

# An Analysis of Digital 3D Body Imaging Technology

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## Abstract

A web-based study was done to identify consumer satisfaction with digital 3-D body imaging and desire to adopt this technology for personal use. This study specifically targeted questions concerning how helpful and informative the 3-D body imaging software was in providing individuals a better understanding their body shape and how different apparel items fit their body, progress monitoring of body shape and size manipulation, and practical use during online shopping. A total of 361 participants, between the ages of 18 and 57, were asked to visit two websites where they could create two separate personal avatars with their body dimensions. The four objectives of this research were to determine: consumer satisfaction with 3-D body imaging technology, willingness to adopt this technology for body size and shape monitoring, willingness to adopt this technology for online shopping, and willingness to adopt this technology for custom clothing applications.

**Keywords:** 3d body imaging, virtual try-on, consumer satisfaction

## 1. Introduction

Technology is continually improving and becoming a bigger and more influential part of life. An increasing number of companies are creating websites for their customers to view products and purchase items online. Many retail and fashion design companies have begun utilizing this technology. According to Kim and Forsythe (2008), online clothing sales are growing rapidly and are now greater than online sales for computer hardware, but one major problem that exists is determining which size of apparel item to buy without physically trying it on. This problem can and has lead to the need to return products that don't fit properly. Clothing purchased online is returned twice as much as other products purchased online (Kim and Forsythe, 2008). This calls for a need for online clothing retailers to provide a better way for their customers to determine which size they should purchase. Improved visualization technologies such as virtual try-on will provide consumers improved product knowledge concerning proper fit and will help reduce the amount of returns that done. Virtual try-on is a new technological advancement which deals with personalized 3-D body imaging. This software enables individuals to input various body measurements and physical details to create personal avatars. This avatar can be used to track changes in body size and shape, help with development of custom made clothing, and allow consumers to virtually try on clothes when shopping online. Virtual try on can serve as a surrogate for traditional apparel shopping with direct product examination because it provides sensory experiences to help evaluate products online (Citrin *et al.*, 2003).

Online shopping has the draw back of not really seeing the product and knowing if it is going to work until you purchase it. This factor can really discourage consumers desiring to purchase apparel products because so much is riding on the fit and look of the garment when worn on the body. Using interactive technologies such as virtual try on has been shown to increase transactions online (Kim and Forsythe, 2008). This can be attributed to the shoppers being able to better evaluate the product and really know and understand it before purchasing it. Virtual try on can reduce the fear of purchasing the wrong size. It can also minimize the risk of being disappointed with the fit or drape of the garment on your own body. Most websites only provide one or two views of their products along with a few written descriptions. This, however, can be insufficient for the online shopper, especially when purchasing clothing that needs to fit properly. The availability of virtual try-on would allow consumers to gain a much better understanding of the product they are interested in purchasing.

Virtual try-on can not only decrease product risk but can increases shopping enjoyment. According to Childers *et al.* and Babin *et al.*, decisions to shop are influenced by both hedonic and functional motives (2001, 1994). Consumers have a desire to find products they need and want but also shop to fulfill the need of being entertained. Virtual try-on is one technology which provides added visual sensory and entertainment to the online shopping field which can be an important motivator for consumers (Hoffman and Novak, 1996). Since virtual try-on is fun and entertaining consumers are more likely to have a positive attitude towards this new technology and the websites using it (Kim and

Forsythe, 2008). Consumers who enjoy virtual try-on will be more likely to return to the website for entertainment purposes as well as functional purposes which will lead to increased online sales. Shopping is a fun past time and with virtual try-on consumers are more likely to shop online not only for the convenience but for the entertainment value.

Virtual try-on has the potential to increase online purchases if adopted by clothing consumers but there are a number of factors which affect use of these new technologies and consumer adoption. Virtual try-on makes shopping online more interactive, can provide added product knowledge, and be a powerful screening tool but if the quality of the digital information is poor consumers may be less likely to find the technology useful and therefore will be less willing to adopt it (Burke 2002; Alba *et al.* 1997; Quelch and Takeuchi 1981). Other issues involving new technology can include needed time to learn new technology, quirks with technology making it frustrating to use or causing the technology to fail, and fear of using new technology, all of which can effect consumer adoption. Technologies that save time, are easy to use, work reliably, address a need, and are easy to access tend to increase consumers satisfaction and willingness to adopt. On the other hand technology with high failure rates, poor design, or process failure tend to cause consumers to loose satisfaction with the technology (Burke, 2002; Meuter *et al.*, 2000). Consumers shop online for convenience and prefer websites that are easy to navigate, efficient, have good site aesthetics, are reliable, responsive, and allow customization and personalization (Burke 2002). If developed well, virtual try-on has the potential to improve the online shopping experience and become a highly enjoyed and widely adopted technology.

## 2. Methods

A web-based study was done to identify consumer satisfaction with digital 3D body imaging, experience with 3D body imaging and virtual try-on, desire to adopt this technology for personal use, and applications of this technology. This study specifically targeted questions concerning how helpful and informative the 3D body imaging software is in providing individuals a better understanding of their body shape and how different apparel items fit their body, progress monitoring of body shape and size manipulation, and practical use during online shopping.

A total of 361 participants, between the ages of 18 and 57, were asked to visit two websites where they could create two separate personal avatars with their body dimensions. After creating personal avatars, subjects were asked to fill out a questionnaire regarding their satisfaction with the 3-D body image/avatar software, desire to adopt this technology, and other suggestions and or comments. The four objectives of this research were to determine: consumer satisfaction with 3-D body imaging technology, willingness to adopt this technology for body size and shape monitoring, willingness to adopt this technology for online shopping, and willingness to adopt this technology for custom clothing applications.

Focus groups were also held to understand participants' experiences with the two different avatar programs including how helpful the technology was in providing additional visual product information, how helpful the technology was in increasing the consumers desire in purchasing a product, which applications they felt the technology was most useful for, the entertainment value of the technology, any gender differences, any cultural differences, and willingness to use/adopt this technology when purchasing items online.

## 3. Results

### 3.1. Demographics

Participants in this study ranged in age from 15 to 57 with 75.3% of participants being between 19 and 24 years old. The ethnic make up of the group consisted of 101 participants of Caucasian descent (28.0%), 104 participants of Asian descent (28.8%), 72 African American participants (19.9%), and 84 participants of mixed descent (23.3%). More females than males participated in this study, 247 females (68.4% of participants) and 114 males (31.6% of participants). As far as education is concerned, 189 participants had at least a high school diploma (52.4%), 122 participants had a bachelor's degree (33.8%), 46 participants had a master's degree (12.7%), and 2 participants held doctoral degrees (0.6%). Careers or college majors of participants were varied with 155 participants being in a humanities field (42.9%), 51 participants working or studying in a science field (14.1%), 11.4% working or studying health/medicine (41 participants), 16 participants in education (4.4%), and 27.1% in a business related field (98 participants).

### 3.2. Body Type

On the questionnaire, participants were asked to choose their body type: ectomorph - tall and thin, mesomorph - athletic and muscular, endomorph - soft and round; to see if attitudes toward 3D body imaging varied between body types. Of the participants, 76 classified themselves as endomorphs, 123 considered themselves as mesomorph, and 162 felt their body type was that of an ectomorph. When body type was compared to helpfulness of 3D avatar technology in purchasing correct sizes online, custom clothing applications, interest in using technology for virtual try-on, and accuracy of personal avatar there were no significant differences. Therefore, body type did not effect participants feelings towards 3D avatar technology. The data displayed in the following table shows these results and suggests that people with all different body types are equally interested in and willing to adopt this technology.

*Table 1. Correlation between body type and: Satisfaction with Image Twin Avatar Created, Satisfaction with My Virtual Model Avatar Created, and Willingness to Adopt 3D Avatar Technology for Virtual Try-On.*

	Satisfaction with Image Twin avatar created	Satisfaction with My Virtual Model avatar created	Willingness to adopt 3D avatar technology for virtual try on
Body type: Ectomorph, Mesomorph, Endomorph	Pearson Correlation .032 Sig. (2-tailed) .538 N 361	Pearson Correlation -.016 Sig. (2-tailed) .786 N 274	Pearson Correlation -.044 Sig. (2-tailed) .404 N 360

\*Correlation is significant at the 0.05 level (2-tailed)

Note: No significant correlations

In regards to body size and helpfulness of 3D avatar technology in purchasing correct clothing sizes online, 24.4% of ectomorphs (n=88) felt this technology would be helpful, 16.1% of mesomorphs (n=58) viewed this technology as helpful, and 11.41% (n=41) of endomorphs thought this technology would help them purchase correct sizes online.

When participants were asked if they would use this technology for custom clothing creation; 25.8% (n=93) of all endomorphs surveyed felt this technology would be helpful for custom clothing creation, 16.3% (n=59) of ectomorphs would use this technology for custom clothing development, and 12.5% (n=45) of mesomorphs were interested in using 3D avatar technology to design custom clothing. Mesomorphs, being averaged sized were the least interested in using this technology for custom clothing where as endomorphs and ectomorphs who may have more difficulty in finding clothing that fits perfectly were more interested in using this technology for custom clothing development.

When body type was compared to interest in using virtual try-on when shopping online are data also found that there was no significant difference. Roughly quarter of the ectomorphs surveyed (24.4%; n=88) were interested in using 3D avatar technology for virtual try-on, a little less than twenty percent (16.1%; n=58) of all mesomorphs surveyed were interested in using this technology, and 11.4% (n=41) of endomorphs were replied they would be interested in using virtual try-on when online shopping. Endomorphs had the greatest number of interest in using virtual try-on for custom clothing creation at about 25.8% (n=93) but ectomorphs and mesomorphs were on almost just as interested at 16.3% (n=59) and 12.5% (n=45) respectively. A couple of quotes regarding interest in using 3D avatar technology for virtual try-on are displayed below:

Quote 1: "I would use this kind of program to shop online. I'm bigger so it is embarrassing and a hassle to try on clothes."

Quote 2: "I get embarrassed when shopping since I'm taller and bigger boned but this would help me see various styles on my body shape."

These quotes suggest future use of 3D avatar programs for virtual try-on for consumers who have bigger body types and have trouble, don't enjoy shopping, or feel embarrassed when trying on clothing at physical retail stores. 3D avatar technology has the potential to increase this sector of the consumer population's clothing purchases.

Accuracy of avatars created in both Image Twin Solutions and My Virtual Model in terms of body type was also determined. To create a personal avatar in Image Twin Solutions, exact measurements were needed such as height, weight, bust, waist, hips, inseam, full underbust, and thigh girth along with selecting pictures of weight distribution and body curves. When using My Virtual Model personal avatars were created avatar based more on body shape than exact measurements. Only height and weight measurements were used and then pictures describing weight distribution and curve needed to be selected. By looking at needed information to create a personal avatar it can be assumed that Image Twin Solutions would be the more accurate representation of an individual's body but our results suggested differently. When asked how accurate Image Twin Solutions and My Virtual Model personal avatars were roughly 71.5% of all participants felt both programs were accurate. Image Twin Solutions results were slightly higher than My Virtual Model but not by much. When the data for Image Twin Solutions was broken down in to the three body types, 71.1% of all ectomorphs were satisfied with accuracy of the avatar, 72.4% of all mesomorphs felt the avatar created was accurate, and 69.7% of all endomorphs believed that the avatar created was an accurate representation of their body. When My Virtual Model's data regarding accuracy of avatar was broken down into body types the results were just slightly lower than that of Image Twin Solutions. Accuracy of avatar created in My Virtual Model results were, 67.4% of all ectomorphs felt it was an accurate representation, 63.3% of all mesomorphs, and 66.2% of all endomorphs felt My Virtual Model created an accurate personal avatar. Therefore, both programs rated about the same in participants' feelings about accuracy of their personal avatar and body type did not change participant's feelings towards accuracy of the avatars created.

### **3.3. Experience, interest, helpfulness, and application**

Our research aimed at discovering how much experience people had with 3D avatar technology and virtual try-on, their interested in using this technology, how helpful they felt this technology could be, and what applications this technology could be used for. In terms of experience, our data determined that the majority of participants surveyed, 338 out of 361 (93.6%), had never used this technology before. 3D avatar technology is a fairly new technology but these results imply that more marketing could be done to increase consumers' awareness of this technology. There is definitely room for more people to become aware of this technology and adopt it. As far as interest in using this technology for virtual try-on, 198 out of 361 participants (54.8%) were interested and felt they would like to use this technology for virtual try-on. With just the brief introduction to this technology through trying out two different websites, half of the participants were interested in this technology. More than half of the participants (51.8%, n=187) felt 3D avatar technology would be helpful and aid in purchasing correct sizes when shopping online. A few quotes regarding 3D avatar technology, virtual try-on and helpfulness in online shopping are listed below:

#### *Quotes from participants who found the technology useful*

- Quote 1: "It would be very useful to see my avatar on the computer and see exactly which clothes would be perfect for my body type."
- Quote 2: "Very helpful. I've never used anything that shows detail down to my measurements. It was cool."
- Quote 3: "This technology has a lot of potential. It would be very helpful to see how different outfits will look on me before I wear them."

#### *Quotes from participants who did not find the technology useful*

- Quote 1: "It was fun to try on clothes but I still feel virtual try-on is not giving a 100% full experience of trying on the garment."
- Quote 2: "Fun but not serious. Programs need a lot more accuracy to be used in real life."
- Quote 3: "Programs are not very accurate, they are geared more towards fantasy and fashion than real world applications."

These quotes show that there are many positive reasons people are willing to adopt virtual try-on and 3D avatar technology but also suggest there is room for improvement in areas such as accuracy and real life application.

Our data also found that 197 out of 361 participants (54.6%) would use 3D avatar technology to create custom clothing. A few quotes regarding 3D avatar use and custom clothing are included below.

- Quote 1: "If I could use this technology to my advantage for example in customizing clothing then I would definitely use it."  
 Quote 2: "This technology would be great for people in theater. It is perfect for customized costumes."  
 Quote 3: "If this technology made me look better I would use it to design my wedding dress."

These results illustrate that there is interest in using 3D avatar technology applications other than virtual try-on such as creating custom clothing

### 3.4. Satisfaction with 3D Avatar Technology

Another key factor of our research was participants' satisfaction with both Image Twin Solutions' avatar and the avatar created with My Virtual Model. Satisfaction regarding the accuracy of the avatar, usefulness and helpfulness of avatar, ease of use of the websites, and enjoyment of using the websites. Our results demonstrate that overall satisfaction of both Image Twin Solutions and My Virtual Model was significantly correlated with accuracy, usefulness, ease of use and enjoyment. When accuracy, usefulness, and ease of use and enjoyment were rated higher overall satisfaction was higher. These results are displayed in the following two tables:

*Table 2. Significant Correlations Satisfaction with Image Twin avatar created and accuracy of avatar, informative/usefulness of avatar, and ease of use/enjoyment with using Image Twin Solutions*

	Satisfaction with Image Twin Body as an accurate representation	Satisfaction regarding informative/usefulness of Image Twin body created	Satisfaction regarding ease of use/enjoyment of Image Twin Solutions
Satisfaction with Image Twin avatar created	Pearson Correlation .828** Sig. (2-tailed) .000 N 361	Pearson Correlation .700** Sig. (2-tailed) .000 N 361	Pearson Correlation .650** Sig. (2-tailed) .000 N 361

\*\*Correlation is significant at the 0.01 level (2-tailed)

*Table 3. Significant Correlations Satisfaction with My Virtual Model avatar created and accuracy of avatar, informative/usefulness of avatar, and ease of use/enjoyment with using My Virtual Model*

	Satisfaction with My Virtual Model as an accurate representation	Satisfaction regarding informative/usefulness of My Virtual Model body created	Satisfaction regarding ease of use/enjoyment with using My Virtual Model
Satisfaction with My Virtual Model body image created	Pearson Correlation .681** Sig. (2-tailed) .000 N 249	Pearson Correlation .602** Sig. (2-tailed) .000 N 269	Pearson Correlation .583** Sig. (2-tailed) .000 N 264

\*\*Correlation is significant at the 0.01 level (2-tailed)

Note: Fewer participants, 249 out of 361, answered questions regarding My Virtual Model because this program does not currently have an option to create a male avatar.

The majority of participants, about three quarter, (71.5%, n=258) were satisfied with the accuracy of their avatars created in both programs. Image Twin Solutions had a 75.1% (n=261) accuracy satisfaction rate while My Virtual Model had a satisfaction rate of 66% (n=186) regarding accuracy of avatar. Only 10% (n=36) of participants were unsatisfied with the helpfulness/usefulness of Image Twin Solutions' avatar while 22.4% (n=81) of participants found the program somewhat helpful to extremely helpful with 21.3% (n=77) feeling the Image Twin Solutions avatar was extremely helpful. My Virtual Model's satisfaction rates regarding helpfulness of the avatar were slightly higher than Image Twin Solutions' rates. A majority of participants (57.1%, n=156) felt My Virtual Model was somewhat helpful to extremely helpful. Only 5.6% (n=15) felt the avatar created in My Virtual Model was extremely unhelpful. Satisfaction regarding ease of use and enjoyment was rated higher for My Virtual Model than Image Twin Solutions. Only 19.1% (n=69) of participants found Image Twin Solutions extremely easy and fun to use while 33.5% (n=121) of participants felt My Virtual Model was extremely fun and easy to use. Overall satisfaction was higher for My Virtual Model than for Image Twin Solutions. The tables below display satisfaction results according to the different websites.

### 3.5. Gender

Results of our study also showed there is a significant correlation between gender and interest in using 3D technology for virtual try-on, as well as, gender and helpfulness of 3D avatar technology in purchasing correct sizes when shopping online. More females were interested in using 3D avatar technology for virtual try-on (60.4%, n=148) and felt that 3D avatar technology would be helpful in purchasing correct clothing sizes when shopping online (54.1%, n=148). Only 38.2% (n=102) of males were interested in using 3D avatar technology for virtual try-on and 32.4% (n=102) thought a personal avatar would aid in purchasing the correct size online. Our data agrees with previous research done by Meyers-Levy and Maheswaran which found that men and women differ with regard to characteristics they consider important in evaluating products and in information processing strategies (1991).

Our research found a significant correlation between interest in using 3D avatar technology for virtual try-on and 1. Desire to use 3D avatar technology to have custom clothing made, 2. Helpfulness of 3D avatar technology in buying correct size when shopping online. Table 7 below depicts these correlations.

Out of the 200 participants who were interested in using 3D body imaging technology to virtually try on clothes, 197 (54.6%) replied that they would use this technology to have custom clothing made and 187 (51.8%) said this technology would help them decide which size to buy when shopping online. Out of the 161 participants who were not interested in using 3D body imaging technology, 164 (45.4%) would not use this technology to have custom clothing made and 174 (48.2%) did not feel this technology would be helpful in purchasing the correct size when shopping online. This demonstrates that interested in using 3D body imaging technology for virtual try-on directly influences interest in using this technology for custom clothing design and help in purchasing correct sizes when shopping online.

### 3.6. Ease of Use and Adoption of 3D Avatar Technology

Previous research has shown that ease of use is an important factor in positive attitudes toward and perceived usefulness of technology (Dabholkar, 1994; Davis et al., 1992; Heijden, 2000; Davis, 1989; Adams, Nelson and Todd, 1992; Segars and Grover, 1993). Research has also shown that complexity discourages individuals from adopting new technology. Individuals are more willing to adopt technology when it is easy to use (Dabholkar, 1994; Heijden, 2000; Rogers, 1995; Agarwal and Prasad, 1997). Therefore, the easier 3D avatar and virtual try-on websites are, the more positive attitudes feelings of usefulness will be towards them. This assumption was proven in our research. On average, creating a personal avatar in Image Twin takes around 10 - 20 minutes because you are required to enter specific body measurements such as height, weight, bust, waist, hips, inseam, full underbust, and thigh girth. Then you choose your hip and body shape and back body shape. After your body shapes have been choose you choose your outfit and hair style. If you would like to make your avatar more personal you can upload a picture of your face to be used for your avatar. The program takes several minutes to process all of the data you input into the computer before your avatar is created. My Virtual Model, on the other hand, is fairly quick in terms of creating a personal avatar. The steps involve choosing your body shape, measurement system, inputting your height and weight, choosing your bust size, waist shape and physical features such as eyes, nose, lips, and hair color. Once your avatar is created you can shop for clothes and virtually try them on your model.

Creating a personal avatar in My Virtual Model is much quicker and easier than in Image Twin Solutions and thus resulted in increased willingness to adopt My Virtual Model technology. A majority of participants (85.8%) felt My Virtual Model was fun and easy to use and were willing to adopt 3D avatar technology for virtual try-on. Only 63.0% of participants found Image Twin Solutions fun and easy to use and were willing to adopt this technology for virtual try-on.

Willingness to adopt 3D avatar technology for virtual try-on was compared to satisfaction of the two websites. The results found that willingness to adopt 3D avatar technology for virtual try-on was significantly related to satisfaction regarding the helpfulness and informativeness of the avatar programs as well as ease of use and enjoyment of the websites.

### **3.7. Visual Aesthetics**

Visual aesthetics also play an important role in acceptance and adoption of technology. Open ended questions regarding overall feelings towards the two websites demonstrate that having a more professional looking website increases people's overall view of the website. Some participants responded that they were scared to use Image Twin Solutions because the website look fake and unprofessional. Others felt it was amateur, disorganized, and neglected and needed a lot of work to be legit. Where as responses toward My Virtual Model were more positive. Participants commented that the website looked more established and was put together better. The layout was more contemporary and user friendly than Image Twin Solutions. Participants felt more comfortable going to the My Virtual Model website.

### **3.8. Reasons for Adoption of 3D Avatar Technology**

Many participants felt their avatar gave them an idea of how they look to others and they enjoyed knowing how others saw them. Many participants felt the technology was very informative, fun and had a lot of potential for future use. Virtual 3D body imaging was new to many of the participants (200 out of 361) and they enjoyed being exposed to the new technology. Many participants responded that they enjoyed seeing what different clothing styles would look like on them. Participants also commented that the 3D avatar programs were very fun and informative to use even though the body images weren't completely accurate. Specific comments from participants are listed below.

Quote 1: "My Virtual Model opened me up to new styles and fashion I wouldn't think would look that good on me."

Quote 2: "My Virtual Model was very fun. It gave me the option to see what styles I would be able to pull off."

Quote 3: "My Virtual Model gave me insight on what I would like to change about myself."

A handful of participants felt that 3D body imaging programs would be helpful for pregnant women, elderly, and disabled individuals to order clothes online. Others felt this technology would be helpful to people who don't enjoy shopping and or trying on clothing but want to buy products that fit correctly. These programs could help people who are extremely busy and don't have time to go to the mall and shop. Some participants suggested that personal avatars/ 3D body imaging programs could also be used to see what your body looks like, set goals for improvement, and track your progress. Many participants felt these programs would be helpful when shopping online to ensure purchase of correctly fitting garments and see if the style or colors look okay on them. One participant felt the 3D avatar programs would be useful in designing her wedding dress and another participant felt they would adopt the technology if they could use it to create custom clothing and costumes. Another participant said she is bigger so it can be embarrassing and a hassle to try on clothes. She felt 3D body imagine and virtual try on would be very beneficial and improve her shopping experiences.

### **3.9. Reasons for not adopting 3D avatar technology**

Many participants felt the avatar created with Image Twin Solutions made them look fat and disproportionate. Others felt the program didn't really work for people of larger size. There were not enough variations in body shape, skin color, or hair style. And the results were not very realistic or accurate. Some participants felt the program was very time consuming and complicated and there was no room for personalization of their avatar. Others were extremely offended by the avatar that was created and felt depressed when viewing their avatar. Another participant felt the websites were not beneficial because he was not a shopper and was not incapable of trying on clothes.

Overall, participants with negative views towards 3D avatar technology and no desire to adopt this technology felt the results weren't worth the time spent because they weren't accurate enough, did not provide enough varieties to choose from in body shape and appearance, were not realistic enough, and took too much time. Other participants commented that they weren't really comfortable with their bodies so it was hard to see an image on the computer. And others felt the avatar was not flattering and were frustrated because body fat was not distributed correctly.

#### 4. Conclusion

It can be concluded from our results that there is positive interest in 3D avatar technology and online shopping, custom clothing creation and body shape monitoring. There is definitely room for improvement with this technology. Participants enjoyed using the technology but felt the websites could be better developed, easier to use, and more professional. Virtual try-on can reduce perceived risk and enhance online shopping enjoyment and therefore has the potential to increase website traffic which will lead to increased online sales. Virtual try-on can engage consumers with websites and provides consumers with added entertainment value which in turn will increase their time spent at the website and may lead to more purchases. However, the functionality of virtual try-on needs to be improved to provide consumers with confidence in the technology, ease of use, increased enjoyment, and better understanding of real world applications. If 3D avatar technology can address these issues there is huge potential for adoption of this technology.

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