GARI 3.0: Gantry Automated Rework Interface

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BACKGROUND

Printed Circuit Boards are ubiquitous in the electronics industry. They are present in all modern digital devices. Some PCBs have anywhere up to 10,000 components across their surfaces. Northrop Grumman uses expensive PCBs that are produced in low volume, rendering board replacement impractical.. However, it is incredibly challenging to reliably remove defects without damaging any peripheral circuitry in an efficient, effective manner. To solve this, we present GARI: a fully automated, reliable solution to automatically remove defective components.

OVERVIEW / DESIGN SPECS

The Gantry Automated Rework Interface uses CNC firmware to precisely and autonomously move the heating and removal systems onto the target component. The machine uses a laser to apply localized heating to desolder the target component, without heating the solder of nearby components. The vacuum then removes the component once the solder is melted. The user can easily start the part removal process with the integrated touchscreen and graphical user interface (GUI). Once the user chooses the component to remove, the Raspberry Pi 4 handles control of the motors, laser, and vacuum.

OPERATIONAL FLOWCHART

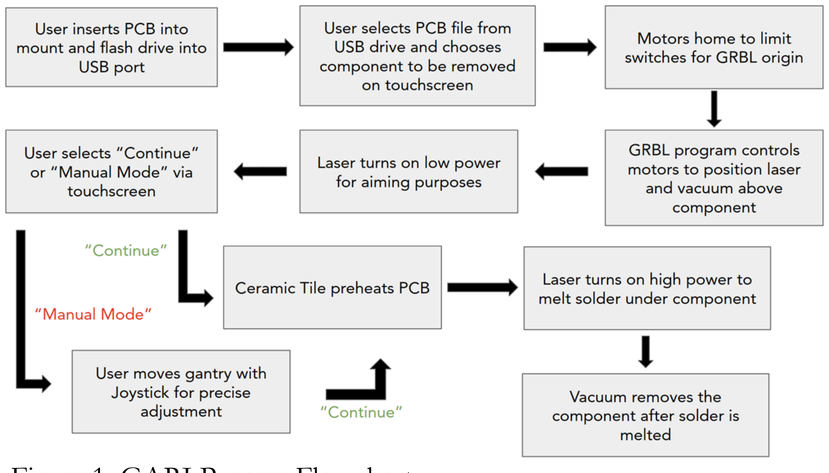


Figure 1: GARI Process Flowchart

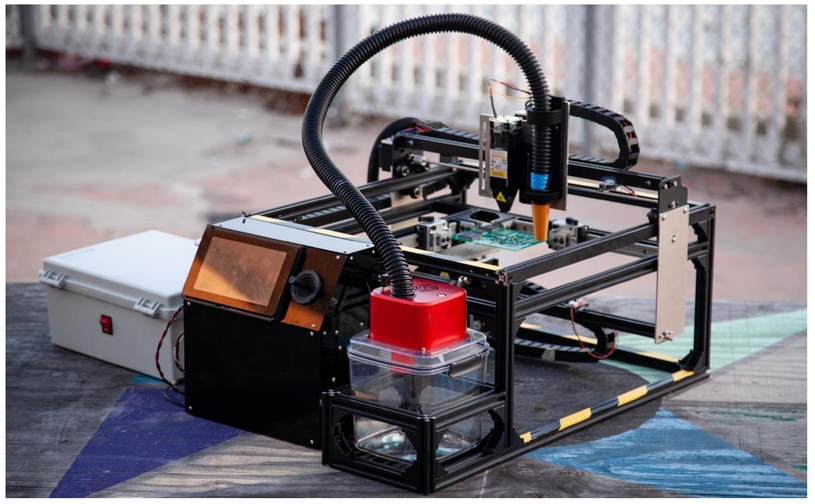
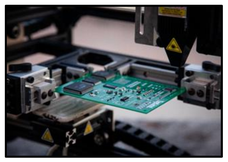


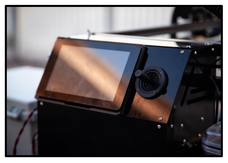
Figure 2: GARI 3.0

CORE SUBSYSTEMS



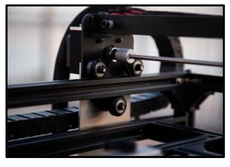
PCB Mounting

User mounts PCB into a fixed extruded corner, securing it with linear guide rail slider assemblies. Provides full 2D coverage for boards from 2“x2" to 10"x10“ in size, up to 2 lbs.



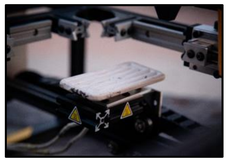
GUI & User Control

7" Raspberry Pi touchscreen with custom GUI that enables component selection from a PCB neutral file (via flash drive). Helps coordinate all subsystems to operate autonomously in sync



Gantry Movement System

Dual-axis stepper motor system with limit switches for homing and precise component positioning. Includes manual joystick override for fine adjustments.



Preheating & Heating

Ceramic heater preheats the board to prevent thermal shock, monitored by a FLIR radiometric camera. A 10W blue light laser then targets components, melting solder within 45 seconds.

Component Removal

Extracts selected component (which can weigh up to 20g) after solder melts, transferring them to a designated offsite location.

Key Results

Customer Need	Engineering Characteristic	Target Specification	Actual Specification
Variable Component Size	Range of Target Removal Part Sizes	1x1mm - 10x10mm	2x2mm - 7x5mm
Detach Target from Board	Target Solder Melting Temperature	~183℃	180℃
Don’t Damage Surroundings	Adjacent Component Max Temperature	<160℃	<160℃
No Heat Shock to PCB	Minimum Preheating Temperature	80-120℃	~110℃
Precise Laser and Vacuum placement	Largest Motor Resolution	0.010”	0.002”

Figure 3: Ceramic Tile Steady State Heating Temperatures Achieved Past 10 Minutes for all Distances Between Component and Circuit Board

PART REMOVAL VALIDATION

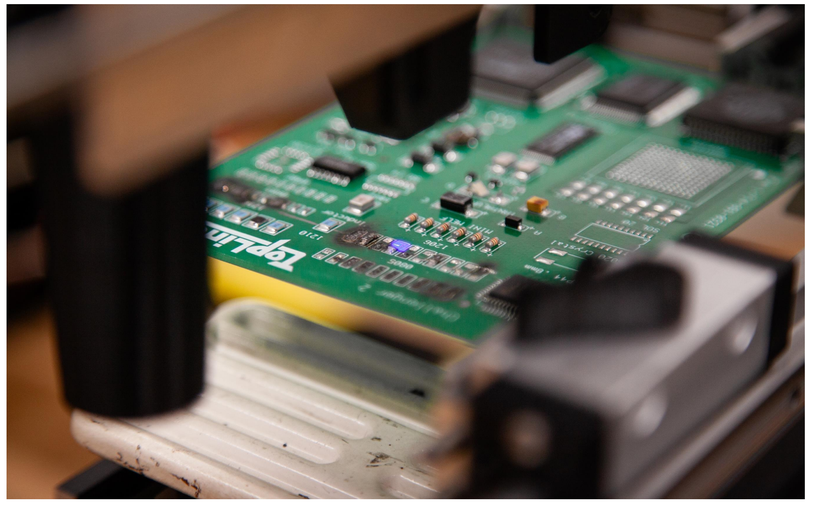


Figure 4: 10W Laser Component Removal @ 20% PWM Signal in 45 Seconds after 5 min Ceramic Tile Preheating Preparation Period

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