

Bracket Bot Update 1

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This project is not about making money. It's to offer a better option to expensive, closed-source humanoid robots. We're creating a hardware and software kit that a developer can write apps for without deep robotics experience.

If you reflect deeply on the amazing things humans have done, it's clear (to me, at least) that people who care the most also affect the most change. When you care, when you are obsessed, your thoughts are like liquid; capillating through every vein of the project. That's what makes difficult things succeed.

0. Some background

Almost exactly [24 years ago](#) we had the Honda ASIMO. Somehow, today, it seems we have even fewer robots now than we did then. Until about a year ago.



Honda ASIMO reveal demo

Two major projects were dropped recently that brought lots of optimism, and hype, to the robotics scene.

1. The [Aloha Project](#) by Tony Zhao introduced the first feasible algorithm for bi-manual manipulation tasks on a low cost platform.
2. The [UMI Project](#) introduced a platform for easily curating the quantity of data needed for robots to learn enough skills to be useful.

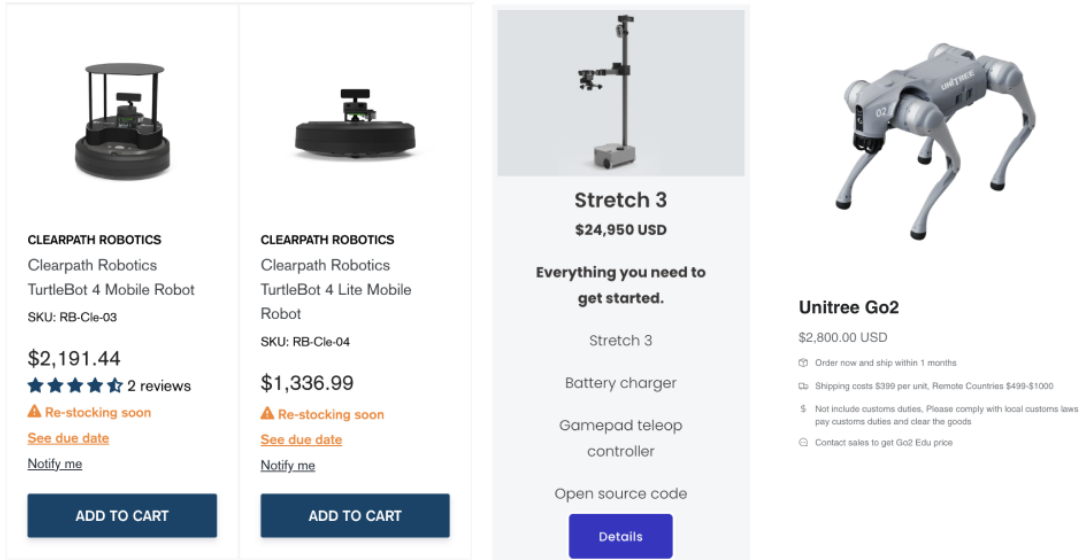
TL:DR; we now have the steps to solve robotics like how self-driving was *solved in the past few years.

*I would say new version of Tesla FSD and Waymo could consider self-driving solved

This led to dozens of humanoid robotics companies popping up in the past year, competing to offer the first humanoid robot. Despite this, **you won't have one in your home until at least 2030**. They still cost \$20,000+, and need a lot more development.

My hypothesis is that a community built around a solid open source robotics platform can beat humanoids to the home, **while** being more fun, inspiring, and customizable.

The reason I care about Bracket Bot so much isn't primarily logical. I just really fucking love robots. I literally cannot buy a robot right now that I can just program to drive around my apartment and hand me something, or even just *talk* — no easy SDK to just download and start playing with. Definitely not easy to add more sensors or actuators to. If you're wondering what the current options are:



Current options in the “hobbyist/hacker” robotics market, with openish source code

Let’s say I **have** \$25,000 and, as a software engineer, I want a simple robot in my home that greets me at the door, says hello, and moves out of the way so I can walk in. How do you do it?

Thinking

There's no good answer. You can buy some premade hardware like above, but to write your own navigation, obstacle avoidance, motion API? That’s not a weekend project. So, suddenly, to program even the simplest idea, you have to become a full-fledged robotics expert.

00. What is a Bracket Bot?

Bracket Bot spawned as a passion project by [Me](#), [Ivan](#), [Clayton](#), and [Ethan](#), inspired by the [Comma Body](#). We just thought it would be fun to make our own, so the past 2 years while in school we worked on it, part time, for fun.

Comma.ai hosted Comma Hacks 4, which was a navigation challenge for the Body. I suggest watching this [very entertaining stream](#) of the demos.

Bracket Bot is just our take on a similar form factor, simply inspired by the idea of the a simple, cheap, mobile platform.

000. What success looks like

In 2000, the cheapest 3D printer was \$20,000. When I started high school, my parents bought me the first Prusa 3D printer. It was \$1000. How did the cost reduce by 95% in just 15 years?

My hypothesis is that the [RepRap](#) project was the driving force. 3D printing had a strong community of hackers that helped commoditize it, building on each other's work, making 3D printing accessible to the masses. Today, we have amazing, easy to use 3D printers for just [\\$200](#). If it weren't for RepRap, we'd likely still have the Stratasys monopoly selling commercial printers for \$20,000. We have **better, cheaper** 3D printers as a result of this project and community.

Having a 3D printer changed my life. It enabled me to learn engineering at home. I am grateful we have the cheap, great 3D printers we do today.

Today, we have humanoid robotics companies, selling robots for \$20,000+. Sounds very familiar... Although no situation in history is identical, we can still observe similarities. I think that we can also make **better, cheaper** home robots with a 2000's 3D printing style moment right now in robotics. Open, accessible primitives mean that progress can be made by the community, rather than only within companies.

I want Bracket Bots to be the new Raspberry Pi. You get one, read up a bit to learn enough to do what you want to do, and then build something new. Some people will take it to extremes, adding lots of new functionality, some will just add a light. The reason I think this is insanely powerful is that **if we do this kit right** it means that a 'simple project' with a Bracket Bot can be something other people are buying humanoids the price of a car for, and a 'complex project' would be something you probably can't even buy for 5-10 years from a commercial company. **ISN'T THAT INSANE?!**

I think we can all agree that the open sourcedness of LLM's right now is really important as well.

I. We built 5.5 Bracket Bots in the first month

One month into the Bracket Bot project, we've built 5.5 robots so far. They're already cheaper and more entertaining than a roomba.



Robots being non-mass-manufactured in our apartment.



First Bracket Bot cleans the house with a swiffer.

II. Reduced the cost per robot from \$1,400 to \$500

Building 50 Bracket Bots means I have to reduce the cost as much as possible. The original cost of a Bracket Bot was around \$1400. Some big ticket items like a [Jetson Nano](#) and [ODrive S1](#) were primary issues. We are going to try and do some *big think* and get everything we need running on an [RPI5](#). I did extensive motor controller testing of about 10 different options, and was able to make these [\\$55 dual axis](#) ones work, saving about \$300.

I also hired a sourcing agent on Upwork to find the equivalent parts I had been buying on Amazon, from Chinese suppliers. If you aren't aware, most mechanical/electrical components you can buy in North America are about 50-80% cheaper if you buy them from China. So for prototyping I was paying a "Fast Shipping" premium to iterate quickly by purchasing from Amazon, Digikey, etc. Now that the design is more figured out, we can find equivalent parts for much cheaper.

Here's the details on the BOM (Bill of Materials) progression.

Original Bracket Bot				Current Bracket Bot Fast Shipping				Current Bracket Bot Chinese Suppliers			
Bill of Materials / per robot				Bill of Materials / per robot				Bill of Materials / per robot			
Component	\$ USD/per	Qty	\$ USD	Component	\$ USD/per	Qty	\$ USD	Component	\$ USD/per	Qty	\$ USD
Jetson Nano	\$500	1	\$500	Raspberry Pi 5	\$84	1	\$84	Raspberry Pi 5	\$84	1	\$84
Extrusion (1 meter)	\$22.00	2	\$44	Extrusion (1 meter)	\$22.00	2	\$44	Extrusion (1 meter)	\$12.00	2	\$24
Extrusion T Bracket	\$5.00	2	\$10	Extrusion T Bracket	\$5.00	2	\$10	Extrusion T Bracket	\$1.43	2	\$3
3D printed parts	-	-	\$10	3D printed parts	-	-	\$10	3D printed parts	-	-	\$10
6.5" Hoverboard Motors	\$40.00	2	\$80	6.5" Hoverboard Motors	\$40.00	2	\$80	6.5" Hoverboard Motors	\$20.00	2	\$40
Intel Realsense 435	\$120.00	1	\$120	Intel Realsense 435	\$120.00	1	\$120	Intel Realsense 435	\$120.00	1	\$120
ODrive S1	\$165.00	2	\$330	ODESC 3.6	\$55.00	1	\$55	ODESC 3.6	\$55.00	1	\$55
20V Dewalt Battery	\$40.00	2	\$80	Battery	\$40.00	2	\$80	Battery	\$15.00	2	\$30
Battery Terminal	\$15.00	2	\$30	Battery Terminal	\$3.50	2	\$7	Battery Terminal	\$3.50	2	\$7
DC7406 connector	\$10.00	1	\$10	DC7406 connector	\$0.70	1	\$0.70	DC7406 connector	\$0.70	1	\$0.70
USB-C PD adapter	\$15.00	1	\$15	USB-C PD adapter	\$15.00	1	\$15	USB-C PD adapter	\$2.00	1	\$2
Hose Clamps 65-75mm	\$1.00	4	\$4	Hose Clamps 65-75mm	\$0.50	4	\$2.00	Hose Clamps 65-75mm c	\$0.50	4	\$2.00
2M usb-c to usb-a cable	\$10.00	1	\$10	2M usb-c to usb-a cable	\$1.30	1	\$1.3	2M usb-c to usb-a cable	\$1.30	1	\$1.3
Wago DF-3012-1 (for ba	\$0.80	2	\$1.60	Wago DF-3012-1 (for ba	\$0.30	2	\$0.60	Wago DF-3012-1 (for bat	\$0.30	2	\$0.60
Wago DF-3012-5 (for ha	\$1.30	2	\$2.60	Wago DF-3012-5 (for ha	\$1.30	2	\$2.60	Wago DF-3012-5 (for hall	\$1.30	2	\$2.60
Wago DF-3012-3 (for 3	\$1.00	2	\$2.00	Wago DF-3012-3 (for 3	\$0.69	2	\$1.38	Wago DF-3012-3 (for 3 pl	\$0.69	2	\$1.38
E-Stop	\$2	1	\$2	E-Stop	\$2	1	\$2	E-Stop	\$2	1	\$2
Buck converter	\$1	1	\$1	Buck converter	\$1	1	\$1	Buck converter	\$1	1	\$1
LSM6DS3 IMU	\$20	1	\$20	MPU-6050	\$2	1	\$2	MPU-6050	\$2	1	\$2
SD Card 128gb	\$15	1	\$15	SD Card 64gb	\$10	1	\$10	SD Card 64gb	\$3	1	\$3
RPI 5 Fan	\$10	1	\$10	RPI 5 Fan	\$6	1	\$6	RPI 5 Fan	\$6	1	\$6
Total			\$1,297	Total			\$535	Total			\$397

Left are older BOMs, right are newer. This shows the work done to lower the cost of Bracket Bot.

The final major improvement in sight is swapping the [Intel Realsense](#) with a cheap USB Camera. This will likely make our underlying software more complex, but would make the robot close to **\$300!**

III. Building a Bracket Bot no longer requires hardware expertise

As I was making the 2nd, 3rd, and 4th Bracket Bots it was getting annoying to solder like 40 connections, and taking about 5 hours per robot. If a robot takes 5 hours to put together from raw parts, and I want to make 50 of them in the next few months, that's 250 hours, or about **20 working days of just assembling.**

I remembered [this fancy connector](#) made by Wago. Using these, it took the time for me to build a robot from around 5 hours, to under an hour.

That was the main change, but a few others helped like changing screw sizes, making things snap fit instead of screw in, and dialing in 3D printing tolerances for smoother assembly. People have entire careers in this skill, called DFA ([Design for Assembly](#)).

At this point, building your own Bracket Bot is about as difficult as the average Arduino kit.

IV. The project has evolved to a clear mission

We discovered that programmers **want** to develop apps for robots. It's just impossible for them to build the entire hardware, electrical, and software stack themselves. So we'll make an easy to use kit, with reliable hardware, and an easy to use SDK, for them to just focus on the **app layer**.

Imagine that to make a reactive website in 2024, you needed to rewrite your own version of React.js every time because there's no library. Sounds stupid? Welcome to robotics in 2024.

We are making the first robot a developer can buy and program at the **app layer**. It will be open source, easily extensible, and meant for people to take as a base platform, and build upon.

Our team has experts in hardware and software. We are building an extremely cheap (\$350), reliable, and easy to build mobile robot kit. Then we are going to write a robust mapping, planning, navigation, and obstacle avoidance SDK that comes with it. Out of the box, you can just start writing apps for the Bracket Bot.



I expect many people with some hardware experience will make mods and upgrades for the Bracket Bot, like adding manipulators to grab things, more sensors, etc.

We'll have plenty of examples, and a community [Discord](#). You should be able to assemble a Bracket Bot in a few hours, scan your apartment/house/office with your phone to make a map, and tell it to drive to the kitchen, and it just works. **This isn't a research project**. All of these pieces have been solved for years, it's just that no one has packaged it nicely.

V. First customer

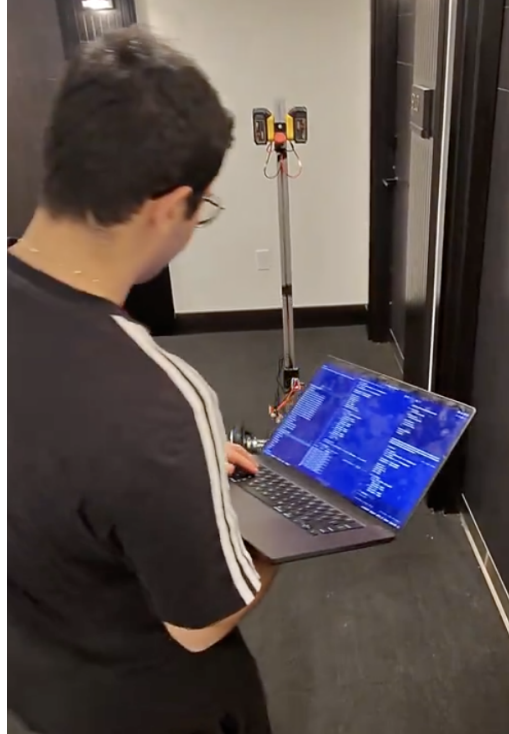
[Shahan](#), our local NeRFs and Gaussian Splatting expert, is basically our target user. He has expertise in applicable software (mapping tech), but not enough hardware knowledge to build

his own robot. This is a shame because the robotics community would never get to benefit from his talent and ideas. I figured if I gave him a Bracket Bot, he could try getting things like [LeRF](#) going, which would be really cool! Instead of just giving him a robot, we invited him to build one from scratch. Over the span of a few hours, he made one with no hardware experience. The experience was a "dream come true" for him.

hey, just wanted to say thanks so much for letting me build a bracketbot! It's always been a dream of mine to build and have a robot, so building one was super fun and an actual dream come true for me! 🙏😊



Shahan wiring his Bracket Bot late at night.



He wrote his own WASD driving code and drove it home.