ChatGPT

Wearable Robotic Systems for Artistic Augmentation

Wearable robotic systems are emerging as creative tools that **augment human capabilities in art-making**. Unlike autonomous art robots, these devices are worn on the body and act as co-creative or assistive partners – guiding, extending, or supporting the artist's own movements. Below, we explore several real-life examples, from extra robotic limbs that give artists new "hands," to exoskeletal supports and haptic teaching devices. Each example highlights how the human remains central to the creative process, with the wearable robot amplifying the user's intent or abilities.

Extra Limbs for Creativity: Robotic "Third Hands" and Thumbs

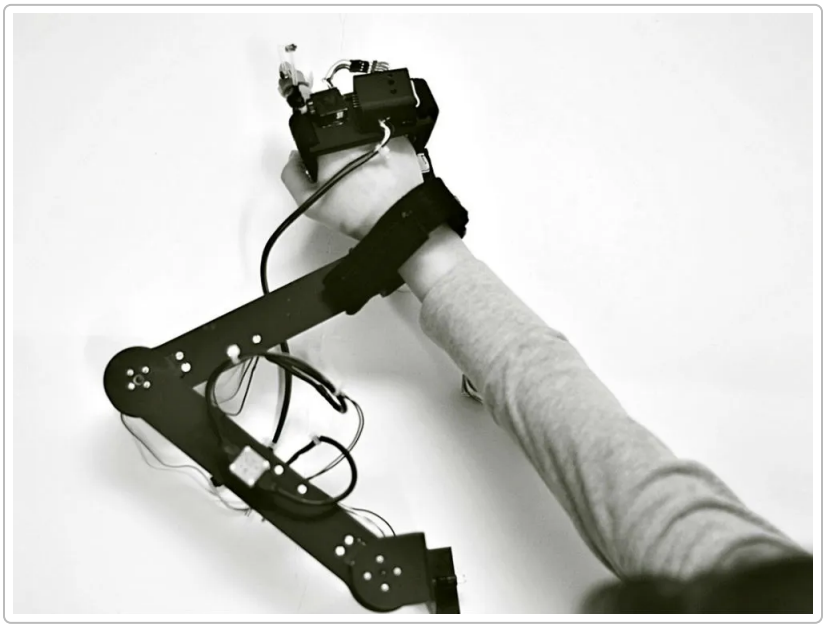
A wearable robotic "Third Thumb" designed by Dani Clode attaches to the hand, allowing the user to grasp and manipulate objects (in this case, holding two halves of an orange) with an extra digit.

One dramatic way to augment an artist is by **adding new limbs or digits**. Pioneering performance artist **Stelarc** demonstrated this with his *Third Hand* device – a human-like robotic hand attached to his right forearm as an extra hand. The Third Hand is built to the same size as his real hand and is **controlled by the artist's own muscle signals**: electrodes on Stelarc's abdominal and leg muscles pick up EMG signals, which trigger the mechanical hand's movements [1]. After training, Stelarc could operate this robotic hand intuitively, without having to consciously think about the muscle signals [1]. In his 1982 *"Handwriting"* performances, he even taught himself to write **different letters simultaneously with all three hands** – for example, writing the word "EVOLUTION" with his left hand writing "E", right hand "L", and the Third Hand writing "I" at the same time [2]. This early art-tech project by Stelarc (dating back to 1980–1981) is a landmark in wearable augmentation: it turned the artist's body into a **cyborg-like canvas**, exploring how an extra robotic limb could extend creative expression.

More recently, designers have explored extra digits. The **"Third Thumb"** by *Dani Clode* (developed at UCL's Plasticity Lab) is a 3D-printed robotic thumb that straps onto the hand opposite the natural thumb [3] [4]. It is **wearable and wireless**, worn on the side of the hand, and controlled via pressure sensors under the user's toes (connected via Bluetooth) [5]. Pressing down with the foot moves the thumb in sync – one toe controls lateral motion and another controls curling, with proportional control for finesse [5]. The Third Thumb effectively **increases the hand's grasping ability**, letting a user hold and manipulate objects in new ways (e.g. holding multiple objects or tools at once) [4]. While not made specifically for painting, we can imagine an artist using a Third Thumb to hold a palette or an extra brush, or perform tasks that normally *"would be challenging or impossible to complete with one hand"* [4]. Tests of the Third Thumb showed that most people could learn to use it for dexterous tasks within minutes [6] [7]. This suggests such **supernumerary robotic prosthetics** could become practical artistic aids. By extending the body's toolkit (literally giving a helping hand), these devices allow artists to explore new techniques – for instance, painting with three hands or manipulating an artwork while simultaneously drawing on it.

Notable creators and tech: Stelarc's Third Hand (controlled by bio-signals) was an artistic provocation that inspired later cyborg-art projects. Dani Clode's Third Thumb, while a design research prototype, has garnered attention for its elegant integration with the body and its cognitive impacts (Cambridge and UCL researchers even studied how the brain adapts to an extra thumb [8] [9]). Both highlight how *"motor augmentation"* – adding wearable robotic appendages – can push creative boundaries by giving artists physical capabilities they didn't have before.

Wearable Systems that Guide or Teach Artistic Motion



"Teacher," a wearable robotic tutor by Saurabh Datta, straps to the user's arm and physically guides the hand through drawing motions [10]. This motorized exoskeletal device can move the wearer's arm to trace shapes, helping build muscle memory for sketching.

Another class of artistic wearables doesn't add limbs, but instead **adds guidance to the artist's existing limbs**. These systems use haptics, force-feedback, or muscle stimulation to actively steer or influence the user's drawing/painting movements. The goal is often co-creative: the human and machine share control of the stroke, combining the artist's intent with the robot's precision or another's input.

One example is *"Teacher"*, a prototype created by **Saurabh Datta** at the Copenhagen Institute of Interaction Design. Teacher is essentially a **robotic armband tutor**: it straps onto a user's wrist and arm, and uses motors and linkages to **physically guide the hand in drawing** basic shapes [10] [11]. Datta built this device to explore accelerated learning of skills – in his words, *"a machine that coaches you to draw by forcing your hand to perform certain motions"*, building muscle memory through repetition [10]. When a user wears Teacher, the device can constrain and move their hand along a predefined path (for instance, forcing the wearer's pen to sketch a perfect circle or rectangle) [11] [12]. Early tests showed that fully surrendering control is uncomfortable – people instinctively resist if a machine drags their hand around [13]. However, when the system was tuned to share control (for example, replaying a user's own traced motion with slight corrections), users found a better *"negotiation"* between human and robot [13]. *Teacher* and Datta's related *"Force Finger"* device (for piano tutoring) are speculative designs probing how far we might go in

outsourcing skill acquisition to machines. They suggest a future in which an aspiring artist could literally *"download"* drawing skills – having a wearable robot guide their hand through practice strokes until the technique is learned [10] [14]. At the very least, they are fascinating **tools for art education**, turning the learning process into a human-robot partnership.

A different spin on guided art wearables is to have the *robotic system controlled by someone else* in real time, effectively making the artist's body a medium for another's creative input. The **EMS Painter** project (by *Ashley Colley et al.*, presented at TEI 2018) explored this by using **electrical muscle stimulation (EMS)** to guide a painter's arm. In EMS Painter, the artist wears electrode pads on their arm muscles, and an audience member can press buttons on a tablet to trigger electrical pulses that cause the artist's arm to jerk in a certain direction [15]. In a public demo, a painter stood at the canvas attempting to paint simple lines and shapes, while passersby could literally *"steer"* his brushstrokes via the EMS device [16] [15]. When a viewer pressed a button (e.g. corresponding to an electrode on the triceps), the painter's arm would involuntarily swing or twitch, perturbing the brush path [16]. This created a kind of **co-creative tug-of-war**: the human painter tried to maintain control and produce an abstract design, while the audience's inputs would intermittently influence the result [17] [18]. Initially, many viewers just enjoyed playfully "messing up" the painting (treating the artist like a marionette), but the project's aim was to explore deeper collaboration – could an artist and audience *truly share* creative agency through a wearable robot interface? [19] [20] The EMS Painter setup revealed that such shared control is possible, but achieving a balanced, meaningful collaboration (rather than mere prankish interference) is challenging [19] [21]. It did succeed, however, in demonstrating a novel mode of interaction: *"social painting"* where the **painter's body becomes a responsive canvas** influenced by others' intentions, mediated by a wearable robotic tech (in this case, electro-stimulation pads).

Notable projects and tech: Datta's *Teacher* (2015) and the EMS Painter (2018) both highlight **haptic human-robot interaction** for art. Teacher uses a **motorized exoskeletal guide** on the arm to directly impart motions [12], while EMS Painter uses **electrical muscle control** to achieve a similar end via the wearer's own muscles [16]. Another related concept (by *Emi Tamaki et al.*) is *PossessedHand*, a system that sends EMS signals to a person's fingers to teach piano by moving them through songs [22] – a technique one could imagine adapted to teach pen strokes. All these systems raise fascinating questions about **agency** in art: when you're wearing a robot that draws or paints through you, who is the artist? The answer is usually *both* – the human provides intent and adaptation, while the wearable provides precision, novel input, or endurance, resulting in a *hybrid creativity* that neither could achieve alone.

Exoskeletons and Assistive Wearables for Artists

Not all artistic wearables are about adding new capabilities; some are about **supporting and enhancing existing ones**, especially to overcome physical limitations. Artists, like any humans, face fatigue, disability, or age-related challenges that can impede their creative expression. Here, wearable robotics can play an assistive role – stabilizing an artist's movements, supporting their limbs, or translating their intentions into art despite bodily constraints. These devices often originate in rehabilitation or industry, but their application in art enables *more people to create art and for longer durations*.

One example is **adaptive exoskeletons for painters**. Consider the act of painting a large wall or ceiling: it requires holding one's arms up or bending in awkward postures for long periods. This leads to strain in the shoulders, neck and back [23] [24]. Companies like **HAPO (ErgoSanté)** have introduced wearable **upper-body exoskeletons** to relieve these issues. The HAPO exoskeleton is a **non-motorized, spring-loaded**

harness that a painter wears to support the arms and torso [25] [26]. It provides a mechanical assist, taking some of the weight when arms are raised or when leaning, thus *reducing muscle fatigue and pain* during repetitive brush-work [27]. Importantly for artists, the design emphasizes *"precision and freedom of movement"* [28] – the exoskeleton supports without rigidly constraining the arm, so the painter can still execute fine brush strokes, just with less effort. Professional painters who tried these exosuits reported that while they *don't give you "extra strength" per se, they support your back and shoulders* and prolong the time you can work comfortably [29] [30]. In essence, such exoskeletons **augment endurance** rather than creativity directly – but by keeping an artist's body healthier and steadier, they allow the art to flourish. An industrial muralist or ceiling fresco painter could wear one to minimize fatigue, ensuring that physical strain doesn't limit the precision or duration of their creative work.

For artists with disabilities or limited mobility, wearable or assistive rigs can literally make the difference between creating art or not. A notable device here is **"Guided Hands"** by *Lianna Genovese*, which is a **mechanical hand support** for people with conditions like cerebral palsy, stroke, or ALS. While not a high-tech robotic arm (it's a passive slide system), it is *worn* in the sense that the user places their hand in it like a brace. Guided Hands stabilizes and guides the hand to allow writing, drawing, or painting with minimal muscle effort [31] [32]. The device consists of a sliding arm mounted on a base (inspired by 3D printer mechanics) that holds a pen or brush; the user moves it using gross arm movements, and the system smooths out tremors or unintended motions [32]. This allows individuals with limited fine motor control to achieve controlled strokes on paper or canvas, restoring their ability to draw and paint [31] [33]. As Genovese describes, the goal was to enable those who *"lost the ability to hold a paintbrush"* to regain their passion and independence in art [34]. By offloading the weight and providing a stable gliding mechanism, the wearable gives the user *just enough assistance* to express their intent despite shaky hands [32] [35]. Users report decreased pain and fatigue and improved accuracy when using the device [33]. While Guided Hands is largely mechanical, it shows the value of **human-centered design in art tech** – sometimes a simple wearable aid can unlock creativity for a population that was excluded.

There are also experimental **rehabilitation robots** that double as art-making assistants. In research settings, stroke patients have been given arm exoskeletons that help them practice drawing as therapy. For example, the **CAREX robotic exoskeleton** (developed at Columbia University) can support a patient's arm and guide it along prescribed paths while they attempt to draw circles [36] [37]. In trials, stroke survivors wore a lightweight exo-cuff on the arm which actively helped **eliminate gravity and kept the drawing motion on track**, so they could re-learn smooth movements by tracing shapes [38] [37]. Such devices are not intended for artists per se, but they demonstrate how a wearable robot's assistive control can be tuned for drawing movements. As rehab patients improve, the robot gradually lets them do more on their own [39]. In the future, a refined version of this kind of exoskeleton could be used by individuals with tremors or weakness to actively **assist in real artistic drawing or calligraphy**, providing a steady hand when needed and letting the user take over when able. This concept blurs into co-creativity – the machine and human coordinating their forces to produce the desired line.

Key players and technologies: In the realm of assistive art wearables, we have **ergonomic exosuits** like HAPO's (a French company's solution for trade workers and artists) which show the commercial uptake of such tools [26] [40]. We also have **award-winning designs** like Guided Hands (which won a James Dyson Award) demonstrating that even low-tech wearable aids can have high impact [31] [32]. Academic efforts (Columbia's CAREX, EPFL's hand exos, etc.) contribute advanced mechatronics that could trickle down to artists with disabilities. Overall, these systems emphasize **user control and comfort** – the artist typically initiates the motion, with the wearable simply augmenting strength or stability as needed [33] [27]. Unlike

the guidance devices above, the assistive exoskeletons do *not* introduce their own creative input; rather, they act as empowering tools, making sure nothing in the artist's body (fatigue, injury, gravity) inhibits the flow of creativity.

Conclusion: The Human–Robot Creative Partnership

From the examples above, it's clear that wearable robots are finding a niche in artistic creation – not to replace the artist, but to **work alongside them**. Whether it's a robotic third arm holding a brush, a haptic armband teaching you how to sketch, or an exoskeleton supporting your arms during a mural painting, these systems all keep the *human* in the loop. The interaction models vary. Some devices grant the user **direct control** over new robotic appendages (e.g. moving a third hand by muscle signals or foot pedals), effectively expanding the artist's embodiment. Others involve a **shared control** or **dynamic influence**, where the robot might nudge the artist's movements (as in EMS Painter or Teacher) or a helper controls part of the action through the wearer's body. And in assistive scenarios, the wearable might simply provide **passive support** – augmenting strength or precision while the artist leads.

What unites these projects is the notion of **co-creation and augmentation**. The best outcomes seem to occur when the device and artist each contribute what they're best at. For instance, a human excels at inspiration and aesthetic judgment, while a robot can provide tireless repetition, precision, or an extra "hand" to execute complex tasks. Notable research institutions and creators are driving this hybrid approach: the *MIT Media Lab* and *KAIST* have looked at supernumerary robotic limbs, the *Media Arts and Technology labs* are exploring performative wearables, and artists like **Sougwen Chung** (who works with painting robots) have demonstrated the artistic value of human-robot collaboration (though her robots are not worn, her work underscores the *mindset* of partnering with a robot). As technology advances, we are even seeing brain-computer interfaces and AR wearables entering the artistic toolkit, which could further blur lines between intent and execution.

In summary, **wearable artistic robots** range from the whimsical to the practical: cyborg arms that let you paint with three brushes, motorized gloves that steady a shaky sketch, or powered suits that let you paint a ceiling like Michelangelo without the backache. Many of these are still experimental or one-off art projects, but they point toward a future where artists might don specialized robotic gear as readily as they pick up a new paintbrush. The *canvas* is no longer limited to what our biological bodies can reach or endure – with a wearable co-robot, an artist can literally push beyond their natural limits, all while maintaining personal expression. As one researcher put it, the aim is to find the *"happy medium between robots we teach and robots we learn from,"* designing systems that **empower human creativity without overshadowing it** [41] [42]. That balance is key to all co-creative technology: the artist and the wearable robot each shape the art, and together they can create something truly novel – art that is *neither fully human nor machine-made, but a synergy of both*.

Sources: The examples and data above were gathered from a range of academic papers, design case studies, and art-tech projects, including performance art literature and HCI research. Notable references include Frontiers/ACM publications on co-creative drawing with robots [15] [16], Wired and Vice articles on Saurabh Datta's haptic tutoring devices [10] [12], the Flash Art journal's profile of Stelarc's Third Hand [1] [2], and product info from assistive-tech innovators like Imaginable Solutions (Guided Hands) [31] [32] and ErgoSanté (HAPO exoskeleton) [27] [26], among others. These sources provide insight into how wearable robotics is being applied in creative domains, illustrating the interplay between human intent and robotic augmentation in artistic practice.

1 2 From Pygmalion to Ping Body | | Flash Art
https://flash---art.com/article/stelarc-leonel-moura-from-pygmalion-to-ping-body/

3 Robotic Extra Thumb Supercharges Your Hand, And Your Productivity
https://www.forbes.com/sites/lesliekatz/2024/06/05/robotic-third-thumb-set-to-supercharge-your-productivity/

4 5 6 7 Getting to grips with an extra thumb
https://www.cam.ac.uk/stories/third-thumb

8 Robotic 'Third Thumb' use can alter brain representation of the hand
https://www.ucl.ac.uk/news/2021/may/robotic-third-thumb-use-can-alter-brain-representation-hand

9 Why you (and everyone else) could soon be wearing this 'third thumb'
https://www.sciencefocus.com/future-technology/prosthetic-thumb

10 13 42 This Machine Guides Your Hand to Teach You How to Draw | WIRED
https://www.wired.com/2015/01/machine-guides-hand-teach-draw/

11 12 14 41 These Machines Will Teach You to Draw Whether You Like It Or Not
https://www.vice.com/en/article/these-machines-will-teach-you-to-draw-whether-you-like-it-or-not-2/

15 16 17 18 19 20 21 22 (PDF) EMS Painter: Co-creating Visual Art using Electrical Muscle Stimulation
https://www.researchgate.net/publication/323767988_EMS_Painter_Co-creating_Visual_Art_using_Electrical_Muscle_Stimulation

23 24 25 26 27 28 29 30 40 Exoskeletons for Painter
https://www.hapo.eu/en/content/32-exoskeleton-for-painter

31 32 33 34 35 Guided Hands™ Assistive Device | James Dyson Award
https://www.jamesdysonaward.org/2021/project/guided-hands-assistive-device/

36 37 38 39 Robotic Exoskelton AIDS in Post-Stroke Motor Skill Rehabilitaion | ScienceDaily
https://www.sciencedaily.com/releases/2016/02/160218062225.htm