China's Unitree Will Dominate Global Robotics

中国宇树科技将主导全球机器人产业

The Fastest Iteration Cycle In Next-Gen Robotics Should See Unprecedented Acceleration

下一代机器人领域最快的迭代周期将迎来前所未有的加速

REYK KNUHTSEN, NIKO CIMINELLI, JACOB RINTAMAKI, AND 4 OTHERS

雷克·努森、尼科·奇米内利、雅各布·林塔马基等四人

JUN 09, 2026 2026 年 6 月 9 日 · PAID · 付费

90 1 11 Share 分享

We are witnessing the birth of another Chinese hardware giant. Three years ago, Unitree was a quadruped company. By last year, they parlayed quadruped dominance into creating and leading the humanoid market. This year, their G1 humanoids are finally entering into viable deployments, and three new designs are on the way, including their most-direct Western humanoid competitor.

我们正在见证又一家中国硬件巨头的诞生。三年前，宇树还只是一家四足机器人公司。到了去年，他们凭借在四足领域的统治地位，成功开创并引领了人形机器人市场。今年，他们的 G1 人形机器人终于进入实际部署阶段，同时还有三款新设计正在推进中，其中包括最直接对标西方人形机器人的产品。



Quadruped State of The Market - Unitree, Boston Dynamics, ANYbotics, DEEP Robotics, and The Rising Application Ecosystem

四足机器人市场现状——宇树、波士顿动力、ANYbotics、云深处科技及蓬勃发展的应用生态

REYK KNUHTSEN, DYLAN PATEL, AND 4 OTHERS

雷克·努森、迪伦·帕特尔等 4 人 · 2025年10月20日 2025 年 10 月 20 日

Read full story 阅读完整报道 →

Tesla first unveiled a humanoid in 2022, and while it and other Western players are now producing early humanoids that remain works in progress, **we hear Unitree may**

ship its 10,000th in the coming weeks.

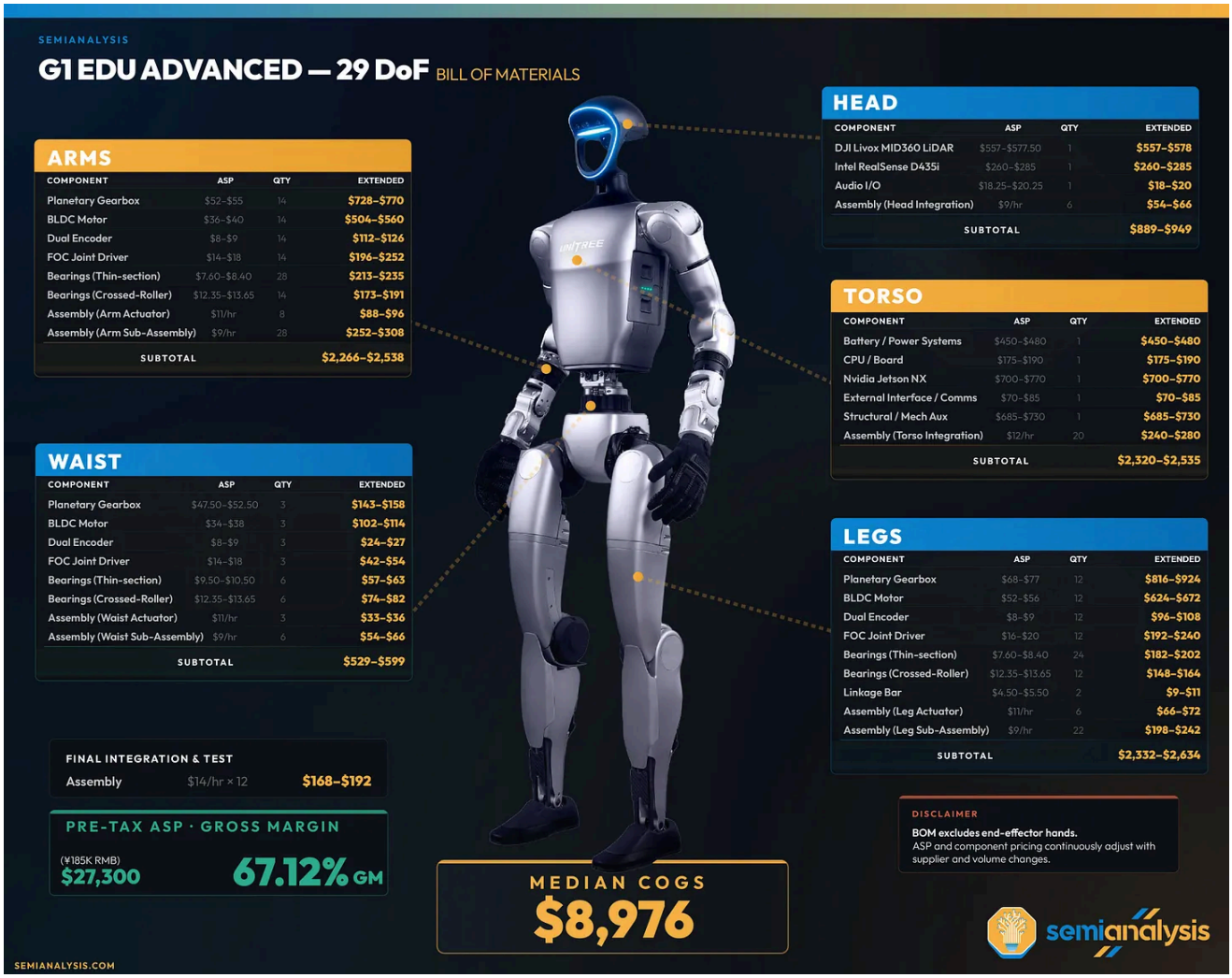
特斯拉于 2022 年首次展示人形机器人，尽管其与西方同行目前推出的早期产品仍处于完善阶段，但我们获悉宇树科技可能在数周内交付其第一万台产品。

Now, Unitree is tripling revenues YoY on 60% gross margin product lines, planning almost $300M of AI R&D spend, increasingly in-housing portions of manufacturing, all while pricing the cheapest humanoids on the market by far. With their upcoming highly anticipated IPO, Unitree is deservedly dominating the humanoids conversation. But historically, Unitree's humanoid robots have a reputation for less than perfect reliability, are not viewed as useful beyond entertainment and R&D, and have a reputation for being "cheap."

如今，宇树科技在毛利率达 60%的产品线上实现年收入三倍增长，计划投入近 3 亿美元用于人工智能研发，并逐步将部分制造环节内部化，同时以远低于市场价的价格销售最便宜的人形机器人。随着备受期待的首次公开募股临近，宇树科技当之无愧地主导着人形机器人的讨论。但历史上，宇树的人形机器人因可靠性欠佳而闻名，被认为除娱乐和研发外缺乏实用价值，且常被贴上"廉价"标签。

Despite this, we believe Unitree's **cost structure** is one of its greatest advantages over competitors. Unitree has slashed pre-tax pricing **from $50K+ to $27.3K over the past 12-18 months.** Even at that price, we estimate they still hit **67% gross margins on their flagship G1.** With their BoM set to plummet as manufacturing scales, **we've already heard pricing well under $20K in some deals.**

尽管如此，我们认为成本结构是宇树科技相较竞争对手的最大优势之一。过去 12 至 18 个月间，其税前售价已从 5 万美元以上降至 2.73 万美元。即便在此价位，我们估算其旗舰机型 G1 的毛利率仍达 67%。随着制造规模扩大，物料清单成本将骤降，我们已听闻部分交易中定价远低于 2 万美元。



Source: SemiAnalysis Estimates

来源：SemiAnalysis 估算

We developed these BoMs by going through a full design examination of Unitree's robot, speaking with manufacturers of every component, and verifying items with multiple supply chain buyers/sellers.

我们通过对宇树科技的机器人进行全面设计审查、与每个组件的制造商沟通，并通过多个供应链买家和卖家核实项目，开发了这些物料清单（BoM）。

And, lastly, despite countless dismissive comments against the company, we argue their G1 humanoids are crossing the viability threshold of real-world deployments.

最后，尽管针对该公司有无数轻蔑的评论，我们认为他们的 G1 人形机器人正在跨越实际部署的可行性门槛。

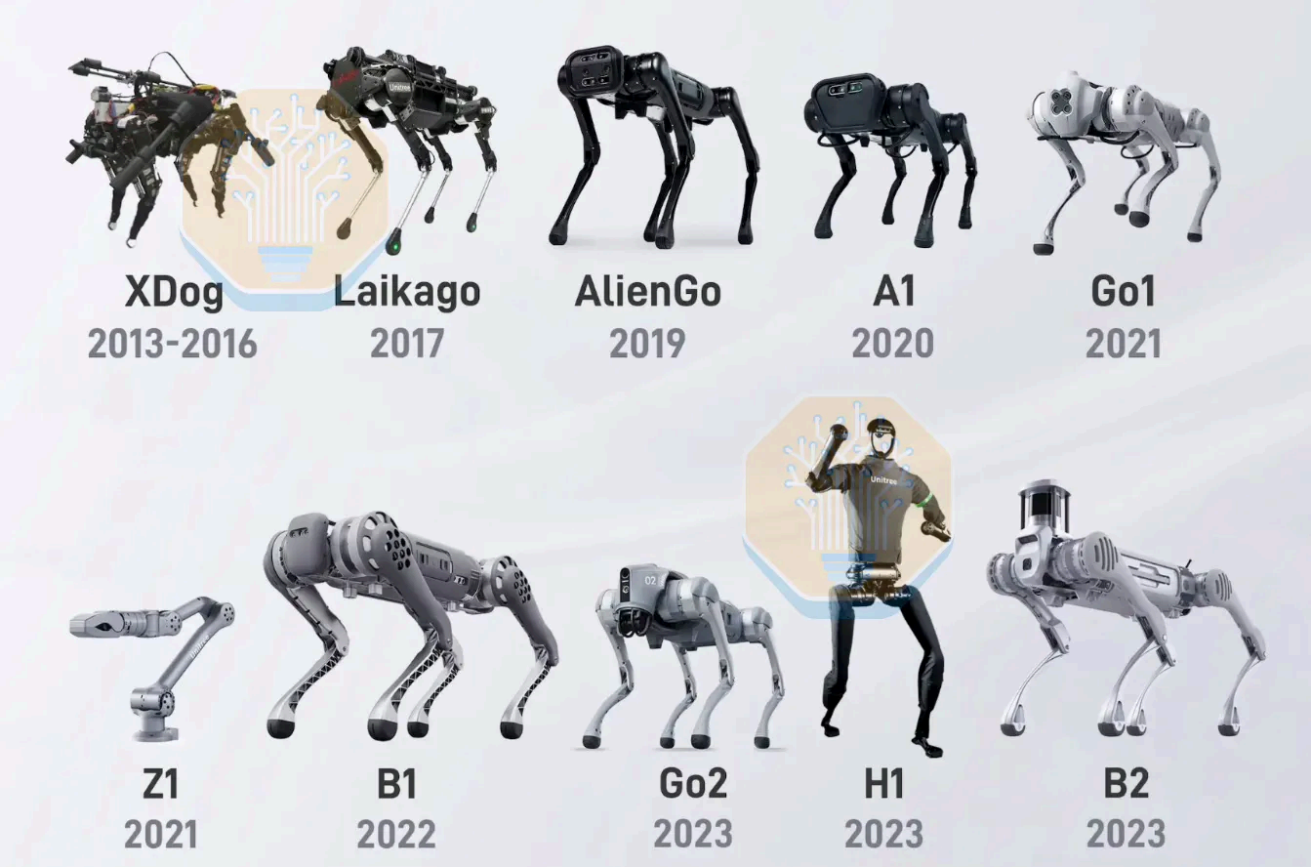


Source: SemiAnalysis Estimates

来源：SemiAnalysis 估算

However, no one understands Unitree's strategy, cost, and manufacturing as well as concerns of the usefulness of the robots at all. But today we are here to set the record straight. In our research we present the history of Unitree mimicking the BYD and DJI strategy, by generating their own ecosystem, spawning new markets, and then eating said markets. This strategy is in process as we speak. New markets on the horizon means that Unitree's explosive growth should continue.

然而，无人能像我们这样透彻理解宇树科技的战略、成本控制与制造体系，更无人能像我们这样深切关注其机器人的实用价值。今天，我们将在此拨云见日。通过研究，我们揭示了宇树科技如何效仿比亚迪与大疆的战略路径：构建自有生态体系，催生新兴市场，继而吞噬这些市场。这一战略正在当下稳步推进。新市场的曙光已然浮现，这意味着宇树科技的爆发式增长仍将持续。



Source: Zoomax 来源：Zoomax

Next we examine their specific hardware strategy, and how their QDD actuator design choice led to a potentially structural advantage, and how their actuator has improved into near-deployment grade.

接下来，我们审视其具体的硬件策略，以及 QDD 驱动器的设计选择如何带来潜在的结构性优势，并探讨其驱动器如何改进至接近部署水平。

Lastly we argue that Unitree's improvement and cost advantage is now breaking into the world of economic viability to displace labor. There are likely over 250 Unitrees deployed in labor settings today, and we detail how the deployment math works out. Notably, Unitree has made it this far on the back of the small hobbyist/researcher market. Should Unitree unlock viable deployments and hit critical mass, they may accelerate at unreal speed.

最后，我们认为宇树科技的改进与成本优势正逐步突破经济可行性的门槛，有望替代劳动力。目前，已有超过 250 台宇树机器人部署于劳动场景，我们将详细解析其部署的经济账。值得注意的是，宇树科技仅凭小众的爱好者/研究者市场便已取得如此成就。一旦宇树科技实现可行的部署并达到临界规模，其发展速度或将超乎想象。



Robotics Levels of Autonomy

机器人自主能力等级

REYK KNUHTSEN, DYLAN PATEL, AND 4 OTHERS

雷克·努森、迪伦·帕特尔等 4 人

• 2025年7月31日 2025 年 7 月 31 日

Read full story 阅读完整报道 →

All of this comes at a level of scale and manufacturing that crushes the West's cost and lead time, and Unitree itself is a standout in the competitive Chinese ecosystem. Behind the paywall we specifically discuss the new robot handmakers that are aiming to unlock more tasks and markets, as well as who will be eaten and who will benefit from the Unitree supply chain.

这一切都建立在规模化和制造能力之上，使得西方在成本和交付周期上难以匹敌，而宇树科技本身在中国竞争激烈的生态系统中也脱颖而出。在付费内容中，我们将具体讨论那些旨在解锁更多任务和市场的新型机器人手部制造商，以及谁将被宇树科技的供应链所吞噬，谁又将从中受益。

Unitree's IPO is the birth of the robotics moment. They are unlocking markets, ecosystems, and are pursuing a strategy of scale that may lead down the path of other Chinese hardware juggernauts. Let's first turn to the past to understand how Unitree could potentially work out.

宇树科技的 IPO 标志着机器人时代的诞生。他们正在开拓市场、构建生态系统，并推行规模化战略，这条道路可能引领他们走向其他中国硬件巨头的成功路径。让我们首先回顾历史，以理解宇树科技未来可能的发展轨迹。



America Is Missing The New Labor Economy - Robotics Part 1

美国正在错失新劳动力经济 - 机器人技术（上篇）

DYLAN PATEL, REYK KNUHTSEN, AND 4 OTHERS

作者：迪伦·帕特尔、雷克·克努特森 等四人

• 2025年3月11日 2025 年 3 月 11 日

Read full story 阅读完整报道 →

The Making of A Chinese Hardware Giant

中国硬件巨头的崛起之路

What does a fully-matured Chinese hardware giant look like in practice? There's a great example of the carmaker BYD (Build Your Dream) today as the mature expression of Unitree's strategy: own the most expensive and challenging component in the BoM, use this ownership to compound cost advantage that nobody can match, and create new markets while adding more value from inhousing your supply chain.

一个完全成熟的中国硬件巨头在实践中是什么样子的？如今，汽车制造商比亚迪（BYD）就是宇树科技战略成熟化的绝佳范例：掌握物料清单中最昂贵、最具挑战性的核心部件，利用这种掌控力积累无人能及的成本优势，同时通过供应链垂直整合创造新市场并提升价值。



Source: BYD 来源：比亚迪

BYD initially focused on the battery cell. Batteries can consume around 30-40% of an EV's BoM (now less, thanks to BYD). BYD was founded in 1994 to make battery cells that Japanese incumbents exited due to toxicity. BYD spent nearly a decade refining their product before entering EVs in 2011, and at first was only a niche player. When BYD launched its first battery-only EV, the e6, to the Chinese market in October 2011, annual EV sales across all of China were just 8,159, or 0.04% of new car sales. There

was no EV market, but BYD helped create one.

比亚迪最初专注于电池电芯。电池成本约占电动汽车物料清单（BoM）的 30-40%（得益于比亚迪，这一比例现已降低）。比亚迪成立于 1994 年，当时日本企业因电池毒性问题退出该领域，比亚迪便接手生产电池电芯。在 2011 年进入电动汽车领域之前，比亚迪花了近十年时间打磨产品，最初仅是小众参与者。当比亚迪于 2011 年 10 月向中国市场推出首款纯电动汽车 e6 时，全中国年度电动汽车销量仅为 8159 辆，占新车销量的 0.04%。当时并不存在电动汽车市场，但比亚迪帮助开创了这一市场。

BYD's strategy was key. **比亚迪的战略是关键。**

Owning the cell at increasing automotive volumes passes through demand, creating improved supply and ecosystem, where players like Hunan Yuneng and Shenzhen Dynanonic (LFP cathodes), Inovance (motors and inverters), and Sanhua (thermal management) emerged to supply BYD's next-generation, improved parts at a lower cost. None of these existed at a meaningful scale in 2010.

随着汽车产量的持续增长，掌控电池单元的需求催生了更完善的供应链与生态系统。诸如湖南裕能、深圳德方纳米（磷酸铁锂正极材料）、汇川技术（电机与逆变器）以及三花智控（热管理系统）等企业应运而生，为比亚迪下一代零部件提供更低成本的升级方案。而在 2010 年，这些企业尚未形成规模化产能。

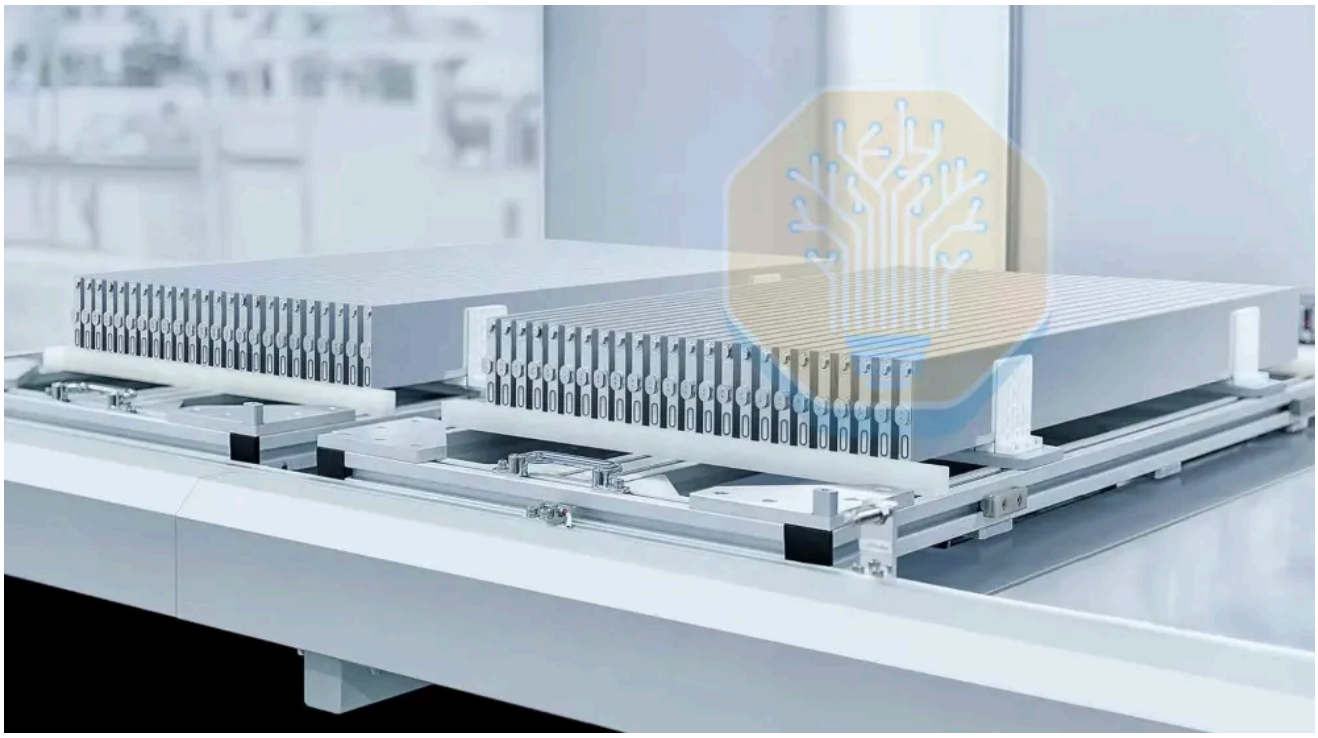
BYD has freedom to in-house manufacturing where it compounds for them. They took in house the battery cell, drives, motors, IGBTs and SiC power modules (one of the only companies in the world running an IDM model), the transmission, the chassis and outer body shells, and even the engine itself. By the late 2010s, nearly every component of an EV was being built under BYD's roof.

比亚迪拥有自主制造的自由，能够在内部实现垂直整合。他们将电池电芯、驱动器、电机、IGBT 和碳化硅功率模块（全球少数采用 IDM 模式的企业之一）、变速箱、底盘及车身外壳，甚至发动机本身都纳入自产体系。到 2010 年代末，电动汽车几乎每个零部件都在比亚迪自有工厂内完成制造。

This creates a positive feedback loop: owning and improving the right hardware lets BYD create a new product that opens a new market, like their 2020 Blade Battery. Pre-Blade, the battery chemistry (LFP, Lithium Iron Phosphate) was cheap, safe, but low-density, fine for vehicles that never traveled far from a charger, like forklifts that charged during operator breaks or buses that returned to depot every night. However,

passenger EVs, which had to handle road trips and unpredictable home charging, saw LFP as unviable.

这就形成了一个正反馈循环：掌握并持续优化正确的硬件，让比亚迪能够开发出打开新市场的产品，例如 2020 年的刀片电池。在刀片电池问世前，磷酸铁锂（LFP）这种电池化学体系虽然成本低廉、安全性高，但能量密度较低，适用于不常远离充电设施的车辆——比如可在操作员休息时充电的叉车，或每晚返回场站充电的公交车。但对于需要应对长途驾驶和不确定家庭充电场景的乘用电动车而言，LFP 电池曾被视为不可行的方案。



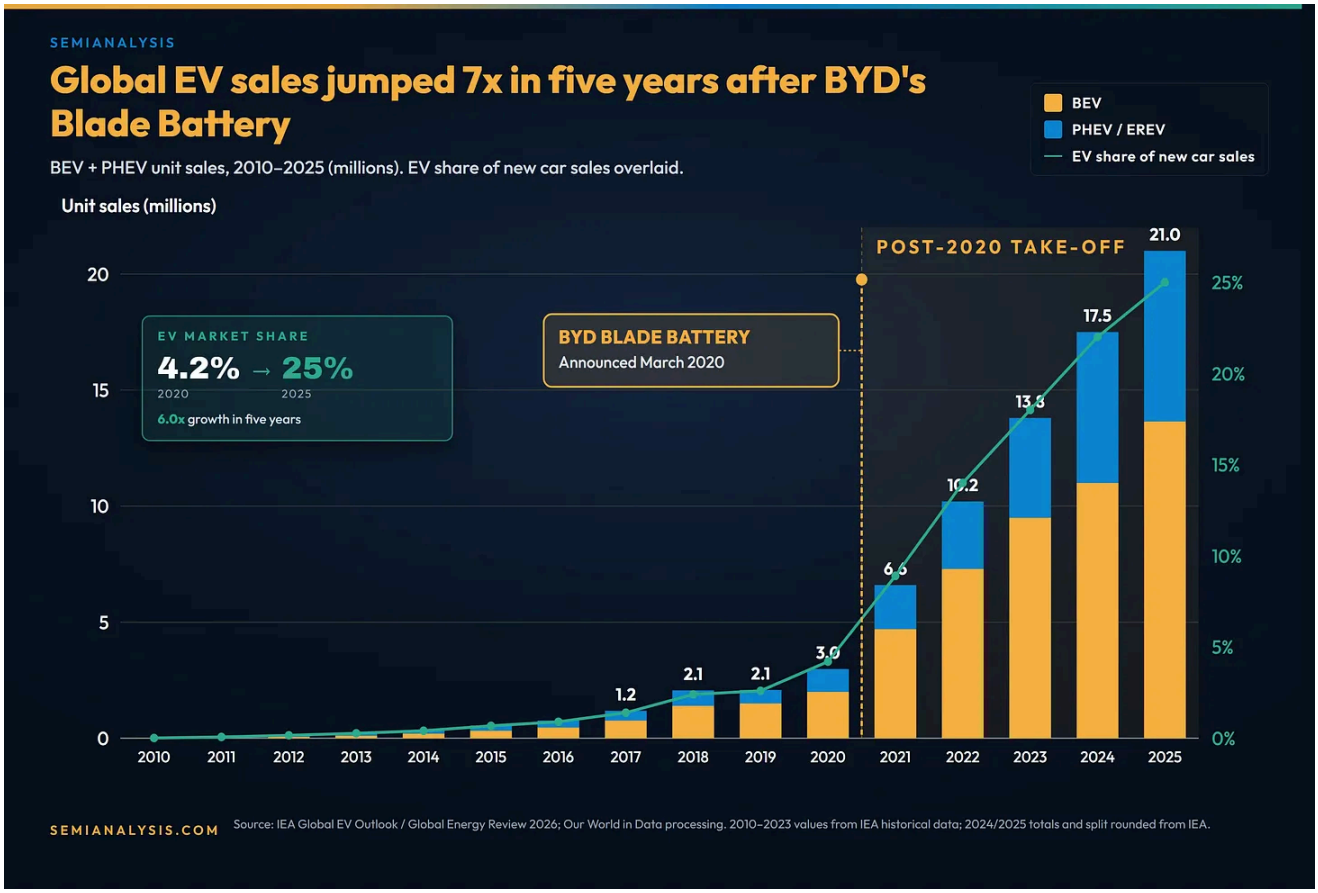
Source: BYD 来源：比亚迪

In 2021, their Blade Battery took a new packaging geometry, pushing battery pack space utilization per kg up 50%. Now, LFPs could remain the same size, while improving distance to a viable threshold. Tesla shifted the Model 3 and Y to an LFP battery, Ford licensed CATL's LFP technology, and overnight, through meticulous hardware iteration, BYD created the modern affordable EV market to dominate.

2021 年，比亚迪刀片电池采用全新封装结构，使电池组单位体积利用率提升 50%。磷酸铁锂电池得以在保持原有尺寸的同时，将续航里程推至实用门槛。特斯拉为 Model 3 和 Model Y 换装磷酸铁锂电池，福特获得宁德时代 LFP 技术授权——一夜之间，比亚迪凭借精密的硬件迭代创新，构建了主导市场的现代平价电动汽车格局。

Before the Blade Battery, BYD shipped 189K new EVs in 2020. After the Blade Battery in 2021, BYD shipped 600K new EVs, and by 2025, not only did BYD become the #1 EV producer, but they overtook Tesla as the #1 BEV producer (battery only), Tesla's main product. BYD has now inhoused such a significant portion of its process (75% for the Seal), that their cost-structure is almost untouchable, like the 2023 Seagull model for ~$11,000 (newer models are under $8k in China!) BYD even owns supply chains further upstream with moves like a 2023 refining Joint Venture with Huayou Cobalt and acquiring direct lithium mining rights in Brazil's "Lithium Valley."

在刀片电池问世之前，比亚迪在 2020 年交付了 18.9 万辆新能源车。而 2021 年推出刀片电池后，其年交付量跃升至 60 万辆。到 2025 年，比亚迪不仅已成为全球最大的电动汽车制造商，更超越特斯拉成为纯电动车（仅电池驱动）领域的领跑者——而这正是特斯拉的核心产品线。如今比亚迪的垂直整合程度极高（海豹车型自研部件占比达 75%），其成本结构几乎令竞争对手望尘莫及，例如 2023 年推出的海鸥车型定价仅约 11000 美元（约合人民币 1001 元#），而最新款车型在中国市场售价已低于 8000 美元！比亚迪甚至通过向上游延伸布局，例如 2023 年与华友钴业成立精炼合资企业，并在巴西"锂谷"获得锂矿直接开采权，进一步强化供应链控制。



Source: SemiAnalysis SemiAnalysis

This scaling outcompeted European EVs so much that VW announced its first-ever German plant closures and Stellantis cut guidance, all citing Chinese EV pressure. Even the United States had to increase its tariffs on Chinese EVs to 100% to protect its domestic industry. Now, BYD has scaled so much they even own their own freight to ship their cheapest, and best EVs in the world.

这种规模化生产使欧洲电动汽车难以匹敌，以至于大众汽车宣布首次关闭德国工厂，斯特兰蒂斯也下调了业绩预期，均将原因归咎于中国电动汽车带来的压力。就连美国也不得不将对中国电动汽车的关税提高至 100%，以保护本国产业。如今，比亚迪的规模已如此庞大，甚至拥有自己的货运船队，用以运输全球最物美价廉的电动汽车。

SemiAnalysis is a reader-supported publication. To receive new posts and support my work, consider becoming a free or paid subscriber.

《SemiAnalysis》是一份由读者支持的刊物。如果您希望获取最新文章并支持我的工作，欢迎成为免费或付费订阅用户。

The DJI Playbook - Niche Researcher/Hobbyist Markets Are Viable Bootstraps

大疆模式——小众研究者/爱好者市场是可行的起步跳板

DJI pioneered a playbook different from BYD, and Unitree is running that playbook today, starting with the researcher/hobbyist beachhead, and a low-quality product.

大疆开创了一条与比亚迪不同的发展路径，而宇树科技如今正践行这一模式：从研究者/爱好者这一滩头阵地起步，以低质量产品切入市场。

In 2013, “useful consumer drone” wasn’t a category. Parrot’s AR.Drone, the leading product, won its 2010 CES award in the *Electronic Gaming Hardware* bracket and shipped alongside augmented-reality dogfighting games. The drone had no camera stabilization, no GPS, and only took 640x480p pics/videos. Anyone who actually wanted a useful flying camera had two options: pay $19,995 for a Draganflyer X6, or stitch together frames, motors, flight controllers, and gimbals (stabilizers) from disparate vendors for up to $1,200 in parts, plus dozens of hours of assembly and PID (controller) tuning, usually ending in expensive crashes.

2013 年，“实用消费级无人机”还不是一个独立的品类。作为该领域的领军产品，Parrot 的 AR.Drone 在 2010 年 CES 展上荣获电子游戏硬件类奖项，并随增强现实空战游戏一同发售。这款无人机既没有摄像头防抖功能，也没有 GPS 定位，拍摄的照片和视频分辨率仅为 640×480 像素。 当时，任何真正想要一台实用飞行相机的用户只有两种选择：要么花 19,995 美元购买 Draganflyer X6，要么从不同厂商处采购机架、电机、飞行控制器和云台（稳定器），仅零件费用就高达 1,200 美元，再加上数十小时的组装和 PID（控制器）调校，结果往往以代价高昂的坠机告终。



Source: AR Drone 2.0 来源：AR Drone 2.0

Researchers, hobbyists, and early professional camera workers were a willing market for something new. DJI's Phantom 1 shipped January 2013 at $679, and was not a fully-fledged product at the time. It had no built-in camera, no gimbal (stabilizer), ten minutes of flight, no live video feed, but it was roughly half the cost of the build-it-yourself drone, with none of the assembly burden. A far cry from DJI's drones today, but **DJI went from $4M in revenue in 2011 to $130M in 2013, after the Phantom 1's release**. This was more than enough to kickstart DJI's flywheel.

研究人员、爱好者以及早期的专业摄像工作者，对新事物有着旺盛的需求。大疆的 Phantom 1 于 2013 年 1 月以 679 美元的价格发货，当时它并非一款成熟的产品。它没有内置摄像头，没有云台（稳定器），续航仅十分钟，也没有实时视频传输功能，但它的价格大约是 DIY 无人机组装方案的一半，且无需任何组装负担。这与今天的大疆无人机相去甚远，但大疆在 Phantom 1 发布后，营收从 2011 年的 400 万美元飙升至 2013 年的 1.3 亿美元。这足以启动大疆的增长飞轮。

DJI then reaped the fruits of the Shenzhen consumer electronics ecosystem, now huge from the Smartphone boom. GPS prices went from $800 to below $14 from 2003-2013, controllers went from $2,000 to $400 from 2006-2011, and more. From DJI's boom, there are now over 3,000 drone component suppliers for most anything you desire.

随后，大疆受益于深圳消费电子生态系统的红利——该生态系统因智能手机的繁荣而变得庞大。GPS 模块的价格从 2003 年的 800 美元降至 2013 年的 14 美元以下，控制器从 2006 年的 2000 美元降至 2011 年的 400 美元，其他组件也类似。得益于大疆的崛起，如今已有超过 3000 家无人机组件供应商，几乎能满足你的一切需求。



Source: GlobalSources 来源：环球资源

DJI chose to inhouse the most expensive and technically difficult component first: the flight controller. Third-party suppliers were still selling at $200-400 even in batches of thousands in 2014. Later on, DJI brought inhouse the gimbals, motors, and ESCs.

大疆创新选择首先将最昂贵且技术难度最高的部件——飞控系统——进行自主研发。即便在 2014 年批量采购数千件的情况下，第三方供应商的售价仍维持在 200 至 400 美元之间。随后，大疆又将云台、电机和电子调速器纳入自研体系。

Like BYD, new DJI generations unlocked a new market the previous one couldn't address. The 2013 Phantom 1 ($679, no camera, 10-minute flight, no live feed) was the bootstrap, engaging hobbyists/researchers. The Phantom 2 Vision+ in 2014 then came with a 3-axis gimbal (stabilizer) into the frame, where previously broadcast-stable aerial video had required a $2,000+ aftermarket gimbal mounted to a hand-built rig,

operated by a skilled pilot.

如同比亚迪的发展路径，大疆每一代新产品的问世都开拓了前代产品无法触及的市场。2013 年推出的 Phantom 1（售价 679 美元，无摄像头，续航 10 分钟，无实时图传）作为初始产品，成功吸引了爱好者和研究人员。而 2014 年的 Phantom 2 Vision+则将三轴云台（稳定器）集成至机身，在此之前，要实现广播级稳定的航拍画面，需要由熟练飞手操控手工组装的设备，并加装价值 2000 美元以上的第三方云台。

Pre-Vision+, professional aerial photography was the domain of helicopters and Hollywood second-unit teams, but now, small businesses could perform this on their own. As such, whole new markets were unlocked for DJI, like real estate listings, wedding videos, local news, agricultural surveying. By the Phantom 4 in 2016 ($1,399, 4K camera, 28-minute flight, forward obstacle avoidance, 44 mph sport mode), the enterprise market was unlocked: surveying, inspection, first response, and more that we detailed here.

在 Pre-Vision+时代，专业航拍是直升机与好莱坞第二摄制组的专属领域，但如今小企业也能独立完成。由此，大疆解锁了全新市场，如房产展示、婚礼录像、地方新闻、农业测绘等。到 2016 年 Phantom 4 问世时（售价 1399 美元，配备 4K 相机、28 分钟续航、前向避障、44 英里/小时运动模式），企业级市场被彻底打开：测绘、巡检、应急响应等应用场景，我们在此已有详述。



Source: DJI 来源：大疆创新

In 2016-17 DJI held roughly 70% global consumer drone share, and global drone shipments hit 6.4 million units and $1.9 billion in revenue, a market that hardly existed before. Multiple competent dronemakers were crushed. 3DR, GoPro's Karma, and Parrot's consumer line had all exited or were exiting the category. Chris Anderson, the 3DR CEO, estimated that DJI cut prices by as much as 70% in less than a year during the Phantom era.

2016 至 2017 年间，大疆创新占据全球消费级无人机约 70%的市场份额，全球无人机出货量达 640 万架，收入 19 亿美元——而此前这一市场几乎不存在。多家实力不俗的无人机制造商遭到重创：3DR、GoPro 的 Karma 系列以及 Parrot 的消费级产品线均已退出或正在退出该领域。3DR 首席执行官克里斯·安德森估算，在精灵系列主导市场的时期，大疆在不到一年内将价格下调幅度高达 70%。

For brevity, we'll call this the "**DJI Strategy**" throughout the rest of this piece: own one critical component, bootstrap a willing audience, ride the ecosystem, and let each hardware generation unlock the next market. (An earlier version of this framing appeared in our first robotics paper.)

为简洁起见，下文将称其为"大疆策略"：掌握一个关键组件，培育一个愿意参与的受众群体，借助生态系统发展，让每一代硬件解锁下一个市场。（此框架的早期版本曾出现在我们的首份机器人研究报告中。）

Unitree As An Early DJI
宇树科技如同早期的 DJI

Unitree is a live DJI Strategy case study: own the bottleneck component, bootstrap a willing audience, ride and seed the ecosystem, unlock new markets generation by generation. So far, Unitree has

宇树科技是一个活生生的 DJI 战略案例：掌握瓶颈组件，培育忠实用户群体，滋养并播种生态系统，逐代解锁新市场。截至目前，宇树科技已

- **Parlayed actuator scaling into quadrupeds**, building the most cost-efficient legged platforms in the market.

将执行器规模化优势延伸至四足机器人领域，打造市场上最具成本效益的腿式机器人平台。

- **Scaled the quadruped program into researcher humanoids**, with the G1 becoming the dominant research platform for a surprisingly large market.

  将四足机器人项目扩展至科研级人形机器人领域，G1 凭借其惊人的市场规模成为主导性科研平台。

- **Funded hardware improvements enough to begin real-world deployments**, with the threshold being crossed right now.

  资金支持的硬件改进已足以开始实际部署，这一门槛目前正在被跨越。

- **Signaled promising improvement on their next generations to compete on performance with Western humanoids.**

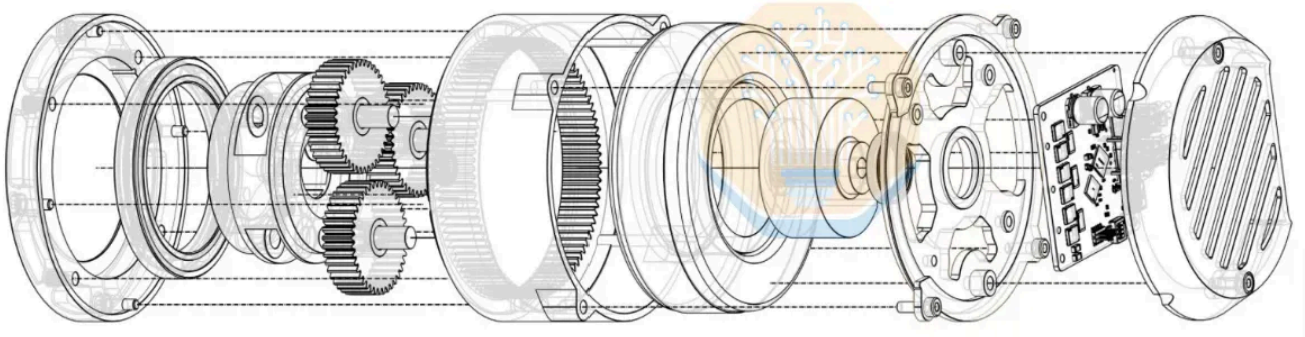
  他们在其下一代产品上展现出显著进步，将在性能上与西方人形机器人一较高下。

Let's walk through the history, design, strategy, and the critical threshold they are crossing right now humanoid deployments.

让我们回顾其发展历史、设计理念、战略布局，以及他们目前在人形机器人部署领域正跨越的关键门槛。

In 2016, Wang Xingxing, a former employee at DJI, developed a low-cost quadruped robot called XDog for his master's thesis. He iterated upon the same quadruped in his new company named "Unitree." For Unitree, their core component of choice was the actuator, the integrated joint that moves the robot's limbs. Like BYD and their cells, DJI and their flight controller, Unitree chose the expensive actuator (50%-70% of the humanoid BoM) to improve and scale out from.

2016 年，前大疆员工王兴兴为完成硕士论文，研发了一款名为 XDog 的低成本四足机器人。他在新创立的"宇树科技"公司中，对同一款四足机器人进行了迭代升级。对宇树而言，其核心部件选择是执行器——这种集成关节能驱动机器人的四肢运动。如同比亚迪之于电池、大疆之于飞控系统，宇树选择从昂贵的执行器（占人形机器人物料成本的 50%-70%）入手进行改进和规模化生产。



Source: Thomas Godden 托马斯·戈登

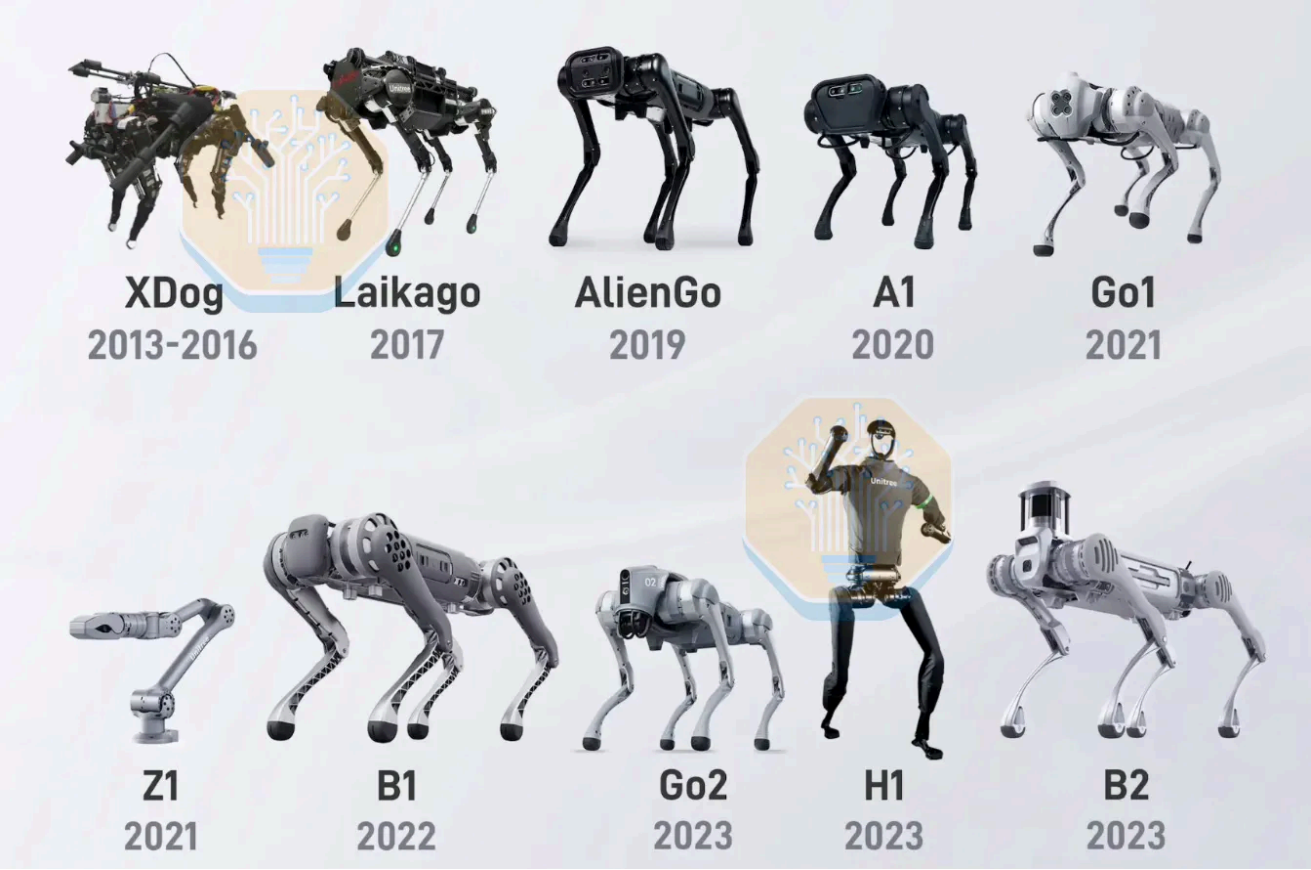
Unitree started with the academic robotics community as merely a quadruped company. Just as DJI had hobbyists paying out the nose for half-finished drones, Unitree saw university labs looking for a legged platform that didn't cost $70-100K+. The Laikago shipped in 2018 at $45,000. The A1 followed in 2020 at $15,000; the Go1 in 2021 started at $2,700 for the Air trim and ran up to $8,500 for the Edu; the Go2 today starts between $1,600 and $2,800 depending on trim and region.

宇树科技最初在学术机器人界仅被视为一家四足机器人公司。正如大疆创新让爱好者为半成品无人机支付高昂费用一样，宇树科技发现大学实验室需要价格不超过 7 万至 10 万美元的足式平台。2018 年发布的 Laikago 售价 4.5 万美元；2020 年推出的 A1 定价 1.5 万美元；2021 年问世的 Go1 基础版 Air 起价 2700 美元，教育版 Edu 最高达 8500 美元；如今的 Go2 根据配置和地区差异，起售价在 1600 至 2800 美元之间。

A 94-96% price decline in entry-level quadrupeds over six years pushed Unitree from academia into consumers and now even industry deployments -- with the broader AI wave lifting the hardware's capabilities. More importantly, it gave Unitree years of real volume on the same systems for a humanoid: actuators, controls, suppliers, and production process. When Unitree released the H1 in 2024 at roughly $90K, the humanoid was less a brand-new product, but rather the direct result of their quadruped scaling curve. We've heard from people close to Unitree that the H1 was essentially a **quadruped standing on two legs** - note the bent knees and awkward walk. The H1 showed how far quadruped-era IP could be pushed into humanoids, but the

following G1 changed Unitree's world.

入门级四足机器人价格在六年内下降 94-96%，推动宇树科技从学术界走向消费市场，如今更拓展至工业部署领域——而更广泛的人工智能浪潮则提升了硬件的性能。更重要的是，这为宇树科技在类人机器人所需的执行器、控制系统、供应链及生产流程等相同系统上积累了多年实际量产经验。当宇树科技于 2024 年以约 9 万美元价格发布 H1 时，这款类人机器人与其说是全新产品，不如说是其四足机器人规模化发展曲线的直接成果。据接近宇树科技的人士透露，H1 本质上就是站立行走的双足四足机器人——注意其弯曲的膝盖和笨拙的步态。H1 展示了四足机器人时代的技术积累能多大程度延伸至类人机器人领域，但随后推出的 G1 彻底改变了宇树科技的发展格局。



Source: Zoomax 来源：Zoomax

The $30-50K G1 - A New Possibility In 2024

3 万至 5 万美元的 G1——2024 年的新可能

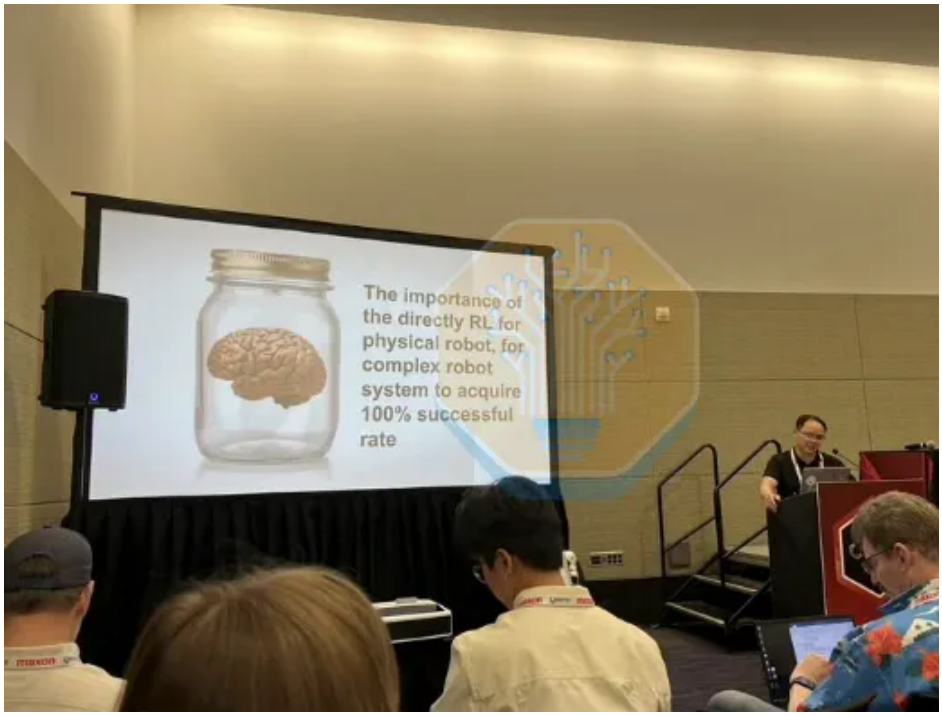
In mid-2024, affordable, off-the-shelf humanoids were few and far between until Unitree came along. Agility's Digit was just beginning to deploy a handful of robots into factories. Apptronik's Apollo, unveiled August 2023, was pre-commercial. Figure's

initial commercial agreement with BMW, signed January 2024, was shipping in single-digit volumes. Tesla wasn't (and as of V3, still isn't) shipping Optimus externally at all. On the Chinese side, UBTech's Walker, Fourier, and the early signs of AGIBot existed, but not as cheap nor at volume. No one could just "buy" a humanoid.

2024 年年中，在宇树科技出现之前，市面上几乎没有价格亲民、可直接购买的人形机器人。Agility 公司的 Digit 才刚刚开始向工厂部署少量机器人；Apptronik 于 2023 年 8 月发布的 Apollo 仍处于商业前阶段；Figure 公司 2024 年 1 月与宝马签署的首份商业协议，出货量仅为个位数；特斯拉的 Optimus 当时（且截至 V3 版本）尚未对外交付。在中国市场，优必选的 Walker、傅利叶智能以及初露锋芒的 AGIBot 虽然存在，但既不够便宜也无法量产。当时没有人能真正"买到"一台人形机器人。

The G1 enabled an incredible academia sized market. Ask any researcher and they will tell you how dramatic a step-change in accessibility it was using a $30-50K, ready-to-purchase bot. This share of the research community has since bled into top-tier AI research companies via hirings, like Nvidia, Apple, and Meta, all purchasing hundreds of G1 units. Unitree has become the leading platform for humanoid AI research.

G1 开启了一个规模惊人的学术市场。随便问一位研究人员，他们都会告诉你，使用一台 3 万至 5 万美元、可直接购买的机器人，在可及性上实现了多么巨大的跨越式进步。这部分研究社群随后通过人才招聘渗透到顶级 AI 研究公司，如英伟达、苹果和 Meta，这些公司均采购了数百台 G1 机器人。宇树科技已成为人形 AI 研究的领先平台。



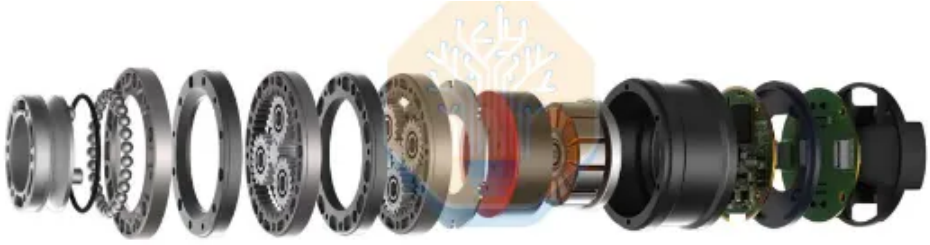
Source: Core Research, Unitree Presentation at Robotics Summit 2025

来源：核心研究，宇树科技在 2025 年机器人峰会上的演讲

The Ecosystem Advantage 生态系统优势

Unitree inherits both the supplier base of DJI and BYD's past. China assembled 31.3 million vehicles in 2024, 40.9% of them new-energy (BEV or PHEV), and the aforementioned 3,000 drone component suppliers had already scaled many of the BLDC motors, drives, encoders, batteries, and manufacturing processes that general robotics can reuse. However, Unitree's gravity is exemplified by the rise of new humanoids+quadrupeds supply chains. Every province now has several manufacturers of rightly sized/spec'd gearboxes, high-torque BLDC motors, and more. Within China, there are now ~200 humanoid companies all reaping the benefits of and contributing to this ecosystem.

宇树科技继承了 DJI 的供应商基础以及比亚迪过去的积累。中国在 2024 年组装了 3130 万辆汽车，其中 40.9%为新能源汽车（纯电动或插电式混合动力），而前述的 3000 家无人机零部件供应商早已规模化生产了通用机器人可重复使用的无刷直流电机、驱动器、编码器、电池及制造工艺。然而，宇树科技的重心体现在新型人形机器人与四足机器人供应链的崛起上。如今每个省份都有多家生产合适尺寸与规格的减速器、高扭矩无刷直流电机等零部件的制造商。在中国境内，现有约 1001 至 200 家人形机器人公司，它们既受益于这一生态系统，也为其发展做出贡献。



Source: Leaderdrive 来源：Leaderdrive

All of this stemmed from Unitree's decision to perfect the actuator. However, the first generations of their actuator didn't work very well.

这一切都源于宇树科技决定完善其执行器。然而，他们最初几代执行器的表现并不理想。

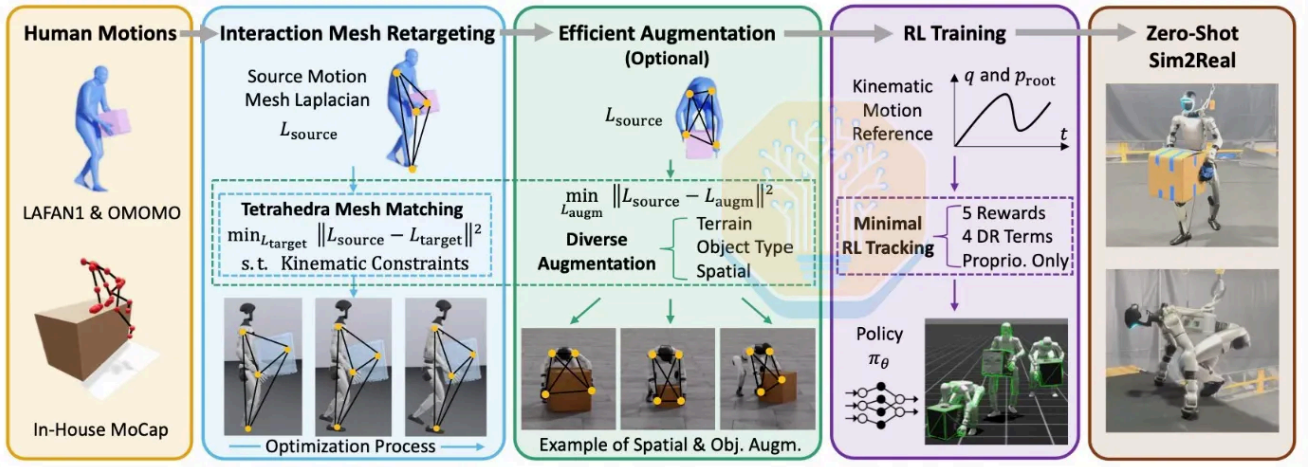
In 2024, Their Humanoids Weren't Good
2024 年，他们的人形机器人表现不佳

For brevity, we'll use QDD in this piece to mean the combination of a brushless DC motor and a low-ratio planetary gearbox, typically in the single digits and up to 20:1, which can still provide adequate backdrivability, but understand there are nomenclature debates.

为简洁起见，本文中"QDD"指代无刷直流电机与低减速比行星齿轮箱的组合（减速比通常为个位数至 20:1，仍能提供足够的反向驱动能力），但需注意相关术语存在争议。

Let's be clear: DJI and BYD unlocked markets when the product **worked**, and the H1 and original G1 were **not** very capable upon shipping. Whenever users pushed them toward real work, the motors often overheated. The G1 could only hold a 2kg payload, like a 2-liter bottle of soda, with arms fully outstretched for a few seconds before mandatory cooldown. The same 2-3kg with arms bent or contracted for maybe 2-3 minutes, like the diagram below.

需要明确的是：大疆和比亚迪是在产品成熟后才打开市场，而 H1 和初代 G1 在交付时性能并不理想。每当用户试图将其投入实际作业，电机往往就会过热。G1 仅能承载 2 公斤载荷（相当于 2 升装碳酸饮料），双臂完全伸展状态下仅能维持数秒便需强制冷却；若屈臂或收臂状态，同样 2-3 公斤载荷可维持约 2-3 分钟，如下图所示。



Source: OmniRetarget 来源：OmniRetarget

After that, the robot typically needed about 30 minutes to return to functionality, and likely a full hour before resuming a real work task. Five minutes of work followed by the rest of the hour cooling down is not a productive robot.

之后，该机器人通常需要大约 30 分钟才能恢复正常功能，且很可能要整整一个小时才能重新执行实际工作任务。工作五分钟、剩余时间都在冷却降温——这样的机器人毫无生产力可言。

The issue primarily came from Unitree's core actuator choice: the **QDD, or quasi-direct-drive, which are simpler and cheaper than typical robotics actuators**. Historically, companies favored high-precision, high-power actuators that could both move the robot and support its weight. Industrial arms often use HarmonicDrives. Boston Dynamics' early humanoids and quadrupeds used bulky hydraulic actuators. Even today, many humanoid companies default to high-gear-ratio actuators, like strainwaves from HarmonicDrive.

问题主要源于宇树的核心执行器选择：准直驱（QDD）执行器，这类执行器比传统机器人执行器更简单、成本更低。历史上，企业更青睐高精度、高功率的执行器，既能驱动机器人运动，又能支撑其自身重量。工业机械臂常采用谐波减速器。波士顿动力早期的双足机器人和四足机器人则使用笨重的液压执行器。即便在今天，许多双足机器人公司仍默认采用高减速比执行器，例如谐波减速器公司的应变波齿轮。

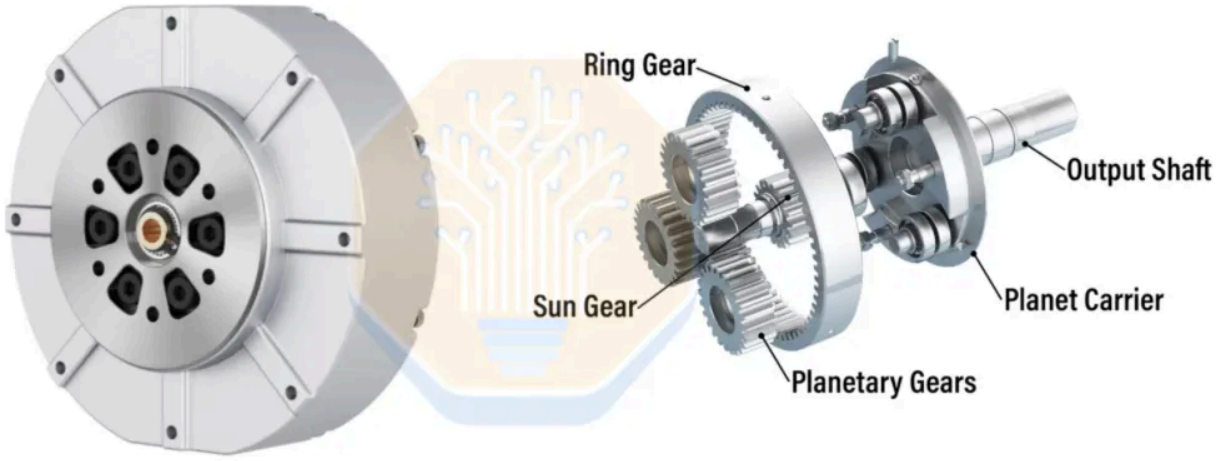
Those architectures work, but they are expensive, hard to manufacture, and often difficult to maintain. In 2018, the MIT Mini Cheetah popularized the QDD (quasi-direct-drive): a cheaper, simpler alternative. The open question was whether QDDs could scale and prove reliable enough for real-world robotics. Unitree believed this to

be a yes.

这些架构虽然可行，但成本高昂、制造困难且往往难以维护。2018 年，MIT Mini Cheetah 普及了 QDD（准直驱）技术：一种更便宜、更简单的替代方案。悬而未决的问题是，QDD 能否实现规模化生产，并在实际机器人应用中证明其足够可靠。宇树科技坚信答案是肯定的。

Why The Issues Around QDD?

为什么 QDD 会存在问题?



Source: Unitree (motor) and Power Electric (gearbox)

来源：Unitree（电机）和 Power Electric（变速箱）

QDDs flip the historically common robot-joint setup. Instead of a small motor with a big gearbox, they use a beefier motor with a much smaller gearbox. If the robot wants to lift 5kg, there's two options.

QDD（准直驱驱动器）彻底颠覆了传统机器人关节的设计逻辑。传统方案采用小电机配大减速箱的组合，而 QDD 选用更大功率的电机配合更紧凑的减速箱。当机器人需要抬起 5 公斤重物时，有两种技术路线可选：

- **Big gearbox, small motor.** The gearbox works like low gears on a bike, trading speed for force and multiplying the motor's twisting force (torque) by 30x, 100x, or even 200x in some cases. This is the "gear ratio," like 30:1, 100:1, 200:1, etc (not a

direct 1:1 mapping in most cases). This setup is how industrial arms swing whole car bodies around with modest motors: the gearbox does most of the heavy lifting.

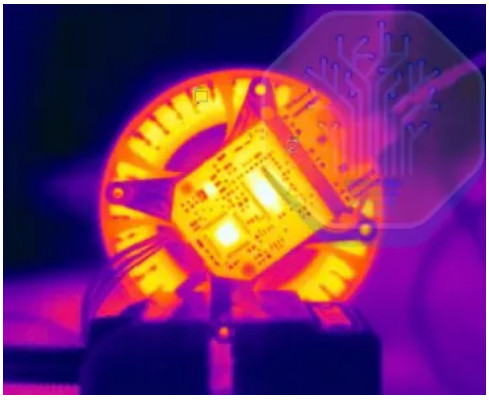
> 大减速箱配小电机：减速箱如同自行车的低档位，通过牺牲速度换取力量，可将电机扭矩放大 30 倍、100 倍甚至 200 倍（对应 30:1、100:1、200:1 等减速比）。这正是工业机械臂能用小电机轻松挥舞整辆汽车车身的奥秘——减速箱承担了绝大部分重负荷工作。

- **Small gearbox, big motor.** QDDs go this route, with gear ratios typically under 20:1 using a basic, off-the-shelf planetary gearbox. Since the gearbox barely multiplies anything, the motor has to be way stronger. Lifting the car chassis from above would require a huge motor (our quadrupeds piece explores the QDD further).

  > 小减速箱，大电机。QDD 采用这种路线，使用基础的标准行星减速箱，减速比通常低于 20:1。由于减速箱几乎不产生倍增效果，电机必须更强劲。从上方抬起汽车底盘需要巨大的电机（我们的四足机器人文章对 QDD 有进一步探讨）。

While there's bonuses to Unitree's QDD, like easily adapting to opposing forces (like collisions), or invoking a rapid, dynamic range, it does come with tradeoffs. Because the motor carries more of the torque burden directly, rather than relying on the gearbox to amplify it, early critics argued Unitree's motors would draw very high current, run hot, and prove too unreliable for practical work.

> Unitree 的 QDD 虽有优势，例如能轻松适应碰撞等反向力，或实现快速动态范围，但也存在权衡。由于电机需直接承担更多扭矩负荷，而非依赖变速箱放大扭矩，早期批评者认为 Unitree 的电机电流消耗过高、发热严重，且可靠性不足，难以投入实际应用。



Source: MIT - An Actuator Running Hot

来源：MIT - 一款运行过热的执行器

Two Years Later, The QDDs Are Defying Expectations

两年后，QDD 的表现远超预期

The early critique was fair, QDDs gave Unitree a cheaper, simpler actuator, but pushed too much thermal burden onto the motor, hence the aforementioned overheating. **But while most stuck with the strainwave (HarmonicDrive) route, Unitree took the chance and iterated.**

早期的批评是合理的，QDD 为宇树提供了更便宜、更简单的执行器，但将过多的热负荷转移到了电机上，因此导致了前述的过热问题。然而，当大多数厂商坚持采用应变波（谐波减速器）方案时，宇树抓住了机会并进行了迭代改进。

Over the last few years, Unitree appears to have improved the actuator in several ways, now showing promising signs of scalability, with many other (Chinese) humanoids **switching** to the QDD wave and, consequently, **building up the ecosystem**. We will aim to cover here of the improvements Unitree has displayed, but to clarify: we have not had access to cycle test numbers, this is simply our best approximation of evaluating their hardware improvements.

过去几年间，宇树科技似乎从多个维度改进了其执行器，如今展现出令人瞩目的规模化潜力——众多（中国）人形机器人企业纷纷转向 QDD 技术路线，由此构建起蓬勃发展的生态系统。本文将重点梳理宇树科技展现的技术突破，但需说明：我们尚未获取循环测试数据，以下分析仅基于对硬件改进的最佳评估。

Let’s begin with the usual P=I^2R, or in this case, Heat *roughly* scales with I^2R. So you may do two things: lower the current (I) the motor needs to draw, or lower the resistance (R) of the windings the current flows through. Most focus on Current

because it's squared, but both contribute.

先从常见的公式 $P=I^2R$ 说起，这里热量大致与 I^2R 成正比。因此有两种方法：降低电机所需电流（I），或降低电流流经绕组的电阻（R）。多数人关注电流，因其为平方项，但两者均有影响。

One major lever to reduce wasted current is to make the motor's torque smoother through each rotation. **In plain terms: pedaling a bike with a slightly wobbly wheel takes more energy than a true one. Each rotation, you fight a small surge of resistance, and you push harder on average to hold the same speed.**

减少电流浪费的一个关键手段是让电机在每次旋转中扭矩更平滑。通俗来说：骑一辆轮子轻微晃动的自行车比骑一辆轮子正圆的自行车更费力。每转一圈，你都要对抗一股小小的阻力波动，为了保持相同速度，平均下来就得蹬得更用力。

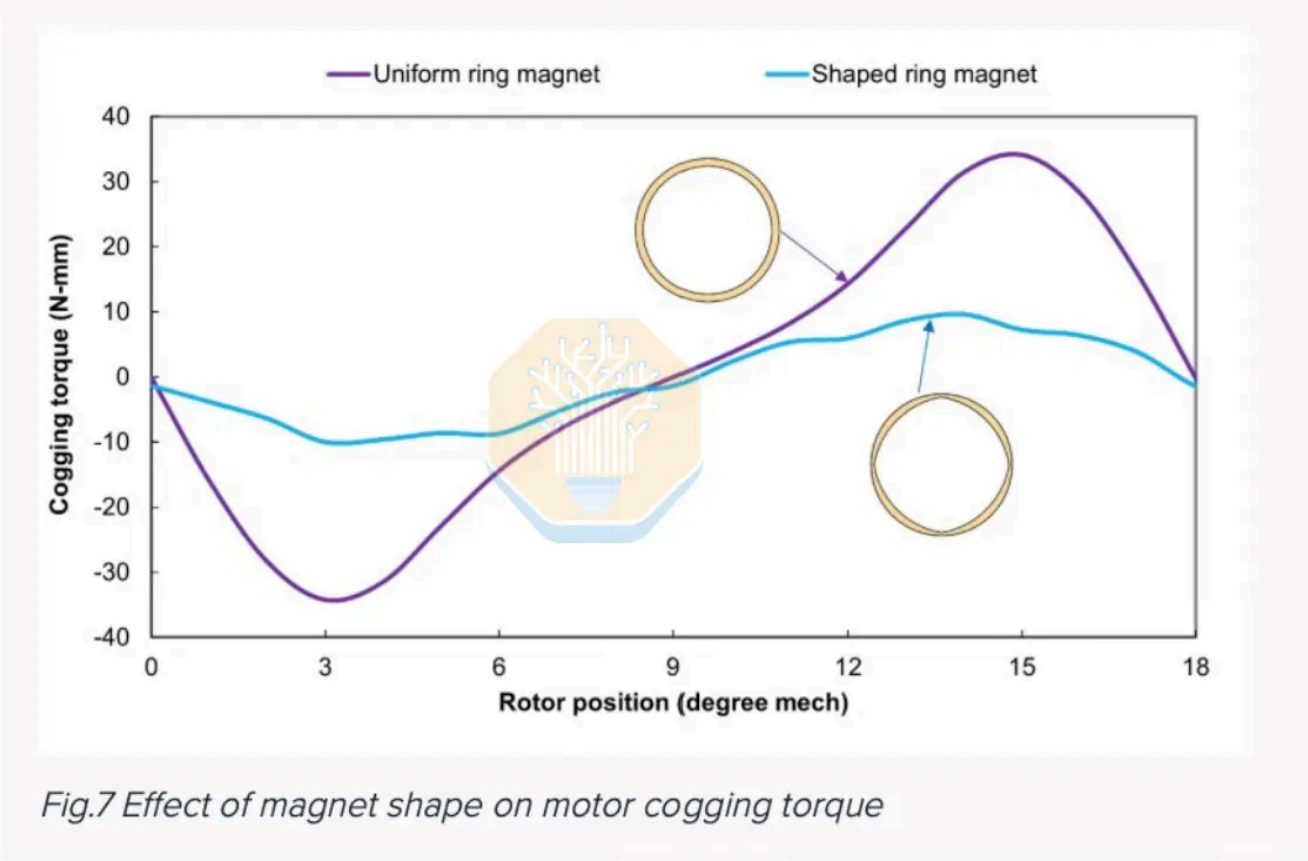


Fig.7 Effect of magnet shape on motor cogging torque

Source: MQITechnology 来源：MQITechnology

A motor with a rough magnetic pull has the same problem: the rotor jerks slightly with every revolution, and the extra current you draw to overcome that jerkiness turns directly into heat. Those hiccups come from effects like cogging torque, where the rotor magnets interact with the stator teeth, and from non-ideal magnetic-field shapes

that create torque ripple. Less ripple means less vibration, less wasted current, and more usable torque before overheating.

磁性拉力粗糙的电机存在同样的问题：转子每转一圈都会轻微抖动，为克服这种抖动而额外消耗的电流会直接转化为热量。这些抖动源于齿槽转矩效应（转子磁钢与定子齿槽相互作用）以及非理想磁场形状产生的转矩脉动。脉动越小，振动越少，电流损耗越低，在过热前可用的有效扭矩就越大。

To resolve this, **we can reshape or curve the magnets and slots so the pull stays smooth between rotations**. Additionally, we can also skew the magnets so the stator teeth take turns engaging the field rather than all snagging at once.

为解决此问题，可以通过重塑或弯曲磁钢与槽型，使旋转间拉力保持平稳。此外，还可采用磁钢斜极设计，令定子齿轮流接入磁场，而非同时卡滞。

Another useful solution is to **pack more copper wire into the motor.** A thicker, more densely-packed wire carries the same current with less resistance, known by Unitree as their "Low Copper Consumption Coil." Halodi, now known as 1X, famously tweaked their copper fill as well by using thick, square copper wire.

另一个有效的解决方案是在电机中塞入更多铜线。更粗、更密集的导线能以更低的电阻承载相同电流，宇树科技将其称为"低铜耗线圈"。如今更名为 1X 的 Halodi 公司，也曾通过使用粗方形铜线来优化铜填充量，这一做法广为人知。

Cooling is still important for a functional robot, but Unitree's architecture is fairly conservative on this front. We've found **passive cooling** across most of the body, with active air cooling only at the main control board and hip joint, and a vapor chamber heat spreader at the knee. Unitree has **iterated here too**, adding active cooling around the pelvis in an October 2025 update that improved thermal headroom for subsequent G1 batches.

对于功能型机器人而言，散热依然至关重要，但宇树科技在此方面的架构设计相对保守。我们发现其机身大部分区域采用被动散热，仅主控板与髋关节处配备主动风冷，膝关节则使用均温板散热片。宇树科技在此领域同样进行了迭代优化——2025 年 10 月的升级版本在骨盆区域增加了主动散热系统，为后续批次的 G1 机器人提升了热管理余量。



Source: JONVER Electronics

来源：JONVER Electronics

We suspect Unitree not focusing much on its cooling can be attributed to wanting to reduce costs and manufacturing complexity while focusing on the core problem we mentioned earlier: lowering the amount of current its motors need.

我们推测，Unitree 之所以没有过多关注散热问题，可能是为了降低成本和简化制造流程，同时专注于我们之前提到的问题：降低电机所需的电流。

So Why QDDs In The First Place? A Quick Detour On Speed+Cost

那么，为什么一开始要选择 QDD 呢？关于速度与成本的简要探讨

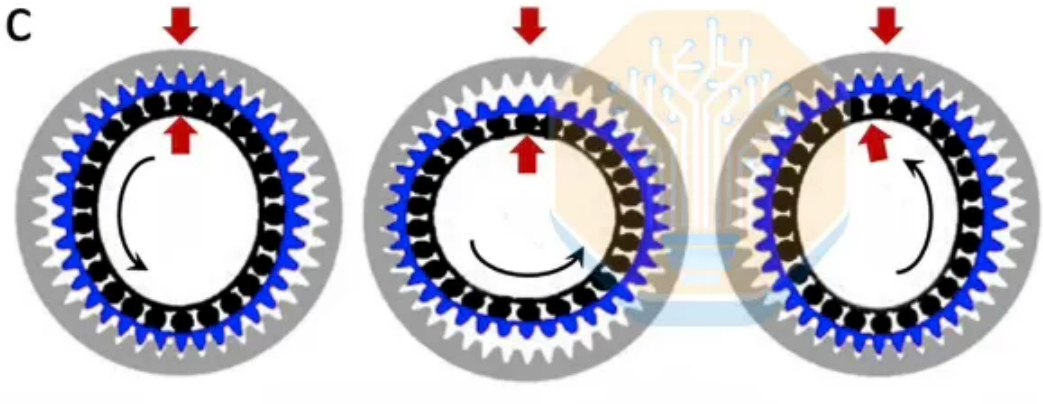
Unitree made a bet on the QDD, taking an unproven architecture (in deployments) on the most expensive component in the robot. While difficult to work with, they are still higher efficiency (95%-98% vs 85%-90% for strainwaves), and up to 80% cheaper. Importantly, low-ratio planetary gearboxes are also common industrial components, machined with standard gear hobbing (think grinding) on widely available equipment,

enabling many suppliers to exist.

宇树科技将赌注押在了 QDD 上，在机器人最昂贵的部件上采用了未经大规模部署验证的架构。尽管这种架构操作难度较大，但其效率更高（95%-98%，而应变波齿轮仅为 85%-90%），成本却降低高达 80%。更重要的是，低减速比行星齿轮箱也是常见的工业组件，可通过广泛普及的标准滚齿设备加工，这使得供应商数量众多。

Meanwhile, competitors choosing strainwave gearboxes for example, like from HarmonicDrive or LeaderDrive, face a more complicated ~13-step process. Multi-hour heat treatment of the metal grains to allow “flexing,” (shown below) precision hobbing into micron-level tolerances, etc, all lead to a process that took HarmonicDrive decades to perfect, and LeaderDrive is still considered by many to be lagging HarmonicDrive’s reliability after 20+ years.

与此同时，选择使用谐波减速器（如 HarmonicDrive 或 LeaderDrive 产品）的竞争对手，则需面对更为复杂的~13 步工序。例如，需对金属晶粒进行数小时的热处理以实现"柔性变形"（如下图所示），再通过精密滚齿加工达到微米级公差——这一整套流程耗费了 HarmonicDrive 数十年才臻于完善，而 LeaderDrive 历经二十余年仍被业界普遍认为在可靠性上落后于 HarmonicDrive。



Source: Nature 来源：《自然》

Instead of verticalizing an entire decades-long learning curve, Unitree chose the QDD. Now, **a new QDD redesign can become a sample actuator within weeks for Unitree**. For context, a custom motor and gearbox subsystem may take a Western humanoid company 3+ months due to so many supply chain handoffs. Weeks of spec iteration, 6-8 weeks for motor+gearbox samples, then validation and reorders. The result is both cheaper production, as shown in our BoM, and faster iteration, as seen in the active

pelvis-cooling rollout that went largely unnoticed.

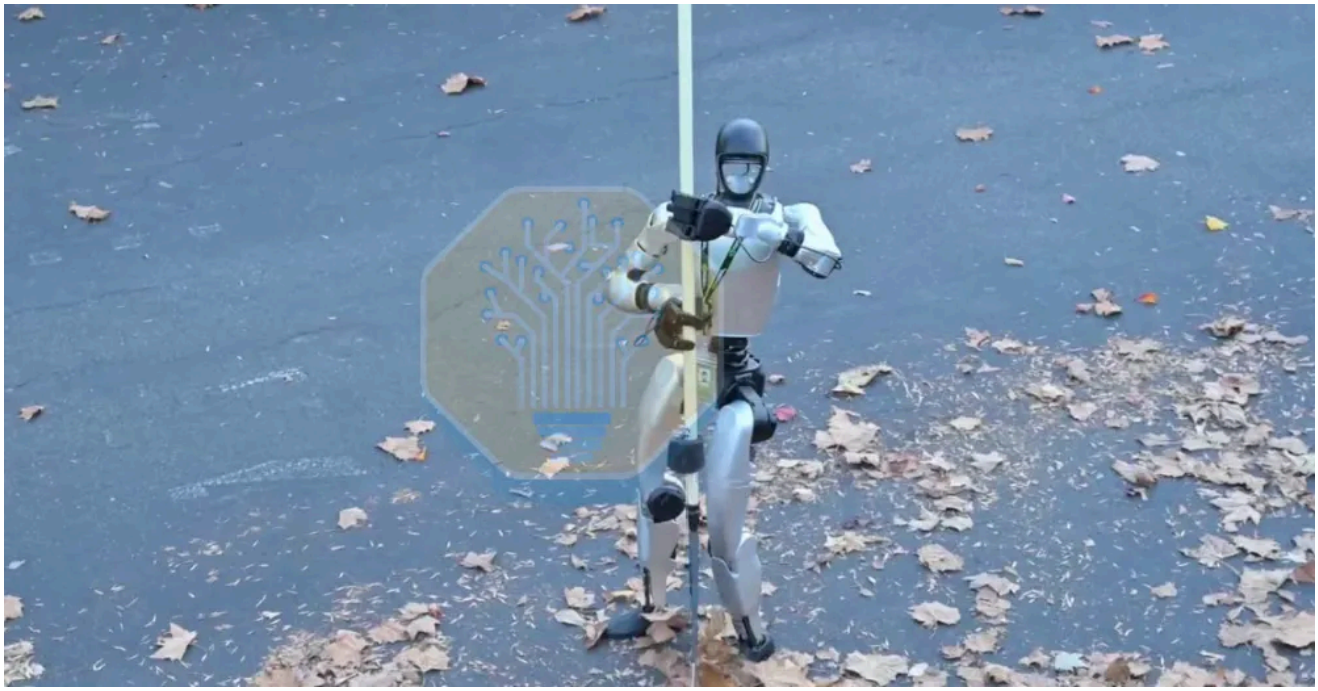
宇树科技没有选择将长达数十年的学习曲线垂直整合，而是采用了 QDD 方案。如今，宇树科技仅需数周就能完成新型 QDD 的重新设计并制成样品。作为对比，西方人形机器人公司定制电机与减速器子系统可能需要 3 个月以上——这源于供应链中过多的交接环节：数周的规格迭代、6-8 周的电机与减速器样品制作，随后还要进行验证和二次订购。正如我们的物料清单所示，这种策略既降低了生产成本，也加快了迭代速度——从几乎未被察觉的主动式骨盆散热系统的快速部署便可见一斑。

From Burnout To Lightweight Tasks

从高强度任务到轻量化作业

Now, Unitree has iterated and improved their G1's and actuators enough that small, but legitimate, tasks are within *arm's* reach. Arms bent, the G1 sustains upwards of 10-15 minutes of operations carrying 5 kg, a roughly 2x increase in payload and a 5x increase in duration over our original numbers! With arms fully outstretched, 5kg (roughly a bowling ball) can be held for ~1 minute before hitting thermal limits. Even for humans this is considered a workout. But how close are we to Unitree being a "viable" humanoid?

如今，宇树科技已对 G1 机器人和其执行器进行了充分迭代改进，使得小型但切实可行的任务已触手可及。在手臂弯曲状态下，G1 可维持 10-15 分钟负重 5 公斤的操作，有效载荷较原始数据提升约 2 倍，持续时间提升 5 倍！当手臂完全伸展时，5 公斤（约等于一个保龄球）可保持约 1 分钟才会触及热极限。即便对人类而言，这也可视为一次力量训练。但距离宇树科技成为"可行"的人形机器人，我们还有多远?



Source: NVIDIA 英伟达

Heading Towards Useful Work

迈向实用化工作

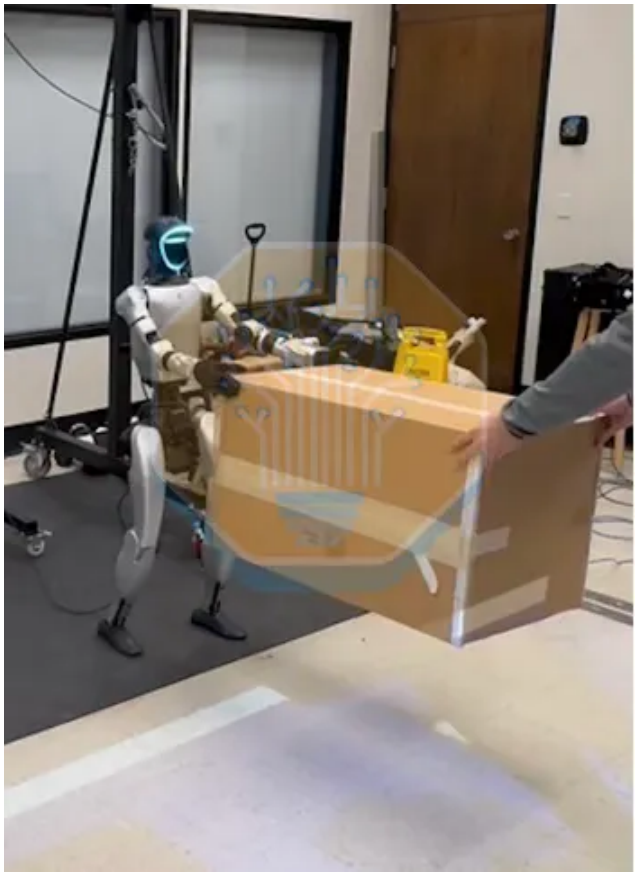
Unitree is obviously very cheap, and we know the strategy they are taking, and how their hardware is improving, but does it matter? Many might point to the previous section declaring that 15 minutes carrying 5kg doesn't matter: perhaps "dexterity is lacking," "it doesn't have hands," "that's not very long," etc. However, we estimate that Unitree may have shipped roughly **up to 250 humanoids** into productive industry pilots or deployments in 2025, aside from their research/hobbyist sales. We've even found one company with **30 G1s deployed today, and multiple companies with 5-6 G1s deployed**. Granted, these deployments are likely software limited (e.g. AI model capabilities), leading to differing economics based on what solutions are used, like

100% teleoperation (which is what we assume in our calculations).

宇树科技的产品显然价格低廉，我们清楚他们的战略方向以及硬件提升的成效，但这些真的重要吗？许多人可能会质疑上一节提到的"15 分钟搬运 5 公斤"的实际意义：或许会说"灵巧性不足"、"没有机械手"、"持续时间太短"等。然而我们估算，截至 2025 年，宇树科技除科研/爱好者市场销售外，可能已向工业试产项目交付约 250 台人形机器人。我们甚至发现某家公司现已部署 30 台 G1 型机器人，另有数家公司部署了 5-6 台 G1 型。需要承认的是，这些部署很可能受限于软件能力（如 AI 模型性能），导致基于不同解决方案的经济效益差异——例如我们计算中预设的 100%远程操控方案。

Unitrees do not need to run perfectly, nor for extended periods of time, nor do we expect them to. Rather, it is a question of what's sufficient for useful work. The G1's arms are still underpowered, they don't have enough "degrees of freedom" for perfectly human-like movements, and they still overheat on overly strenuous jobs. But this only puts a **ceiling** on the types of tasks the G1 can do, not a **floor** on whether it can do anything at all.

宇树机器人无需完美运行，也无需长时间运作，我们对此本无期待。关键在于其能否胜任实际工作。G1 型机器人的手臂动力仍显不足，缺乏足够"自由度"以实现完美仿人动作，且在高强度作业时仍会过热。但这仅限制了 G1 可执行任务的类型上限，而非其能否完成任何任务的下限。



Source: ExtremControl 来源：ExtremControl

Looking past performative backflips, Unitrees can already perform “useful work,” non-exhaustively defined here as either.

抛开那些表演性质的后空翻，宇树科技的机器人已经能够执行"实用工作"——此处不完全列举的定义包括：其一，执行对人类而言重复、危险或劳动强度过大的任务；其二，通过降低成本，在传统自动化不经济的垂直领域实现经济可行性。

A task performed in a business to produce some economic output, like sorting boxes, or a task performed to relieve a physical burden of a human, like folding clothes.

商业活动中为产生经济产出而执行的任务，例如分拣箱子；或是为减轻人类体力负担而执行的任务，例如折叠衣物。

So what are these Unitrees actually doing? Essentially, carrying boxes/items from A to B. Currently, it tends to be lightweight materials handling, like in e-commerce tote

(bin) handling with <3-5 kg payloads, or moving even empty boxes/totes.

那么这些宇树机器人到底在做什么？本质上，它们是在将箱子/物品从 A 点搬运到 B 点。目前主要涉及轻量级物料搬运，例如在电商周转箱（料箱）搬运中处理 3-5 公斤以下的载荷，或是移动空箱/空周转箱。

None of these are 24-hour, fully-autonomous production lines, and most are still teleoperated. Nonetheless, let's demonstrate that moving boxes around is becoming economically viable.

这些都不是 24 小时全自动生产线，大多数仍采用远程操控。尽管如此，我们仍需证明：搬运箱子这件事正在变得具有经济可行性。

Unitrees Are Crossing The Deployment Viability Threshold

优必选机器人正跨越部署可行性门槛

"*Thanks to Adamo for helping us understand teleoperated deployments further!*"

"感谢 Adamo 帮助我们进一步了解远程操作部署！"

We've discussed humanoid economics in depth in our Levels of Autonomy paper, but here we perform a full calculation for Unitree. Taking Agility Robotics' (fantastic) task as a baseline, and plugging in Unitree inputs, we find Unitrees are **currently passing below** the $30 per hour labor cost of a human.

我们在《自主性等级》一文中已对类人机器人经济学进行了深入探讨，但在此我们将针对 Unitree 进行一次全面的成本核算。以 Agility Robotics（这一绝佳案例）的任务为基准，并代入 Unitree 的相关参数后，我们发现 Unitree 当前的每小时运营成本已低于人类 30 美元的劳动力成本。

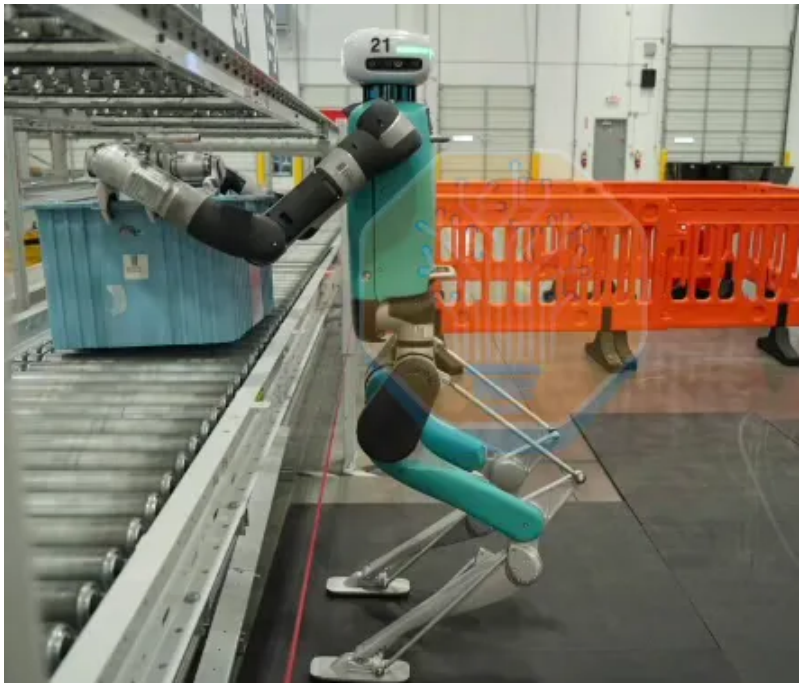


Source: SemiAnalysis Estimates

来源：SemiAnalysis 估算

No humanoid is at mass-scale production/deployments yet, all are still iterating on the technology, and these figures may change from deployment to deployment (grippers/hands, payload, throughput, etc). Instead, we will show our best estimate of what they're capable of today and what that looks like on a specific task, but want to note: these are early-stage numbers, and **if Unitree's hardware continues its improvement trajectory, and Autonomy improves, the economics likely only improve from here.**

目前尚无任何人形机器人实现大规模生产或部署，所有产品仍处于技术迭代阶段，相关数据（如夹爪/手部设计、负载能力、吞吐量等）可能因部署场景不同而变化。因此，我们将基于现有能力给出最佳估算，并针对特定任务展示其表现。但需注意：这些均为早期数据。若宇树科技的硬件持续沿当前改进轨迹发展，且自主性不断提升，其经济性很可能只会持续优化。



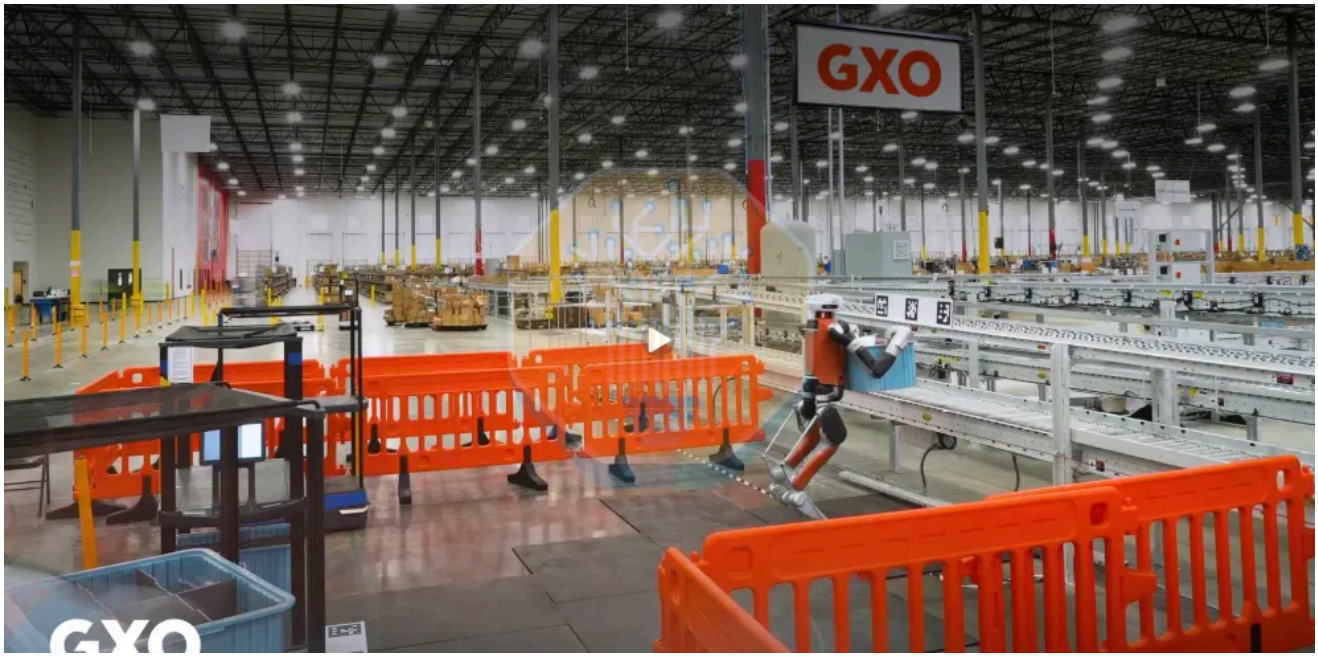
Source: Agility Robotics 来源：敏捷机器人公司

A Lovely Task: Tote Handoff

一项可爱的工作：料箱交接

In this particular job, Agility serves as a “bridge” between automation systems, for example, carrying totes (bins) off the AMRs to place onto conveyor belts. It’s a standard, but particular, logistics workload, where a human typically waits on automation systems to line up for the transfer, but leaving dead time in between. It’s why Agility’s 66 totes per hour (from a conference demo, likely higher in deployments) is perfectly fine.

在这项特定工作中，Agility 充当自动化系统之间的“桥梁”，例如，将料箱从自主移动机器人上取下并放置到传送带上。这是一项标准但特定的物流任务，通常需要人类等待自动化系统排列整齐以完成交接，但期间会产生空闲时间。正因如此，Agility 每小时处理 66 个料箱的效率（来自会议演示，实际部署中可能更高）完全能够胜任。

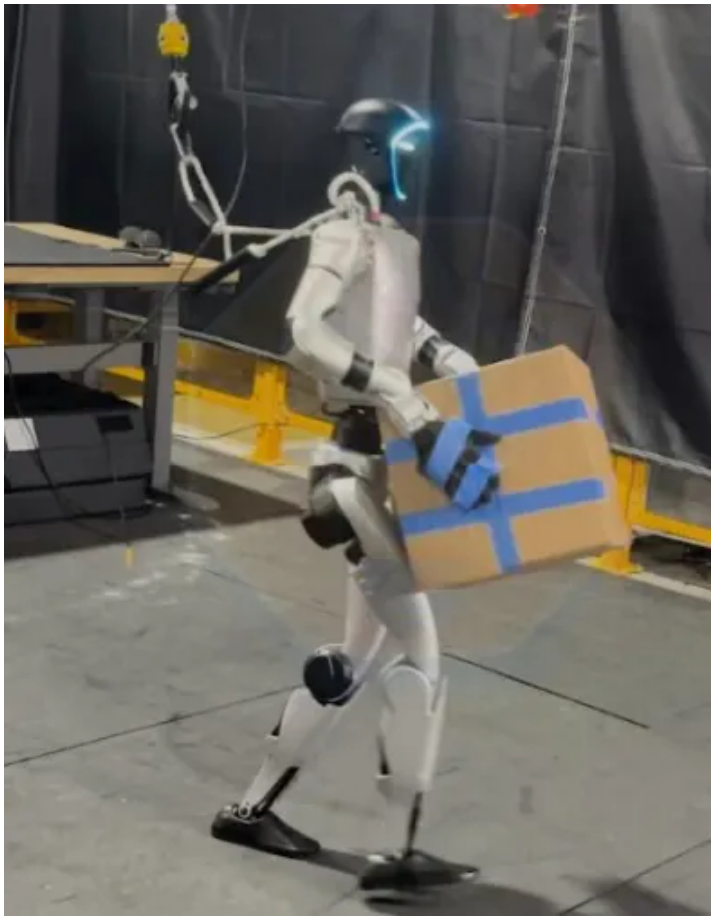


Source: The Robot Report

来源：The Robot Report

Additionally, in Agility's GXO deployment, the totes are 2-4kg (good for our aforementioned Unitrees). With light payloads, low-throughput, forgiving retries upon failure, and little dexterous manipulation, it's a perfect task for the current Level of Autonomy.

此外，在 Agility 的 GXO 部署中，料箱重量为 2-4 公斤（这对我们前述的 Unitree 机器人很友好）。由于负载轻、吞吐量低、失败后可轻松重试，且无需复杂灵巧操作，这对当前自主水平而言堪称完美任务。



Source: OmniRetarget 源：OmniRetarget

Calculating Unitree's Economic Viability

计算宇树的经济可行性

Agility currently operates using a 2:1 utilization model, two units of operating time for every one unit of charging, giving Digit a **two-thirds utilization rate** relative to a human.

Agility 目前采用 2:1 的使用模式，即每充电 1 单位时间可运行 2 单位时间，这使得 Digit 相对于人类拥有三分之二的使用率。



Source: Agility Robotics 来源：敏捷机器人公司

Operators deploying Unitrees on similar 2-4 kg tote transfer work reported to us a throughput matching Digit on this task. However, Unitrees aren't the most robust robots. A Unitree G1 typically runs a similar task for 10-15 minutes, while needing 5-10 to cool down, but still leaving a 50%-67% utilization rate. In our assumptions, we remain **very** conservative, assuming full teleoperation, 15% service contract (typically 5-10% in industrial scenes), a two-year useful life, zero residual value, and only two shifts. Even still, the robot proves viable **today.**

操作员部署 Unitree 执行类似的 2-4 公斤搬运任务时反馈，其工作效率与 Digit 机器人持平。但 Unitree 并非最坚固的机器人——G1 型号通常运行同类任务 10-15 分钟后需冷却 5-10 分钟，仍能保持 50%-67%的利用率。我们在测算中保持高度保守：假设全程远程操控、15%服务合同（工业场景通常为 5-10%）、两年使用寿命、零残值且仅运行两班制。即便如此，该机器人目前仍具备经济可行性。



Source: SemiAnalysis Estimates

来源：SemiAnalysis 估算

To get the caveats out of the way, we are not proposing Unitree as the full package. Many layers still need to be added. Agility, for example, has a great operating system to coordinate with the Warehouse Management System, a deeper functional safety approach, their own layer of autonomy, and much more. However for Unitree, even full teleoperation seems to be viable in the right business settings **now.**

先说几个前提条件，我们并非将宇树视为完美的解决方案。还有许多层面需要完善。例如 Agility 公司拥有出色的操作系统，能与仓储管理系统协调配合，具备更深入的职能安全方案、自主运算层级以及其他诸多功能。但对宇树而言，即便在当前的商业环境下，纯远程操控似乎也已具备可行性。

Where This Goes 未来走向

To our knowledge, this is the first stage of Unitree's humanoids exhibiting useful work in deployments. It's not that this task is exceptional, or a $100T TAM, but it shows Unitree may be crossing a threshold, and their trajectory is quite remarkable. Recall that DJI shipped a half-perfect drone to niche hobbyists and 32x'd their revenue, quickly catapulting themselves into drone dominance. In the beginning, the G1 would overheat from holding a box for 2-3 minutes too. The performance improvements thus

far were funded by hobbyists/researchers. If Unitree unlocks even a slice of the warehouse TAM, progress can accelerate at breakneck speed.

据我们所知，这是宇树人形机器人首次在部署中展现实用价值。这项任务本身并不特殊，也不代表百万亿美元级别的市场，但表明宇树可能正在跨越某个临界点，其发展轨迹相当引人注目。回想大疆当年向小众爱好者交付了半成品无人机，随后营收增长 32 倍，迅速成为无人机领域的霸主。最初，G1 机器人也会因手持箱子 2-3 分钟而过热。迄今为止的性能提升都是由爱好者和研究人员资助的。一旦宇树能撬动仓储市场哪怕一小部分，其发展速度将呈指数级加速。



Robotics Levels of Autonomy

机器人自主能力等级

REYK KNUHTSEN, DYLAN PATEL, AND 4 OTHERS

雷克·努森、迪伦·帕特尔等 4 人 · 2025年7月31日 2025 年 7 月 31 日

Read full story 阅读完整报道 →

With signs of robotic AI models gaining new capabilities, BoMs falling, and the quality of hardware improving thus far, Unitree could become the cheapest, competent humanoid platform in the market. Let's talk about how they got to their world-leading $8,976 BoM.

随着机器人 AI 模型展现出新能力、物料清单成本下降以及硬件质量持续提升，宇树科技有望成为市场上性价比最高的人形机器人平台。让我们探讨他们如何实现全球领先的 8976 美元物料清单成本。

China's Manufacturing Competence

中国制造实力

Throughout the piece so far, we've hinted at Unitree's manufacturing competence and the ecosystem surrounding them. For robotics, and many other industries, working with the Chinese ecosystem is necessary to compete on a global scale when: Suppliers are mere hours away by train, samples arrive the same/next day, vertical iteration cycles can run in weeks instead of quarters, and components can run 20-40% cheaper than Western equivalents. It should be noted that strainwave gearboxes from

Leaderdrive, for instance, sometimes cost **a third** of HarmonicDrive's -- granted HarmonicDrive **currently** remains the reliability leader.

至此，本文已多次暗示宇树科技的制造能力及其所处的生态系统。对于机器人行业乃至众多其他产业而言，当供应商仅需数小时火车车程即可抵达、样品当天或次日送达、垂直迭代周期可缩短至数周而非数月、零部件价格比西方同类产品低 20%-40% 时，与中国生态系统合作便成为在全球竞争中立足的必要条件。需要指出的是，以 Leaderdrive 的应变波齿轮箱为例，其价格有时仅为 HarmonicDrive 的三分之一——当然，HarmonicDrive 目前仍是可靠性领域的领导者。

Most American robotics startups are already working with Chinese supply chains, like Sunday Robotics, Dyna, and XDOF, who all run their hardware teams out of China. Even Tesla Optimus sources from the Chinese supply chain, and will likely continue to do so.

大多数美国机器人初创公司已经在与中国供应链合作，例如 Sunday Robotics、Dyna 和 XDOF，它们的硬件团队都设在中国。就连特斯拉的 Optimus 也依赖中国供应链，并且很可能会继续这样做。



America Is Missing The New Labor Economy - Robotics Part 1

美国正在错失新劳动力经济 - 机器人技术（上篇）

DYLAN PATEL, REYK KNUHTSEN, AND 4 OTHERS

作者：迪伦·帕特尔、雷克·克努特森 等四人

• 2025年3月11日 2025 年 3 月 11 日

Read full story 阅读完整报道 →

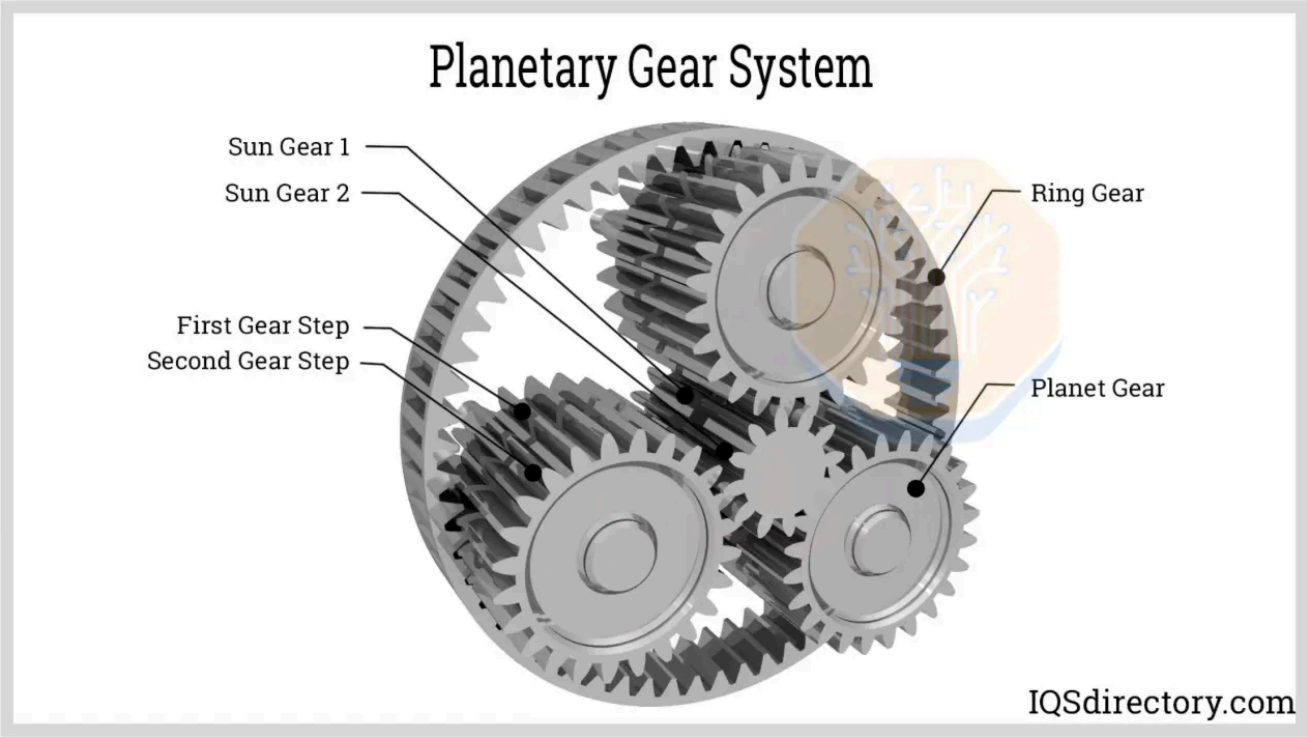
Unitree's Verticalization Is Remarkable - Even In China

宇树科技的垂直整合在中国也堪称惊人

The Chinese ecosystem is amazing, but we've harped on how great verticalization is, so let's expand on this. Unitree self-develops BLDC motors, planetary gearboxes, LiDARs, and depth cameras, each typically (or even previously for Unitree) outsourced by other Chinese humanoid OEMs. Instead, Unitree's self-produced motors can run as low as 30-40% of equivalent Western motors, and **they now make some of the cheapest**

humanoid gearboxes in the world.

中国的生态系统令人惊叹，但我们已经反复强调垂直整合的优势，因此不妨深入探讨这一点。宇树科技自主研发无刷直流电机、行星减速器、激光雷达和深度相机——这些部件通常（甚至包括宇树此前）由其他中国人形机器人制造商外包生产。而宇树自产电机的成本仅为西方同类产品的 30-40%，如今他们已能制造出全球最廉价的人形机器人减速器。



Source: IQSDirectory 来源：IQSDirectory

These same benefits are very apparent in the IPO filing. In Unitree's First Round Inquiry Response with the Shanghai Stock Exchange (SSE), they explicitly state that scaling production gave them **upstream bargaining power**, which created a lasting cost advantage.

这些优势在 IPO 文件中表现得非常明显。在 Unitree 对上交所的首轮问询回复中，他们明确表示规模化生产为其带来了上游议价能力，从而形成了持久的成本优势。

公司通过核心部组件的自研自产，逐步建立自有产线，实现对供应链的深度掌控，既保障产品与技术快速迭代，也显著降低物料采购与制造成本；全栈自研与规模化生产增强了公司与上游供应商的议价能力，最终形成的较强的成本控制优势。由此，公司产品在性能保持行业领先的同时，形成了显著的性价比优势。

Full-stack in-house R&D—combined with scaled production—has bolstered the company's bargaining power with upstream suppliers, ultimately establishing a robust competitive advantage in cost control.

Source: Unitree First Round Inquiry Response, 8-1-1-14

源：宇树科技首轮问询回复，8-1-1-14

This translated to margins on their quadruped robots improving from **42.36%** to **55.49%** while costs dropped nearly in **half.** However, SemiAnalysis subscribers knew these quadruped margins already back in September.

这使得其四足机器人的利润率从 42.36%提升至 55.49%，同时成本几乎减半。不过，SemiAnalysis 的订阅用户在去年九月就已获悉这些四足机器人的利润率数据。

Unitree Go2							
Component	Type	Supplier	Material	Mass (kg)	Number	ASP	Cost
Gearbox							
Motor							
Encoder							
Linkage Bar							
Assembly (Actuator)							
Drive							
Bearings							
Casing							
Battery							
LiDAR							
Camera							
Foot Sensors							
Depth Camera							
External Communication							
Compute							
Structural Components							
Assembly							
CPU							
COGS							$3,272
ASP (EDU)							$8,000
Margins							59%

Source: SemiAnalysis SemiAnalysis

This verticalization is a spectacle in Western markets, but even within China, where razor thin hardware margins require verticalization for survival. BYD and DJI from earlier showed their path to dominance via verticalization. UBTECH and AGIBot (two of the main Chinese humanoid competitors) are actively moving to bring more of the

hardware under control, like gearboxes, motors, etc -- components Unitree already self-develops.

这种垂直整合在西方市场堪称奇观，但即便在中国，极低的硬件利润率也迫使企业必须通过垂直化生存。比亚迪和大疆此前已通过垂直整合展示了它们的统治路径。优必选和智元机器人（中国主要人形机器人领域的两家竞争者）正积极将更多硬件纳入掌控，例如减速器、电机等——而宇树科技早已实现这些部件的自主研发。

Both UBTECH and AGIBot still lean on ODM/OEM partners for manufacturing and, in some cases, final assembly, like AGIBot outsourcing European production to Minth Group in Serbia. Even then, AGIBot is licensing full tech transfer at $4M, scaling through partnerships instead of owning the manufacturing learning curve. Meanwhile, Unitree states in their S-1 they plan to bring further development inhouse, including "tooth-profile design, simulation optimization, material validation, and high-precision machining."

优必选和智元机器人仍依赖 ODM/OEM 合作伙伴进行制造，有时甚至包括最终组装，例如智元机器人将欧洲生产外包给敏实集团的塞尔维亚工厂。即便如此，智元机器人仍以 400 万美元的价格授权完整技术转让，通过合作伙伴关系扩大规模，而非自主掌握制造环节的学习曲线。与此同时，宇树科技在其 S-1 文件中表示，计划进一步将"齿形设计、仿真优化、材料验证以及高精度加工"等环节纳入内部开发。

However, neither Unitree nor other humanoid companies are at high-volume production. This implies that even as they scale production, Unitree may likely maintain a **structural cost advantage** from a first-mover standpoint. A future piece will detail the Chinese industrial ecosystem in all its glory, but for now, assume most humanoids will source from China, and even in China, Unitree is exceptional.

然而，无论是宇树科技还是其他仿人机器人公司，目前都尚未实现大规模量产。这意味着即便在扩大生产规模的过程中，宇树科技作为先行者，仍可能保持结构性成本优势。未来将有一篇文章详细阐述中国工业生态系统的全貌，但就目前而言，可以预见大多数仿人机器人企业会从中国采购零部件，而即便在中国本土，宇树科技的表现也堪称卓越。

Conclusion 结论

While Western manufacturers were/are still prototyping humanoids, Unitree has profitably shipped tens of thousands of quadrupeds, built up an entire humanoid market, entered into useful humanoid work, but everyone should consider: where does this stop for Unitree? BYD began with just battery cells, DJI with just controllers, and are now titans of industry.

当西方制造商仍在研发人形机器人原型时，宇树科技已通过四足机器人实现盈利并交付数万台设备，构建起完整的人形机器人市场，并开始涉足实用化的人形机器人作业。但值得深思的是：宇树科技的边界究竟在哪里？比亚迪从电池电芯起步，大疆从控制器起家，如今都已成为行业巨头。

Watching how Unitree has accelerated success through multiple robot form factors, and increasingly solidified a manufacturing advantage, they may continue to expand at this same pace and unlock markets previously unthinkable.

观察宇树科技如何通过多形态机器人加速成功，并持续巩固制造优势，他们或许会以同样的速度持续扩张，开拓此前难以想象的市场领域。

For now, let's discuss robotic hands and which of Unitree's suppliers may benefit, all now beyond the paywall.

暂时，我们来讨论一下机器人手部，以及宇树科技的哪些供应商可能从中受益——这些内容现在都已解锁，不再受付费墙限制。

Hands and Handmakers 双手与手部制造者

Hands may be very key to unlocking more tasks for our Unitrees, but designing a robotic hand is a whole new challenge on its own. There seem to be two options at the moment:

双手可能是解锁宇树机器人更多任务的关键，但设计一只机械手本身就是一个全新的挑战。目前似乎有两种选择：

Joint-actuated: For this architecture, an actuator is placed at each joint to control the movement. These can be precise, but may be very expensive, bulky, or lack in payload

capacity.

关节驱动型：这种架构在每个关节处放置一个执行器来控制运动。这类设计精度较高，但可能非常昂贵、笨重，或缺乏负载能力。

Tendon-driven: The actuators can be placed in the forearm to pull the tendons and drive the fingers. This makes the hands lighter, and many argue more “accurate.” However, modeling tendons for action is a challenge, overheating with continuous tension, and the tendons are constantly subject to wear and breakage due to bending fatigue.

肌腱驱动：执行器可置于前臂，通过拉动肌腱驱动手指。这种设计使手部更轻巧，许多人认为其"精准度"更高。然而，肌腱动作建模颇具挑战，持续张力会导致过热，且肌腱因弯曲疲劳而不断承受磨损与断裂风险。



Source: 1X 1X

It’s unclear which will prevail, as both have their pros and cons, but some believe tendon-driven is the optimal path with more “human-like” action and stronger actuation.

目前尚不清楚哪种方案会胜出，因为两者各有利弊，但有人认为肌腱驱动是更优路径，能实现更"类人"的动作和更强的驱动力。

In China, Inspire, Sharpa, Robotera, Tencent-spinoff Dexcel, and many more are all racing to build the best hands. The more dexterous hands run a hefty price tag, like

Sharpa at around $50K each.

在中国，因时机器人、星动纪元、睿尔曼、腾讯孵化的戴盟机器人等众多企业都在竞相打造最优秀的灵巧手。越灵巧的手价格越昂贵，例如星动纪元的灵巧手每只售价约 5 万美元。

In the US, emerging hand companies include Proception, Origami Robotics, and Kyber Labs, among others. Additionally, 1X seems to have built an impressive tendon-driven hand, claiming many more cycles than Optimus' hand. This is likely thanks to different materials (like Dyneema) and system integration (avoiding bending fatigue), but still tackling the same issues as Tesla.

在美国，新兴的手部公司包括 Proception、Origami Robotics 和 Kyber Labs 等。此外，1X 似乎开发了一款令人印象深刻的肌腱驱动手部，声称其循环次数远超 Optimus 的手部。这很可能得益于不同的材料（如迪尼玛）和系统集成（避免弯曲疲劳），但仍需解决与特斯拉相同的问题。



Source: Interesting Engineering

来源：Interesting Engineering

Interestingly, similar to how Unitree is dominating the academic robotics learning market, Sharpa, seen above, has been aggressively reaching out to many academic and industry labs to get involved with active collaborations. It's now even to the point where they will let labs borrow them, some at huge discounts, and even ask to be involved in weekly project meetings. It's a worthy gamble, as if the next few years of hand research is based on their hardware, then Sharpa stands to benefit immensely. And, judging from many recent research releases (NVIDIA's GEAR lab is famously a

big user), it seems it already is.

有趣的是，正如宇树科技正在主导学术机器人学习市场一样，上图所示的 Sharpa 公司也积极联系众多学术和行业实验室，寻求深度合作。如今甚至发展到允许实验室借用其设备（部分提供大幅折扣），并主动要求参与每周项目会议。这是一场值得的豪赌——如果未来几年关于机械手的研究都基于他们的硬件，Sharpa 将从中获益匪浅。而从近期众多研究成果来看（英伟达 GEAR 实验室正是其知名大客户），这似乎已成现实。

Unitree's Suppliers: Who Gets Hurt, Who Survives

宇树科技的供应商：谁将受损，谁将幸存

We believe that as Unitree gains scale, it will bring components and modules in-house to capture more margin but leave the underlying silicon suppliers alone. The clearest suppliers who will be hurt by this are:

我们认为，随着宇树科技扩大规模，它将把零部件和模块纳入内部生产以获取更多利润，但不会动底层芯片供应商。受此影响最明显的供应商包括：

Livox (DJI's LiDAR subsidiary). The original G1 used the Livox MID360 at a ~$550+ BOM, making it the most expensive singular component at ~9.2% of total BOM. Unitree's in-house LiDAR cuts that to ~$250-300, and the H2 reportedly doesn't use LiDAR or depth cameras. Thus, despite Livox being a top supplier per the IPO filing, we expect that to shrink substantially.

Livox（大疆旗下激光雷达子公司）。初代 G1 采用 Livox MID360，物料成本约 550 美元，成为总 BOM 中占比 9.2%的最昂贵单一组件。宇树自研激光雷达将成本压缩至 250-300 美元，而 H2 据称已不再使用激光雷达或深度摄像头。因此，尽管招股书显示 Livox 是主要供应商，我们预计其份额将大幅缩减。



Source: Livox 来源：Livox

Orbbec and RealSense. These are both providers of depth cameras to Unitree and face a similar dynamic as Livox, as Unitree has begun manufacturing its own depth cameras rather than externally sourcing them.

奥比中光和英特尔实感。这两家公司都是宇树科技的深度摄像头供应商，面临着与 Livox 相似的处境——宇树科技已开始自主生产深度摄像头，不再依赖外部采购。



Source: Orbbec 源：奥比中光

However, the silicon vendors are safe. For them, it doesn't matter whether Unitree buys Livox MID360 modules off the shelf or builds their own LiDAR; they'll still need

the same underlying silicon. It's just that Unitree can now procure those same Sony sensors and Chinese-fabbed ASICs directly, likely following the RoboSense model of direct procurement from Sony's sensor division.

然而，芯片供应商们大可高枕无忧。无论宇树科技是直接采购 Livox MID360 模块，还是自研激光雷达，他们所需的底层芯片始终如一。只不过现在宇树科技可以直接采购同款索尼传感器和中国制造的 ASIC 芯片，很可能效仿 RoboSense 的模式，从索尼传感器部门直接进货。

Additionally, besides Sony, we see several other beneficiaries of this trend. Rockchip benefits via the RK3588S in the G1 base, while LONGSYS supplies the 64GB storage and BIWIN the 8GB memory. NVIDIA also benefits through the Jetson Orin NX modules (100 TOPS) in the G1 EDU, procured via Beijing Plink AI Technology per the IPO filing, though this could shift if Chinese edge accelerators become more capable, as Unitree is not currently switching to Chinese-made onboard compute. Finally, CMSEMICON supplies the motor drive board MCU and gate-driver SiP, likely the CMS32M5733Q048, identified via a recent open reverse-engineering effort since Unitree deliberately laser-removes the package markings to prevent reverse-engineering.

此外，除索尼外，该趋势还惠及多家企业。瑞芯微通过 G1 基础版搭载的 RK3588S 芯片受益，而龙芯中科提供 64GB 存储、佰维存储供应 8GB 内存。英伟达亦通过 G1 教育版搭载的 Jetson Orin NX 模块（100 TOPS）获益——该模块由北京普林思拓人工智能科技有限公司根据 IPO 招股书采购，但若中国边缘加速器性能提升，此格局可能生变，因宇树科技目前尚未切换至国产机载计算方案。最后，中微半导体提供电机驱动板 MCU 及栅极驱动 SiP，型号疑似 CMS32M5733Q048——该信息源自近期公开逆向工程成果，因宇树科技刻意通过激光去除封装标识以防逆向破解。



Recommend SemiAnalysis to your readers

向您的读者推荐 SemiAnalysis

Bridging the gap between the world's most important industry, semiconductors, and business.

连接全球最重要的半导体产业与商业之间的桥梁。

Recommend 推荐



90 Likes 90 个赞 · 11 Restacks 11 次转帖

Previous 上一篇



A guest post by 客座文章

Niko Ciminelli 尼科•奇米内利

Intelligent Systems 智能系统

Subscribe to Niko 订阅尼科



A guest post by 客座文章

Robert Ghilduta 罗伯特•吉尔杜塔

Robotic practitioner - RL, sim2real, VLAs

机器人实践者 - 强化学习、仿真到现实、视觉语言动作模型

Subscribe to Robert 订阅罗伯特



A guest post by

Joe Ryu

Pioneering physical superintelligence 🚀

Subscribe to Joe

Discussion about this post

Comments **Restacks**



Write a comment...



va 5h

How does Unitree plan to solve intelligence part? I've been always under impression that mechanical hardware is "easy" part. To be truly general-purpose, humanoid robot must be able to understand human language either via locally deployed language model or cloud. It also must have capable vision AI.

LIKE REPLY SHARE

© 2026 Dylan Patel · Privacy · Terms · Collection notice
Substack is the home for great culture