Setting kecepatan gerak *engraving speed* 1500 mm/min dan daya laser *S-Max* 105

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Gambar 1.10 Setting kecepatan gerak *engraving speed* 1500 mm/min dan daya laser *S-Max* 155

🔸 LaserGRBL v3.3.0	Junport Raster Image	
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Gambar 1.11 Setting kecepatan gerak *engraving speed* 1500 mm/min dan daya laser *S-Max* 205

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F4252           Lines: 12853		

Gambar 1.12 Setting kecepatan gerak *engraving speed* 1500 mm/min dan daya laser *S-Max* 255

AserGRBL v3.3.0	🗼 Import Raster Image	
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Gambar 1.13 Setting kecepatan gerak *engraving speed* 2000 mm/min dan daya laser *S-Max* 105

🔸 LaserGRBL v3.3.0	🖕 Import Raster Image	
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Gambar 1.14 Setting kecepatan gerak *engraving speed* 2000 mm/min dan daya laser *S-Max* 155

🗸 🔸 LaserGRBL v3.3.0	🔸 Import Raster Image	
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F4252		Cancel Createl

Gambar 1.15 Setting kecepatan gerak *engraving speed* 2000 mm/min dan daya laser *S-Max* 205

🔸 LaserGRBL v3.3.0	🐇 Import Raster Image	
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⊘ MS	Conversion Tool  Une To Line Tracing  Une To Line Options Direction Uertical  Quality 13.000 Lines/mm  Line Preview	Target image       Speed       Engraving Speed 2000       mm/min       Laser Options       Laser ON       M3 • Laser OFF       M3 • Laser OFF
F4252		

Gambar 1.16 Setting kecepatan gerak *engraving speed* 2000 mm/min dan daya laser *S-Max* 255

kaserGRBL v3.3.0	🔸 Import Raster Image
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Gambar 1.17 Setting kecepatan gerak *engraving speed* 2500 mm/min dan daya laser *S-Max* 105

🚸 LaserGRBL v3.3.0	with the ster Image	
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Gambar 1.18 Setting kecepatan gerak *engraving speed* 2500 mm/min dan daya laser *S-Max* 155

A LaserGRBL v3.3.0	🔺 Import Raster Image	
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© G3X50.5Y25.8I-25J0F200 ⊘ M5 @ [5 lines, 0 errors, 47 ⊘ G0 X0 Y0 Z0	1bit BW Dthering     Vectorize!     Centerline Line To Line Options Direction Vertical	Engraving Speed 2500 mm/min Laser Options Laser ON M3 Laser OFF M5 1 S-MIN 0 S-MAX 205 1 Image Size and Position [mm]
	Quality 13.000 🛬 Lines/mm 👔	Cancel Createl
F4252 Lines: 12853 Buffer		

Gambar 1.19 Setting kecepatan gerak *engraving speed* 2500 mm/min dan daya laser *S-Max* 205

g     LaserGRBL v3.3.0     Import Raster Image       Grbl     File     Colors     La       Do     COM COM23     Baud       Progress     Contrast       Vpts spcode hare     BaW       © G98     0.55       © G98     0.55       © G98.0.5755.8     Conversion Tool       © G98.2.5755.8     © Line To Line Tracing				
Grbl     File     Colors     La       Parameters     Perview     Original       Progress     Contrast       Progress     Contrast       Progress     Contrast       Passe     Conversion Tool       Pass     Speed       Passe     Speed	A LaserGRBL v3.3.0	🖕 Import Raster Image		
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Gambar 1.20 Setting kecepatan gerak *engraving speed* 2500 mm/min dan daya laser *S-Max* 255



Gambar 1.21 Tampilan Gambar yang akan di grafir laser aplikasi GRBL

+	Parameter	Value	Unit	Description	
\$0	0 Step pulse time	10	microseconds	Sets time length per step. Minimum 3usec.	
\$1	1 Step idle delay	25	milliseconds	Sets a short hold delay when stopping to let dynamics settle before disabling steppers. Value	
\$2	2 Step pulse invert	0	mask	Inverts the step signal. Set axis bit to invert (000002YX).	
\$3	3 Step direction invert	5	mask	Inverts the direction signal. Set axis bit to invert (000002YX).	
\$4         Invert step enable pin         0         boolean           \$5         Invert limit pins         0         boolean           \$6         Invert probe pin         0         boolean		boolean	Inverts the stepper driver enable pin signal.		
		boolean	Inverts the all of the limit input pins.		
		boolean	Inverts the probe input pin signal.		
\$1	10 Status report options	1	mask	Alters data included in status reports.	
\$1	11 Junction deviation	1,000	millimeters	Sets how fast Grbl travels through consecutive motions. Lower value slows it down.	
\$1	12 Arc tolerance	0,002	millimeters	Sets the G2 and G3 arc tracing accuracy based on radial error. Beware: A very small value may	
\$1	13 Report in inches	0	boolean	Enables inch units when returning any position and rate value that is not a settings value.	
\$2	20 Soft limits enable	0	boolean	Enables soft limits checks within machine travel and sets alarm when exceeded. Requires homin	
\$2	21 Hard limits enable	0	boolean	Enables hard limits. Immediately halts motion and throws an alarm when switch is triggered.	
\$2	Homing cycle enable 0 bool		boolean	Enables homing cycle. Requires limit switches on all axes.	
\$2	Homing direction invert 0 mask		mask	Homing searches for a switch in the positive direction. Set axis bit (000002YX) to search in n	
\$2	Homing locate feed rate         25,000         mm/min           Is         Homing search seek rate         500,000         mm/min		mm/min	Feed rate to slowly engage limit switch to determine its location accurately. Seek rate to quickly find the limit switch before the slower locating phase.	
\$2			mm/min		
\$2	26 Homing switch debounce delay	250	milliseconds	Sets a short delay between phases of homing cycle to let a switch debounce.	
\$2	27 Homing switch pull-off distance	Homing switch pull-off distance 1,000 millimeter		Retract distance after triggering switch to disengage it. Homing will fail if switch isn't cle.	
\$3	30 Maximum spindle speed	Maximum spindle speed 300 RPM Maximum spindle speed. Sets FWM to 100% duty cycle.		Maximum spindle speed. Sets PWM to 100% duty cycle.	
\$3	31 Minimum spindle speed	0	RPM	Minimum spindle speed. Sets PWM to 0.4% or lowest duty cycle.	
\$3	32 Laser-mode enable	1	boolean	Enables laser mode. Consecutive G1/2/3 commands will not halt when spindle speed is changed.	
\$1	100 X-axis travel resolution	80,000	step/mm	X-axis travel resolution in steps per millimeter.	
\$1	101 Y-axis travel resolution	80,000	step/mm	Y-axis travel resolution in steps per millimeter.	
\$1	102 Z-axis travel resolution	250,000	step/mm	Z-axis travel resolution in steps per millimeter.	
\$1	110 X-axis maximum rate	10000,000	mm/min	X-axis maximum rate. Used as GO rapid rate.	
\$1	111 Y-axis maximum rate	10000,000	mm/min	Y-axis maximum rate. Used as GO rapid rate.	
\$1	112 Z-axis maximum rate	500,000	mm/min	Z-axis maximum rate. Used as GO rapid rate.	
Ref	efresh 🧧 Write	Export -	nc 🧣 Import		

Gambar 1.22 Konfigurasi GRBL

#### Lampiran 2. Arduino nano PIN out



Pin No.	Name	Туре	Description
1-2, 5-16	D0-D13	I/O	Digital input/output port 0 to 13
3, 28	RESET	Input	Reset (active low)
4, 29	GND	PWR	Supply ground
17	3V3	Output	+3.3V output (from FTDI)
18	AREF	Input	ADC reference
19-26	A0-A7	Input	Analog input channel 0 to 7
27	+5V	Output or	+5V output (from on-board regulator) or
		Input	+5V (input from external power supply)
30	VIN	PWR	Supply voltage

#### Arduino Nano Mechanical Drawing



# Lampiran 3. Desain alat



Desain mesin laser grafir



Gambar Tampak Samping kiri



Gambar Tampak Depan



Gambar tampak atas



# Lampiran 4. Dokumentasi Penelitian



Hasil uji kontrol dan fungsi laser gambar segi tiga



Hasil uji kontrol dan fungsi laser gambar Persegi



Hasil uji kontrol dan fungsi laser gambar lingkaran



Spesimen untuk pengujian kontrol dan fungsi laser



Bahan kulit untuk pengujian grafir parameter daya dan kecepatan



Proses pemasangan komponen mikrokontroler



Proses pemasangan frame dan bracket



Proses pemasangan komponen laser module



Bahan-bahan kulit di industry kerajinan kulit Ma`wa art Jember



Alat-alat pendukung di industry kerajinan kulit Ma`wa Art Jember

## Lampiran 5. G Code

otocol Raster import Jog control Autor	natic cooling GCode	
Header		
G90 (use absolute coordinates)	LaserGRBL will append this GCode before starting any job. You can customize this code, for example adding M8 to tum on fan. Here you can use the same syntax of custom buttons if you need to push some positioning related to the specific job is going to be executed.	
Multiple Passes		
G91 G0 Z-1 (sinks the Z axis) G90	When performing multiple passes LaserGRBL will push this GCode in the between of each passes. Can be used to move Z down to perform deeper cuts. Here you can use the same syntax of custom buttons.	
Footer		
G0 X0 Y0 Z0 (move back to origin)	LaserGRBL will enqueue this GCode at the end of any job. Can be used to push back your engraver in a initial state like going back to zero position or sending M9 to turn off far etc. Here you can use the same syntax of custom buttons.	
	Cancel	ave

Pengaturan G Code pada aplikasi GRBL

Pengetahuan tentang perintah G-code akan memberi kita pengetahuan yang lebih komprehensif mengenai teknik pencetakan 2D dan 3D. Orang yang mampu memecahkan masalah printer 3D, mereka akan lebih baik pemahamannya dalam mengontrol setiap aspek dari proses cetak dan mampu mengidentifikasi dan mencegah kegagalan cetak jauh sebelum terjadi.

G-code adalah singkatan dari "Geometric Code". Fungsi utamanya adalah untuk menginstruksikan mesin dalam menggerakkan nozzle bagaimana cara bergerak secara geometris dalam 3 dimensi. Disamping itu juga dapat memerintahkan mesin untuk melakukan hal-hal non-geometris. Sebagai contoh, perintah G-code dapat memberitahu printer 3D untuk menghentikan penggunaan material pada tingkat ekstrusi yang ditentukan atau mengubah suhu extruder.

Dalam istilah formal, G-Code bisa dikatakan sebagai bahasa pemrograman kontrol numerik. Bagi mereka yang tahu cara memprogram, itu adalah bahasa pemrograman yang mudah. Hingga saat ini, G-Code belum memiliki konstruksi lanjutan seperti variabel, kondisional, dan loop (pengulangan). Contoh G-Code: Untuk mengenal lebih detail mengenai G-Code, berikut akan disertakan satu baris script dari G-Code.

### M03 G1 X-9.2 Y-5.42 M05

- Baris ini memberi tahu mesin laser untuk menghidupkan laser (laser ON) dengan perintah M03 dan bergerak dalam garis lurus menuju koordinat tujuan X = -9.2, dan Y = -5.42. Setelah itu menginstruksikan mesin laser untuk mematikan laser (perintah M05).
- 2. Perintah kode-G yang dimulai dengan huruf G yang mengandung arti sebagai perintah geometris. Memberi tahu mesin laser bagaimana cara bergerak, tetapi ini jelas tidak cukup untuk mengontrol semua aspek mesin tersebut. Bagaimana jika Anda perlu memberi tahu mesin untuk mematikan laser atau menyalakannya? Untuk tugas-tugas non-geometris ini, implementasi kode-G juga mendefinisikan serangkaian perintah lain yang dimulai dengan huruf M, secara tepat disebut Kode M. Misalnya, perintah M03 untuk menyalakan laser dan perintah M05 memberitahu mesin untuk mematikan laser.
- Setiap huruf bahasa Inggris yang Anda temui dalam kode akan memiliki arti tertentu. Sebagai contoh, kita belajar bahwa G berarti perintah geometris, M berarti perintah non-geometris, X berarti koordinat X, Y berarti koordinat Y, F berarti laju umpan, dan sebagainya

## Lampiran 6. BIODATA PENULIS



Sekolah / Universitas	Jenjang	Tempat	Tahun
TK Muslimat NU Nurul huda	ТК	Wuluhan	1998- 2000
SD NU 03 Nurul Huda Dukuh Dempok	SD	Wuluhan	2000- 2006
SMP Muhammadiyah 06 Wuluhan	SMP	Wuluhan	2006- 2009
SMA Muhammadiyah 2 Wuluhan	SMA	Wuluhan	2009- 2011
Universitas Muhammadiyah Jember	Strata 1	Jember	2013- 2020