A Pilot Study Using a Remote, AI-Powered Measurement Technology to Enable a Decentralised Production System, from Ideation to Delivery

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Abstract

Our AI-powered, contactless measurement solution has been recently introduced to provide a cost-effective and scalable platform for designers to obtain reliable measurements remotely[1]. With the recent rise of digital fashion, there has been a move towards more rapid iterations of the design process and streamlining of the supply chain, with an outlook on producing more sustainably. In light of these recent developments, we tested how our remote solution for contactless measurement could be used as part of a decentralised production process for small-batch designers in different geographical areas.

Five digital fashion designers provided design artwork in 3D format, to be tailored to each of the customers' sizes. At the start of the pilot project, each customer was asked to submit two full-body images, front and side, for the AI platform to calculate the measurements. Of the five designers, 1 provided pre-cut fabrics, 2 provided fabric only, and 2 sourced and cut the fabric at the same location where tailoring took place, so that different processes could be tested.

The process from submission of the images by the customers to delivering the final measurements to the designers was completed within one hour's time and with positive feedback from the designers. The designs were adapted to each of the customers' measurements to form 3D patterns. Pattern making and tailoring took place in Accra, Ghana, where the fabrics were also sourced. The final items were delivered directly to customers.

This pilot study showed the potential for accomplishing a new production system that will create customized items on demand and regardless of geographic location, using a universal measuring system based on objective measurements from image data. Using The PS Collective's contactless, remote solution for measuring customers' sizes it was possible to streamline the design process with minimal movement of designers, pattern-makers, and customers. On a larger scale, this solution has the potential to enable a more sustainable production process, without sacrificing the quality that comes with made-to-measure.

Keywords: Machine learning and artificial intelligence for 3D body modeling and processing, Portable human body measurement systems, Custom apparel, Digital fashion designers

Introduction

Recent shifts in shoppers' perspectives on sustainability and expectation of personalization, along with the disruption caused by the recent pandemic have resulted in the development of new supply chain strategies. With a responsive supply chain strategy, production is flexible, tied to the consumer, and less wasteful, all enabled by a fast exchange of information. With agile supply chains, production is driven by demand and updated in real-time [1]. These two approaches allow for improved sustainability and a stronger consumer focus. With both approaches, it has proven vital to embrace digital technologies to combat the rising marketplace challenges. The push towards integration of digital technologies has resulted in digital supply chains, using the latest developments in analytics, IoT, and cloud computing for the production of both physical and digital goods [2].

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Among the technologies enabling this change, contactless measurement systems and virtual try-ons have been key to reducing waste and enabling decentralised production, especially for small to medium-sized designers. In the past few years, size recommendation technologies have been developed to enable businesses to reach a wider audience and minimize the time and effort to purchase. In the process of digitization of measurement systems, there is a risk linked to data bias towards certain customer groups, thus undermining inclusivity [3].

With this project, we are focusing on building a system that leverages digital technologies, while also being representative of all body types.

The PS Collective provides a remote measurement solution that can be used from any device with a digital camera. Using computer vision algorithms that extract information from two images uploaded by the customer, 24 measurements are estimated. These are collected on a secure cloud application and can then be shared to designers working on bespoke and custom-made clothing [4]. The solution has been running as part of a marketplace providing measurements to 15 designers in the US and Europe, and serving the US market. To test the feasibility of its use in a decentralised production system, we partnered with TAKAII, a digital design platform looking to produce physical items from digital designs.

In this paper, we'll first outline the method used to set up a pilot study for a decentralised production system and how remote measurements enabled a faster and more sustainable delivery of the project. We will then present the results from the pilot study, including insights into the designers' perception of the technology. Finally, we'll conclude with future development plans to expand the project.

Methods

Our remote measurement system was developed as an API with the goal to enable ease of integration into other platforms outside of its internal functionality on The PS Collective marketplace. Via a style quiz, the system allows the user to submit two full-body front and side images along with their height and a few other stylistic preferences. The images are stored on a secure cloud server, and subsequently processed using computer vision algorithms to extract 24 body measurements. Once extracted, the table of measurements is sent to the designer to be used in creation of the shoppers' custom pieces. The system uses Amazon Web Services for storage and processing of the data, and the AI algorithms used were developed using standard Python and OpenCV libraries.

To create a more inclusive designer network and help independent designers reach a larger customer base, TAKAII is currently developing a decentralised production platform where designers can upload digital fashion designs, mint them as NFTs, and have access to a network of tailors and seamstresses who can produce their designs in a made-to-order model.

Within this process, The PS Collective's AI measuring technology enables designers to digitally scale designs to the shopper's submitted measurements. Once the patterns are adapted to the customer's body, they are sent to the tailor closest to the customer's location as seen in Figure 1.

In this study, we tested the process along with five digital fashion designers from different geographical areas: Germany, Spain, UK, and USA. Each designer provided design artwork in a 3D format, to be tailored to each of the shoppers' sizes. The tailors were based in Accra, Ghana, while the customers' and designers' locations varied. At the start of the pilot project, each volunteer shopper was asked to submit two photos for the AI platform to calculate key measurements. The designers received the measurements, and prepared a digital design and, according to each of the designers' preferences, either pre-cut fabric, fabric only, or the digital design only. Of the five designers, 1 provided pre-cut fabrics, 2 provided fabric only, and 2 sourced and cut the fabric at the same location where tailoring took place in Ghana. Finally, the unique pieces were sent to the customers. To assess the effectiveness of the process, a 10-question survey was sent to the designers at the end of the pilot program and after the garments were ready. The survey was designed to reflect the acceptance of both the remote sizing technology and the decentralised production process by the designers.

Figure 1: The process from digital to physical designs as part of the decentralised production system.

Results

All 5 designers participated in the survey and returned their responses. The questions posed to the designers are presented in Table 1.

Table 1: Questions asked to designers to assess the application and production process.

	Question
1	When uploading the A-Pose Photos for PS Collective to send the measurements, how easy was it to understand how to take the photos and did you have to retake the photos?
2	How long was the process between the time you submitted the photos and you receiving the measurements?
3	Were there any measurements missing that you would have liked to be included in the results you received?
4	How satisfied were you with the measurements you received on a scale of 1 to 5 (5 being satisfied with accuracy, 1 not satisfied/ big difference in actual measurements)
5	Was extra communication needed to understand the sewing pattern you provided?
6	How did you feel about the time frame provided for the sewing and would you feel confident offering such a time frame to potential customers? (21 days)
7	Were you happy with the fit of the final garment you received, on a scale of 1 to 5 (5 being very happy, 1 being very unsatisfied)?
8	Would you use this method for prototyping?
9	Would you be happy using this method for your customers? (if you had/ have an e-commerce website)
10	Feel free to leave a comment describing this method for you.

The first four questions were designed to measure the applicability of the remote measurement system to the decentralised production method, while the following questions assessed the designers' perceptions of and adaptability to the process.

Only one designer did not use the remote measurement application due to external constraints not related to the application. Of the four designers that submitted the photos, only one had to retake one full body side photo, while the others were able to submit good-quality images in one attempt. Although the model took <20min to produce the measurements, an additional quality check was performed and so the time from submission of the images to receipt of the measurements took less than 1 day for two of the designers, where the remaining two designers took 3 and 6 days, respectively.

Two of the designers received all of the measurements they needed to produce their garment, while the other two had to ask for additional measurements. Overall, three of the designers were extremely satisfied with the fitting (with the maximum score of 5), with one being satisfied with a score of 4.

With regard to the production process, 21 days felt like a reasonable time frame to produce the garments for all except one designer. Three of the designers were extremely satisfied with the quality of the final garment, one was unsure and one was unsatisfied with a score of 2 out of 5. Four designers would use the method for prototyping, while one felt that it would be necessary to check the quality of the prototype in person.

All designers interviewed would use the process for their online customers.

Overall, designers felt this process would greatly benefit sustainability while maintaining customer satisfaction as the quality of the garments was extremely satisfactory. Designers also described the process as more inclusive thanks to the personalization of sizing and the possibility to include all geographical areas.

Discussion and Conclusion

By integrating The PS Collective measurement technology with TAKAII's decentralised production system, The PS Collective enabled remote contactless measurement for the creation of customized, physical designs stemming from digital work.

As we refine both product and process, we acknowledge the challenges faced in our pilot. Communication can be challenging when working across timezones and across different geographic areas, and it is paramount to be precise about requirements for the creation of design patterns such as file formats and scale. Where the designer provided only the design patterns and not the fabric, details about the type of fabric to source and potential substitutes also had to be provided.

The technology deployed also requires specific measures for handling sensitive data, and protecting customers' privacy and systems' security, which is currently implemented using the Amazon Web Services cloud services for security and privacy. While using big data, another challenge is to maintain current levels of personalization while catering for an ever-growing customer base, without losing customization and inclusivity to the benefit of speed and wider outreach.

Overall, the remote measurement technology developed using computer vision and AI, identified customers' measurements to suit the designers' needs for creating patterns without having to rely on manual measurements or a physical appointment. The solution was easily integrated into the process and positively accepted by the designers, and it helped to streamline and reduce the environmental impact of the production process by minimizing the transport needed and keeping production local. Overall the production system was also positively received by designers who expressed interest in a sustainable solution that is supportive of independent designers and inclusive sizing.

In considering a decentralised clothing production system, it's important to also reflect on the environment in which it needs in order to succeed. There are extraneous variables that affect the acceptance and prevalence of new systems beyond the functionality of this decentralised process. One of the biggest detractors from adoption is the acceptance of mass production and holding on to inventory to meet instant demand and quickly changing trends.It is necessary to both pull away from mass production and to empower tailors and seamstresses at the local level to limit fast fashion practices that are harmful to the environment and, often, don't meet the needs of consumers. In addition to prioritizing local talent, utilizing local materials rather than the shipment of fabrics, can aid in increases in sustainability efforts, appreciation of rich, local cultures, and eventually lower the barrier to cost of entry for sustainable clothing creation for both designer and consumer.

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