Augmented Reality in Electronic Shopping

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Abstract. Businesses today are finding it increasingly difficult to compete in a crowded online marketplace. Some companies, have turned to the technological innovations in Augmented Reality to help them create unique and engaging experiences to differentiate themselves from competitors. In this paper, we have outlined the common definition of Augmented Reality, and investigated 2 practical examples of AR apps from different sectors of online retail. Using the SWOT analysis framework, we analyzed the internal and external market forces relating to AR in electronic shopping. We then put forth our predictions on the considerations, future trends and outlook of AR moving forward.

1. Introduction and Background

In recent years, we have seen an explosion in the popularity of Augmented Reality (AR) applications. Gartner predicts that 100 million consumers will shop using augmented reality by the year 2020 (Pemberton, 2017). In fact, just last year (2016), the incredible success (Kuittinen, 2016) of Pokémon Go launched Augmented Reality technology into the limelight. To date, Pokémon Go has been downloaded a total of 750 million times, and has grossed a total revenue of $1.2 billion (Smith, 2017). This has drawn the attention of many businesses and organizations, as they become more aware of the potential of AR technology.

Augmented Reality is the real-time use of information in the form of text, graphics, audio and other virtual enhancements integrated with real-world environments and objects (Schueffel, 2017). There are 3 main types of Augmented Reality technologies: Marker Based AR, Markerless AR, and Superimposition Based AR (Campanelli, 2010). Marker-based AR uses 2D visual markers such as QR codes to allow apps to identify and display appropriate information overlays on top of the markers. Markerless AR, makes use of a combination of sensors such as GPS, digital compass, accelerometer, and cameras to provide location and context aware content. Superimposition based AR allows real-time display and manipulation of digital objects and information overlaid upon the user's field of view. Most Augmented Reality applications today make use of some combination of the 3 types of AR (Prabhu, 2017).

It has been observed, that the retail industries have been constantly disrupted by modern web and mobile technologies (Abidi, 2012). In fact, most traditional brick and mortar businesses have been forced to adopt online based commerce to accommodate for these shifts in consumer buying habits (Farber, 2016). However, the advent of e-commerce does bring about several critical disadvantages when compared to physical stores. Due to the digital nature of e-commerce, shoppers are unable to experience the same fidelity and information richness (Carlson & Zmud, 1999). For example, online shoppers have been unable to try on clothing and accessories to gauge how it would look on them, whereas they could easily do so in the fitting rooms of physical stores. Augmented Reality apps can place virtual objects onto the real world, thereby allowing users to see the objects as they would in a physical store. This presents businesses with a unique opportunity to leverage on such technologies to enrich and enhance the experience of the distributed digital touchpoints with customers in ways that previously could only be achieved through the physical medium. Therefore, in this paper we would like to explore the practical applications of AR in electronic shopping, and provide our analysis and predictions on the state of AR moving forward.

2. Case Studies

To better understand the practical applications of Augmented Reality in electronic shopping, we shall be taking a look at 2 examples of AR apps implemented in 2 different retail sectors. By examining how these businesses have implemented AR into their shopping experience, we can gain valuable insights on how companies can leverage on AR to improve their businesses.

2.1 Augmented Reality for Furniture Shopping

Houzz is an online website and mobile application for browsing home interior design ideas, finding professional contractors, sharing design photos, and purchasing decorative products. The app is one of the most popular home design applications available for download on the Apple App Store and Google Play Store (Houzz, 2017) (Google Play, 2017). Currently, there are 14 million high-quality pictures of home designs provided by the app and they are categorised by style, location, room, etc. Through the aggressive use of promotional marketing strategies, combined with natural word-of-mouth dissemination, Houzz has managed to firmly establish itself in the online furniture shopping retail sector. In fact, it currently has over 9 million products available on its online store (Google Play, 2017).

On 3 May 2017, Houzz introduced a new AR feature to their app called "View in My Room 3D" (Figure 1). This feature enables users to view 3D models of furniture and other household accessories in the practical context of their intended environment, thereby aiding customers in making a more informed decision when making their purchases. When using the Houzz app, users can simply click on the "My Room" button to enable the AR feature. This will open up the camera, allowing users to place 3D product models onto the different areas in their home. A key differentiating feature is the ability to manipulate the models. Users can rotate and resize the models to view the product from different angles and at different sizes (Carlyle, 2017). After they are done with placing the product, users are able to take a picture of it and utilize the "Sketch" function to annotate on the image by adding text, drawings, or other products. Additionally, the app provides a photo sharing function which allows users to post their photos online and share their ideas with the community (Houzz, 2017).

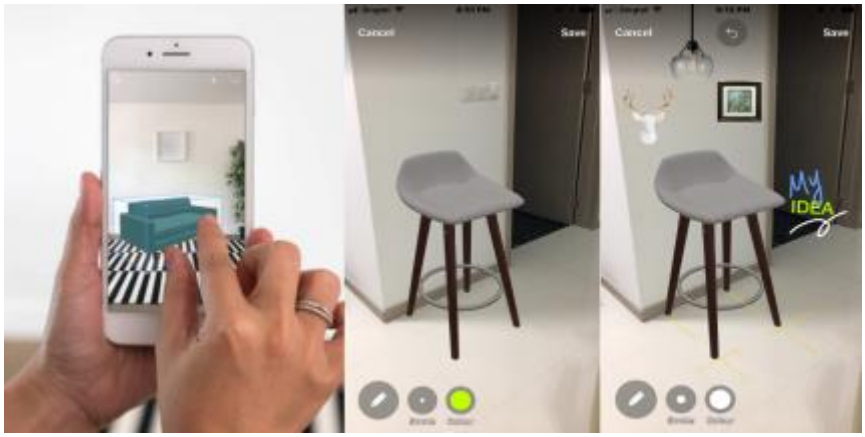


Figure 1 – Screenshots of Houzz AR functions "View in My Room"

The AR functions in the Houzz app truly helps to transform the furniture shopping experience for customers. In the past, shopping for furniture was a cumbersome affair that involved customers having to make pre-measurements of the areas in their homes before heading down to the stores to choose the right furniture that fits their needs. Even with online shopping, it would be difficult to visualize whether a piece of furniture would be the right fit in the overall décor of a room, and returning products after purchase would have added on even more hassles to the furniture shopping experience. With the introduction of the AR features, users can easily view the products in their intended environment to judge for themselves if the furniture is the right fit for them. This helps to

alleviate uncertainty, and potentially, the frustrations of making an incorrect purchase. With more than 320,000 reviews on the Google Play store, and a current rating of 4.6 out of 5 stars (Google Play, 2017), Houzz has shown to be a successful implementation of AR. Through the innovative use of AR together with the social sharing features available in the app, Houzz has not only helped transform the online furniture shopping experience, but also created a platform for aspiring designers to create and share their ideas with the world.

2.2 Augmented Reality for Fashion Boutiques

With immense price competition and aggressive expansion from other fashion retailers, Gap Inc. had faced a significant dip in sales since 2015 (Wahba, 2016). In order to pursue the changing behaviours of customers, Gap Inc. saw an opportunity in using technological innovations to value-add on its customers' shopping experience. DressingRoom by Gap was launched as a pilot app in January 2017. By using AR technology, shoppers are able to view a selected style on a 3D and 360º rotatable virtual mannequin before purchase. Instead of using common fit model sizes, shoppers are able to choose from five different body types.

In addition, the app also shows how the fabric stretches and drapes on the selected body size (Nunan, 2017). The creation of virtual mannequins enables users to correctly visualise the fit and feel of the outfit based on the closest-matched body size and type. Shoppers will also be more confident in making their purchases as the fear of buying the wrong sizes and risks of having to return it afterwards, will be diminished. Furthermore, shoppers are now able to browse and "wear" the online catalogue in the comfort of their environment without having to step into physical shops. Apart from the time saved from commuting and queuing for changing rooms, the app also empowers shoppers to make quicker and more informed decisions. Figure 2 shows an example of the virtual mannequin with two variants of sizes (Avametric, 2017). Additional screenshots of the DressingRoom app can be found in Appendix B.

Figure 2 – An example of virtual mannequin in two variants of sizes

Gap Inc. saw an opportunity to bridge customers who were apprehensive to online shopping. AR transforms the online shopping experience, by bringing virtual fitting rooms to the customers. The success of this app would help drive e-commerce sales internationally, and allow Gap Inc. to expand its reach and operations without having to actually invest heavily in real estate expansion. This would enable them to avoid heavy operational costs such as the high costs of rental and the manpower costs required to run the physical stores.

Gap Inc. created the app in partnership with Google and Avametric. As a result, this app is only available on Google Tango enabled phones, which current limits its target audience to Lenovo Phab 2 Pro and Asus Zenfone AR owners. The number of downloads from the Google Play Store ranges between 1000 - 5000 and the rating review scored 3.8 out of 5 stars. Reviews from users generally welcomed the innovation, but expected more customisation in mannequin sizes. One user

recommended making the mannequin's height customizable, while another proposed a self-model scan function for creating personalized virtual mannequins. With the pilot app only exposed to a small group of users, it is still too premature at this stage to measure its impact. Nevertheless, Gap Inc. has taken a bold step forward in the development of AR technology in the fashion retail industry.

3. SWOT Analysis

We have applied the SWOT analysis framework to identify the possible internal and external factors involved. The SWOT analysis allows us to better understand the Strengths, Weaknesses, Opportunities and Threats pertaining to the application of Augmented Reality in the electronic shopping space. A summary of our findings is illustrated in Figure 3.

Figure 3 – SWOT Analysis

3.1 Strengths

3.1.1 Immersive and Interactive Shopping Experience

AR brings about an enhanced shopping experience where shoppers are able to virtually try out products before purchase. For example, shoppers are able to use AR capabilities to sample the shades of blush and lipsticks without stepping into a physical cosmetics shop. This brings about greater convenience for customers who may be too busy to visit a physical store. Furthermore, the novelty and uniqueness of these AR interactions can help to stimulate interest, keeping shoppers engaged and continuously excited in trying the products virtually (Klamann & Krastev, 2017). The fear of buying wrong sized products has been one of the key reasons deterring customers from online shopping (Loop Commerce, 2015). AR addresses this issue by allowing users to try the products in a real-world environment with live surroundings. For example, the "Dressing Room" app enables potential customers to gauge the fit of clothes by choosing the right body type. This helps bolster the customer's confidence in making a purchase decision, and could potentially convince users who were uncertain about making purchases online.

3.1.2 Personalized Content

The marriage of AR technology with social sharing and networking capabilities creates interesting possibilities for users to design and create their own desired products and end results, and share them with the world. The Houzz app for example, demonstrates such capabilities. Potential

customers are able to place any desired furniture virtually within their homes and share them on their social feeds. From home designs to apparels, users are able to personalize products to suit their own likings, and visualize them in a rich and interactive way that is relevant to the context of their own environment. This level of personalization and experience surpasses that of conventional e-commerce approaches. When used in conjunction with social media technologies, it has the potential to spread quickly among savvy customers, thereby increasing online traffic and driving sales revenue.

3.1.3 Understanding User Behavior

By allowing users to customize and personalize their shopping experience, AR apps also have the ability to generate detailed insights about a company's customers. Combining AR apps with a data analytics engine could reveal valuable information such as consumer decisions, buying patterns, and preferences. In order to leverage on this possibility, businesses should integrate their AR apps with cloud-based infrastructure and social networks to generate the necessary information and reports for further study (Milicevic, 2017). Insights gleaned from such studies, can then be applied back into improving the shopping experience. Retailers can better target advertisements and in-shop recommendations to be more relevant to the customer, and products can be further improved based on buying patterns and preferences. Ultimately, this helps businesses to be better able to give customers what they want, and for customers to tell the companies what they want. By establishing this win-win situation, businesses can build brand loyalty and establish long-term relationships with their customers.

3.2 Weaknesses

3.2.1 Lack of Dedicated AR Devices

Most current implementations of AR require that users brandish a camera enabled smartphone. While the smartphone adoption rate in most countries are considerably high (Poushter, 2016), there are other concerns with the usability aspects of such an implementation. In terms of ergonomics, holding out your smartphone in front of you for extended periods of time to use the AR apps could lead to what is known as the "gorilla arm syndrome", where the users' arm begins to feel sore, cramped and oversized (Jang, 2017). This implies that AR apps must be designed with such considerations in mind, limiting the usage of these apps to shorter sessions. The lack of dedicated AR devices means that users have to use their smartphones, which were not specifically designed for AR usage. One solution to this issue is to make use of head-mounted displays (HMDs) which provide a more ergonomic and comfortable AR experience. However, there is currently a lack of mainstream HMDs available on the market. The Google Glass project, a frontrunner in wearable AR technology, was discontinued by Google in 2015 (Gokey, 2015). The more recent Microsoft HoloLens has yet to gain traction and mainstream adoption (Metz, 2015), and hence does not have a significant amount of applications available at the moment (Odom, 2017).

3.2.2 Limitations of Smartphones

The popular AR apps today are targeted to run on smartphones, which people use for many other activities. Given that AR applications often require real-time access to multiple different sensors on the smartphone – such as video and recording, gyroscopes, compass, accelerometer and geolocation features – it is to be expected that there would be a significant amount of battery drain on users' smartphones. Given that people today use their smartphones for many other functionalities and activities, these apps could potential hamper their lifestyle habits, or require them to bring along extra power sources just to utilize these apps. In terms of data processing, the real-time processing of data from multiple sensors for AR apps require users to possess a fairly up-to-date device with necessary processing power to handle such computations. Most midrange to low-end smartphones experience difficulties in handling such applications (Lass, 2015). Apart from processing capability, sensor accuracy also poses a challenge (Gotow, Zienkiewicz, White, & Schmidt, 2010). AR applications requires camera, sensors and GPS to work in unison in order to deliver rich context-related experiences for users in the open environment. With the fragmentation of types devices,

operating system versions and hardware capabilities, developers face an uphill challenge in developing AR apps that cater to the vast array of mobile devices available on the market. This has led Apple and Google to introduce optimized hardware accelerated frameworks to ease the development of AR apps.

3.2.3 Cross-platform Compatibility

In order to help developers build better performing AR apps, Apple and Google have recently released new software development frameworks. While the introduction of such frameworks attempts to help ease developers in creating performant AR apps that run smoothly, they also create compatibility related issues. ARKit, ARCore and Tango are very different frameworks that require developers to learn new approaches to building their AR apps for each of the different platforms. For instance, Tango is designed to measure multiple physical spaces and all the shapes contained within, while ARKit is built to find and draw on flat surfaces (Holly, 2017). As such, developers may not have the resources to invest in all of the different frameworks, they may simply pick one of them to experiment with. For example, in Section 2, the Houzz app is only available on Apple's iOS11, while the DressingRoom by Gap is only available on Google's Tango AR enabled mobile phones. This fragmentation of AR development approaches not only presents challenges for developers, but also confuses end users who do not understand why the apps are unable to run on their devices. This problem could potentially pose a hindrance to the widespread adoption of AR technology.

3.3 Opportunities

3.3.1 Improved App Development Frameworks

Along with the release of iOS11, Apple announced the introduction of ARKit, an AR development platform for iOS mobile devices (Rouse, 2017). The introduction of ARKit offers developers a framework to more easily build high performance, hardware accelerated AR apps. As a reactionary move, Google later also announced a shift from the Tango platform to the new ARCore, which will be supported from Android 7.0 Nougat onwards (Matney, 2017). Using a similar approach to ARKit, ARCore detects the horizontal plane and manages environment lightings to present objects virtually. With such commitment coming from the providers of the 2 most popular operating systems in mobile devices, we are likely to see more developers starting to leverage on these frameworks and incorporate new AR features into their applications. In fact, the hype generated by Apple and Google in the AR space, has not only affected developers but consumers as well. Recent surveys have shown that there has been an increased in interest in people who are intending to upgrade to the iPhone X simply because of the AR features offered (Munster, 2017). Given the strong backing of the tech giants, coupled with the increased ease of development of AR apps today and its popular reception among consumers, it is quite plausible that AR will become mainstream within the next few years.

3.3.2 Rise of Complementary Technologies

Apart from the improved software frameworks released by the 2 largest mobile platform providers, we have seen an increase in interest and development efforts in technologies that are complementary and work well together with AR. There has been a rise in popularity of companies turning to big data analytics to look for long-term growth opportunities (Bhisey, 2017). As mentioned previously, AR apps provide a viable avenue for businesses to gather valuable data on consumer preferences and behavior (Milicevic, 2017). This would definitely play an integral part in a company's strategy to exploit big data and hence builds a strong business case for pushing AR technology. Another complementary technology that has been gaining much traction recently, is Artificial Intelligence (AI). The amalgamation of computer vision and machine learning technologies has allowed companies to reimagine new possibilities for AR applications. In a 2017 app launch, Google Lens was unveiled as a service that could retrieve and present information on objects just by pointing a camera at it (Sinicki, 2017). By pointing Google Lens at an eatery place for example, information about the shop and food review scores will be shown, and by pointing it at a product, more details

of that product will be shown. The app leverages on machine learning to constantly improve the accuracy of its object recognition and information provided, meaning that it is a service that would continue to get better over time. Understanding that AR is not a technology that is used in isolation, it is likely that we will see more companies begin to adopt AR as an enabler of their broader strategic objectives.

3.3.3 Increased Industry Adoption

Having shown its success (Kuittinen, 2016) via the hit mobile game Pokémon Go in 2016, many companies are beginning to realize the potential of AR in transforming the user experience of the product and services they offer. Recently, Mark Zuckerberg, CEO of Facebook, had announced plans to implement AR effects into the camera features of Facebook's apps (Heath, 2017). In our 2 case studies, we have also seen that companies in the furniture shopping and fashion boutique industries have begun to conduct small-scale experimental development of AR apps. The outcomes thus far have been generally positive, as these companies are discovering that by using AR, they can provide a truly fun and immersive experience, where customers can use AR to design products or assemble outfits and share their creations (Rigby, 2011). Slowly but surely, we expect to see a gradual increase in the uptake of AR technology as more companies begin to realize the value it can bring to their businesses.

3.4 Threats

3.4.1 Competing Technologies

In recent years, there has been increasing interest in both AR and VR technology (Cavanaugh, 2017). These two classes of technologies provide vastly different experiences, yet each of them require businesses to commit substantial investments to implement. Given that these are new and emerging technologies, the business case for them have not been proven as such implementations have not been commonly done before. As such, it would be challenging for businesses to establish the Return on Investment (ROI) of engaging in the development of such technologies. Developers and hardware manufacturers would also be hard-pressed on deciding whether they should devote their limited resources and efforts on developing AR or VR technology. It is hence understandable that most companies would choose to adopt the "wait and see" approach to decide where they should place their investments.

3.4.2 Security and Safety Concerns

The meteoric success of Pokémon Go (Kuittinen, 2016) has had a profound impact on the daily lives of people. At the same time, it has highlighted the lack of social norms, etiquettes and regulations related to the usage of AR applications. This new technology creates new opportunities and experiences, but it also brings about a new set of risks and concerns. Specifically, the rise in popularity of AR has sparked concerns over personal security and safety (Roesner, 2017). As with any application that stores and utilizes personal information, especially to the extent that AR is able to do, there could be concerns over the security of such data from malicious attackers who could exploit the information for illegal purposes. AR offers users the ability to simultaneously experience a mix of reality and virtual content. This inherently creates safety concerns for drivers, pedestrians and other road users. By being overly engaged in the content on their mobile devices, they could put themselves or others at risk. A study has shown that in 2016, more than 110,000 incidents were caused by drivers and pedestrians being distracted from the AR game Pokémon Go, and this happened within a span of 10 days (Borland, 2016). Given the risks involved, it would hence be natural that certain companies and developers may be apprehensive in building such AR apps and games.

3.4.3 Legal and Privacy Concerns

The concept of modern augmented reality relies on the ability of the device to record and analyze the environment in real-time. Due to this inherent requirement, there are potential legal concerns over privacy. In many countries, such recording is allowed in the name of public interest

(Osterreicher, 2012). However, the constant recording nature of AR devices makes it difficult to enforce the prevention of recording outside of the public domain. Legal complications arise when there are infringements to one's rights to privacy or when copyrighted media are displayed. Indeed, these were the problems that plagued Google Glass (Swearingen, 2015) during its public testing phase. In fact, people became so concerned that restaurants and bars started banning the devices on their premises (Newcomb, 2015). Google eventually killed off the Google Glass project (Gokey, 2015). Every new revolutionary technology brings with it a new set of social-political issues. As the population matures and becomes more aware and educated on the usage and etiquette of such technologies, and as lawmakers catch up and implement the necessary safeguards for said technology, we will likely see a gradual improvement in the environmental outlook for AR.

4. Conclusion

In recent years, we have seen an increase in the popularity of Augmented Reality applications (Pemberton, 2017). The success of the AR game Pokémon Go (Kuittinen, 2016), has drawn the attention of many businesses to the potential of AR technology. The disruptions to the retail space caused by modern web and mobile technologies (Abidi, 2012), has led to increased competition and the need for greater differentiation in a crowded marketplace. This has forced retailers to look for new technological innovations to give them a competitive advantage. Companies such as Houzz and Gap, have shown that the application of AR technologies can truly transform the shopping experience and bring about greater convenience for customers. Through the use of AR technology, businesses are able to create immersive and interactive shopping experiences. The novelty and uniqueness of these applications also help to stimulate interest among consumers and keeps them engaged and excited about a company's products (Klamann & Krastev, 2017). Additionally, the ability to "try on" products virtually before purchase, also helps customers to eliminate uncertainty and guesswork when buying online.

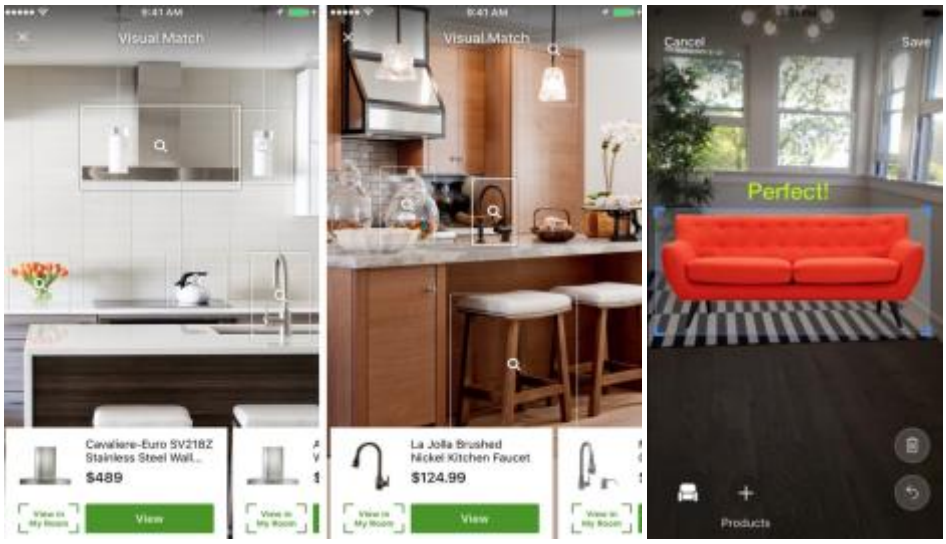
However, the lack of mainstream dedicated AR devices means that most AR apps today will have to run on mobile phones. This creates unique challenges for developers who are required to balance the functionalities of the AR apps with the processing capabilities and battery life of the smartphone. Furthermore, the fragmentation of hardware specifications and operating system versions of mobile devices make it difficult for developers to ensure that their AR apps function well on all their customers' devices. Businesses also need to consider their options before deciding on investing in AR technology. The rise in popularity of VR (Cavanaugh, 2017) could lead to a contention of resources and developer effort as companies need to decide where to place their investments. Moreover, AR has had a track record of security and safety concerns (Roesner, 2017) as well as legal and privacy concerns (Swearingen, 2015). Developers hence need to thread carefully and design their apps to avoid such pitfalls.

Nevertheless, the recent introduction of improved app development frameworks by Apple and Google (Rouse, 2017), means that it has become easier than ever before for developers to start building high quality AR apps. The hype for AR generated by the iPhone X release (Munster, 2017) also means that we can expect to see increased consumer adoption of AR. The rise of complementary and supporting technologies such as AI and big data, help push AR forward by enabling the creation of innovative new services through the synthesis of these technologies. Indeed, we have seen increased industry adoption as more companies have started to announce plans (Heath, 2017) to incorporate AR into their apps. Slowly but surely, we expect to see a gradual increase in the uptake of AR technology as more companies begin to realize the value it can bring to their businesses. We remain optimistic that Augmented Reality in electronic shopping will continue to increase in adoption and that it will someday become an integral part of the online shopping experience.

Appendices

Appendix A

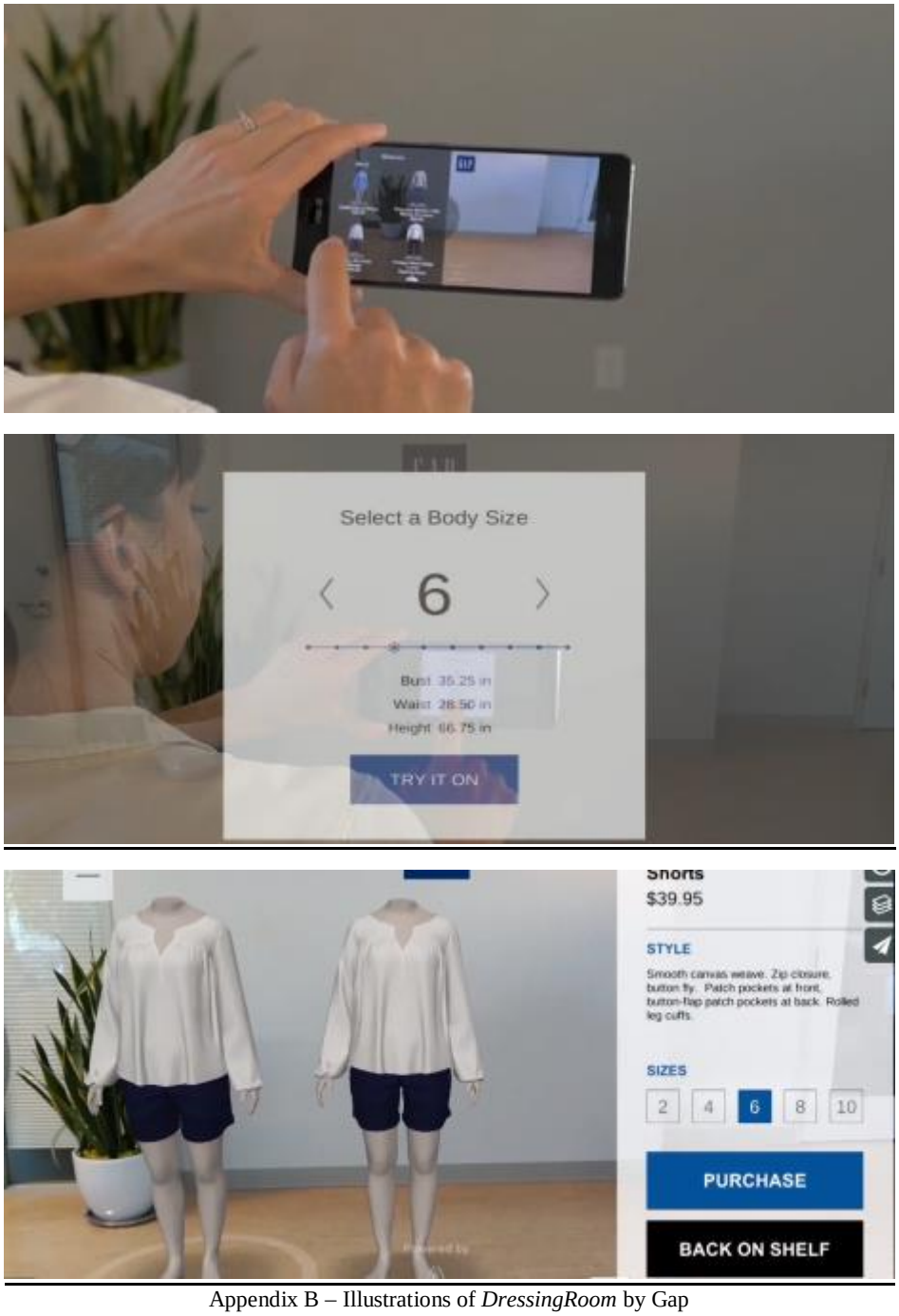
This section shows how the "View in My Room 3D" function works in the Houzz app. The user is able to select the product from the home design photos or products list. Then, they use the camera to place the products at different places in their home and capture the photo. After they capture the product they like, the user can add in some sketches into the photo and share the photo as an idea.



Appendix A – "View in My Room" AR function of Houzz (Houzz, 2016) (Lillo, 2016)

Appendix B

This section provides an illustration of the DressingRoom app (Avametric, 2017). The user first selects an outfit, then personalizes the virtual mannequin to show a preferred body size. A 3D and 360^{o} rotatable view of the outfit is then displayed, with side-by-side size comparisons for a value-added shopping experience.



Appendix B – Illustrations of *DressingRoom* by Gap

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