Representative Title

Advancements in Lightweight Upper Limb Prosthetics: A Technical Overview and Future Applications

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Problem Definition

Our solution addresses the critical need for advanced prosthetic devices for individuals with upper limb amputations or differences. Traditional prostheses often suffer from issues of bulkiness, discomfort, and limited functionality, leading to high abandonment rates among users. Our team recognized this challenge and saw an opportunity to leverage additive manufacturing and innovative design techniques to create a disruptive solution.

The primary challenge our team faced was the lack of prosthetic devices that effectively replicated the complex movements of a natural arm while providing optimal comfort and functionality. Additionally, existing prosthetic designs were limited in their ability to integrate electronic components seamlessly and manage wiring efficiently, further hindering user experience.

By utilizing materials such as PA12 and TPU and employing additive manufacturing technologies, we were able to overcome these challenges. Our solution offers a custom-fitted, lightweight prosthesis that balances rigidity and flexibility where needed, providing a more comfortable and natural fit for users. The integration of a hexagonal lattice structure enables superior breathability and heat dissipation, addressing common discomforts associated with traditional prostheses.

This disruptive approach not only improves the quality of life for individuals with upper limb amputations or differences but also opens up new possibilities for the future of prosthetic development. By solving these longstanding challenges and offering a more user-centric solution, our innovation has the potential to disrupt the prosthetic market and set a new standard for functional and comfortable prosthetic devices.

Background Perspective

Our solution represents a significant advancement compared to the state of the art in upper limb prosthetics. Traditional prosthetic devices often rely on standardized designs and materials, resulting in bulky, uncomfortable, and limited-functionality devices. Current approaches primarily involve manual fabrication techniques and use of conventional materials, resulting in prostheses that may not adequately address user needs.

In contrast, our innovation harnesses additive manufacturing and advanced materials like PA12 and TPU to create custom-fitted prostheses that seamlessly integrate electronic components and offer superior comfort and functionality. By discretely controlling material distribution and employing innovative design features such as hexagonal lattice structures for breathability, our solution sets a new standard in prosthetic design, providing a more natural and comfortable experience for users compared to existing alternatives.

Traditional fabrication methods can span the course of several days by one or mor individuals carving plaster, thermoforming plastic, laminating composites, trimming out the final product, installing the electronics, and validating the form and function. This process is very time and labor intensive and produces a lot of material waste. If anything goes wrong in the process generally speaking the process has to be restarted and the product is a complete loss. The entire prosthesis is bespoke. To replace it, the entire process would need to be replicated. Additive manufacturing provides a better overall product, but one that can also be easily replicated and iterated on as needed.

Technical Overview

Introduction:
The field of upper limb prosthetics has historically grappled with challenges such as bulkiness, discomfort, and limited functionality, significantly impacting the quality of life for individuals with upper limb amputations. However, recent advancements in additive manufacturing and collaborative partnerships offer promising solutions to address these longstanding challenges. This technical overview delves into the collaborative efforts between innovators like Point Designs, LLC, and local prosthetists such as Joe Griffa at Hamilton Prosthetics and Orthotics in London, Ontario, Canada. Together, they have spearheaded the development of innovative prosthetic solutions aimed at enhancing functionality, comfort, and user satisfaction.

Materials and Equipment:
Point Designs, LLC leverages a blend of PA12 (Polyamide 12) and TPU (Thermoplastic Polyurethane) in their prosthetic fabrication process. These materials are carefully selected for their durability, flexibility, and biocompatibility, ensuring that the prosthetic devices meet the rigorous demands of daily use. Advanced additive manufacturing technologies, including the HP Jet Fusion 580 and HP Jet Fusion 5200 machines, are employed to achieve precise and reliable production of intricate prosthetic components. Additionally, vapor smoothing techniques are utilized to refine the surface finish of the prosthetic parts, enhancing both their mechanical properties and aesthetic appeal (Figure 1).

Design Methodology and Results:
The prosthetic design process commences with a meticulous 3D scan of the traditionally manufactured diagnostic prosthesis made by Joe Griffa (Figure 2) using Artec Studio software. This comprehensive scan yields a detailed digital model, capturing the intricate contours and dimensions of the limb. Subsequent design iterations and refinements are carried out using Oqton Geomagic Freeform Plus and nTop software, enabling precise customization tailored to the individual user's needs and preferences. (Figure 3) Through iterative prototyping and rigorous testing, the design team ensures the performance and suitability of the prosthetic devices. The resulting prosthetic solutions exhibit superior comfort, functionality, and aesthetics compared to conventional alternatives. Users consistently report significant enhancements in mobility, comfort, and overall satisfaction, leading to a tangible improvement in their quality of life.

Collaborative Success:
The collaborative partnership between Point Designs, LLC, and local prosthetists such as Joe Griffa represents a pivotal aspect of the prosthetic development process. Prosthetists contribute invaluable clinical insights and expertise, ensuring that prosthetic devices meet the functional and anatomical requirements of users. Through effective communication and collaboration, prosthetists provide crucial feedback and guidance that inform the design and refinement of the prosthetic devices, ultimately resulting in superior outcomes for users.

Facilitating Access to Advanced Technologies:
Collaborative partnerships play a vital role in facilitating access to advanced technologies and resources for prosthetists. Smaller independent prosthetic practices often encounter resource constraints that impede their ability to invest in cutting-edge manufacturing equipment and materials. By partnering with innovators like Point Designs, LLC, prosthetists gain access to state-of-the-art additive manufacturing technologies, enabling them to deliver high-quality prosthetic care without significant capital expenditures. This collaborative approach democratizes access to advanced prosthetic technologies, ensuring equitable access to quality care for users across diverse settings.

Empowering Prosthetists to Deliver High-Quality Care:
Collaborative approaches empower prosthetists to provide personalized and innovative prosthetic solutions tailored to the unique needs of each user. By leveraging advanced technologies and materials, prosthetists can design and fabricate prosthetic devices that optimize functionality, comfort, and aesthetics. This leads to improved patient outcomes and satisfaction, ultimately enhancing the overall quality of life for users.

Addressing Resource Limitations in Private Practices:
Collaborative partnerships are instrumental in addressing resource limitations faced by smaller independent prosthetic practices. Access to advanced manufacturing techniques and equipment enables prosthetists to deliver cutting-edge care without incurring prohibitive costs, ensuring that users receive optimal care regardless of their geographical location or financial circumstances. This collaborative approach fosters inclusivity and equity in prosthetic care delivery, enhancing accessibility for users across diverse communities.

Enhancing Patient Outcomes and Satisfaction:
Collaborative approaches yield tangible improvements in patient outcomes and satisfaction. Prosthetists can design and fabricate prosthetic devices that optimize comfort, functionality, and aesthetics, resulting in enhanced user experiences and quality of life. Users consistently report increased mobility, comfort, and overall satisfaction with their prosthetic devices, underscoring the transformative impact of collaborative prosthetic care delivery models.

Promoting Innovation and Progress:
Collaborative partnerships stimulate innovation and progress in the field of prosthetic care. By leveraging collective expertise and resources, these partnerships foster a culture of innovation that drives the development of novel prosthetic solutions. This collaborative approach spurs advancements in prosthetic technology and care delivery, benefiting users worldwide and propelling the field of prosthetics forward into the future.

Reflections

The collaborative approach to upper limb prosthetic care, exemplified by partnerships between innovators like Point Designs, LLC, and local prosthetists such as Joe Griffa, represents a transformative paradigm shift in the field. By leveraging advanced technologies, fostering collaboration, and prioritizing patient-centered care, this approach offers unparalleled benefits for users, prosthetists, and the broader prosthetic care ecosystem. Through effective communication and shared expertise, collaborative partnerships drive innovation, enhance access to advanced technologies, and deliver high-quality, personalized prosthetic solutions tailored to the unique needs of each user.

This collaborative model not only addresses longstanding challenges in prosthetic care, such as bulkiness, discomfort, and limited functionality but also promotes inclusivity and equity in care delivery. By democratizing access to advanced prosthetic technologies and resources, collaborative partnerships ensure that users receive optimal care regardless of their geographical location or financial circumstances.

Moreover, the collaborative approach fosters a culture of innovation and progress, driving advancements in prosthetic technology and care delivery that benefit users worldwide. As collaborative partnerships continue to evolve and expand, they hold the potential to revolutionize the field of prosthetic care, enhancing the lives of individuals with upper limb amputations and empowering them to lead fulfilling, independent lives.


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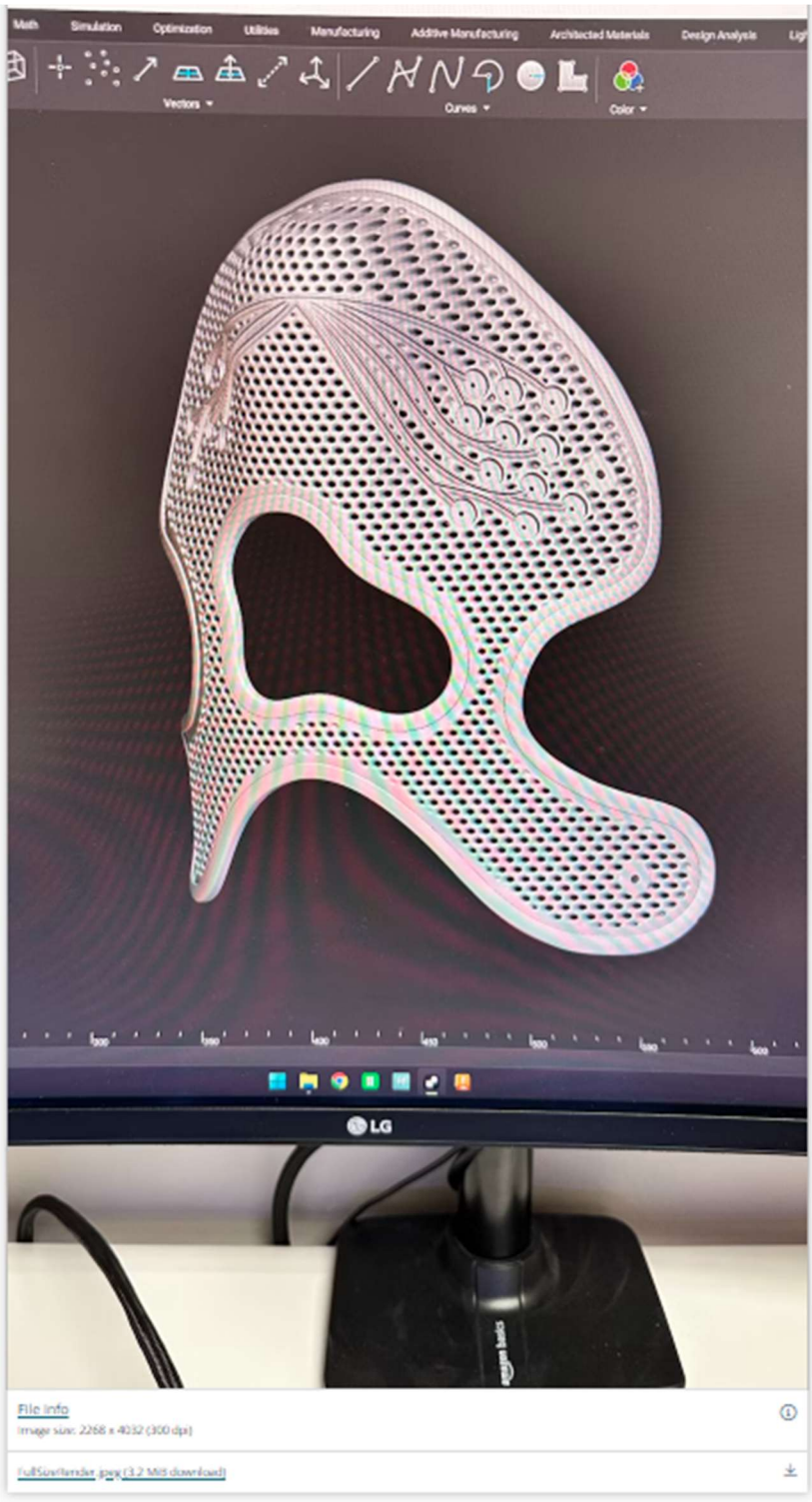

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