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INTRODUCTION & LITERATURE REVIEW

In today's fast paced business environment where transactions happen at the speed of light, it has become crucial for all stakeholders in commerce – from sellers and manufacturers to wholesalers and individual consumers – to adopt new strategies in order to pursue new avenues of profitability, enhanced production, marketing, and sales. In the past two decades, the age of information has brought about a major transformation in the transactional process. Among other sectors, the global and regional fashion industries have also expanded tremendously, with at least half a dozen home-grown clothing brands and as many designer labels emerging in the last two decades. This indicates the fashion sector is undergoing a period of great change. Fashion itself, is a phenomenon that involves great "Change" from various standpoints. The fashion industry demands not just skills but also adoption of constant change and creativity to supplement commercial activities. Designing and manufacturing alone are not enough for the success of the fashion industry. It is the application of marketing that plays a crucial role in managing this growth and change. Therefore, brands in the fashion sector may excel by capitalizing on fashion marketing. The field of fashion marketing too, has evolved over the years to encompass a wide range of methods and techniques to appeal to customers and drive sales. Because fashion is based on change by its very nature, therefore, the traditional marketing techniques may not all be equally applicable or profitable in fashion marketing. Instead, a variety of approaches using visual aids, technology, and a combination of the two must be adopted in order to appeal to customers. Moreover, because the fashion industry is divided across sociocultural and economic sectors, the practice of fashion marketing is not uniform[1].

Fashion has become an integral part of the daily lifestyle, human personality, and societal norms and values. As a matter of fact, fashion has become a statement of expression and individuality. The old adage, "Dress for Success" demonstrates the historical linkages of fashion wear with confidence and performance. In order to appeal to the broad customer base, fashion and clothing sellers have two methods for growth, namely: (i) in-store through displays, banners and ads,

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[1] Lea-Greenwood, G. (2013). *Fashion marketing communications*. Chichester: John Wiley & Sons.

mannequins, point of purchase promotions, lighting, scents, music, and store layouts to name a few; and (ii) online or digital space which may include web presence, social media, and email marketing. The main concern of sellers is to promote products to the general public, and therefore, sellers must capitalize through the technique of visual merchandising.

Visual merchandising refers to "amalgamation of ideas, direction, imagination, originality, and a sophisticated business that is considered as the first connection to the customer's opinion"[2]. Visual merchandising comprises the store construction, setup, furnishing, and design along with its merchandise, functional and aesthetic elements which comprise store layout, display, comfort, privacy, architecture, color, material and style (Oh, Florito, Cho & Hofacker, 2007). Visual merchandising is used for communicating the fashion value, brand presence, compatibility, and quality to the customers. Every component which adds a visual factor can be included in visual merchandising; such as sign boards, shelf arrangement, section divisions, and even cleanliness. Visual marketing may help promote brands by appealing to customers as a unique or standout method of advertising products. This, it may help sellers to create improved relationships with customers and attract them to the store in order to increase sales. Extensive research has been carried out in this domain. Khandai et al.[3] conducted a study to analyze the most effective trading technique leading to on-spot buying and discovered the "Window Display" is an effective tool in attracting customers.

With society's quick pace, it is hard for people having significantly lower time to explore the clothes in a retail point, or to assess the fit, look, and fall of the fabrics. This can cause some doubts and difficulty of decisions in some customers' mind which can cause a down graph of sales. Mostly, the retail fashion stores carry selective product lines. The store layout is narrow usually with deep assortments which results in products being overlooked or missed until clearance which impacts the bottom line and profitability. Because fashion stores mainly target the fashion enthusiasts and followers rather than trendsetters, they seek to focus on specific product lines and market segmentation, which may allow self-service in which customers who walk in to the store

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[2] Pillai R, Iqbal A, Umer H, Maqbool A, Sunil N (2011) Design, effectiveness and role of visual merchandising in creating customer appeal

[3] Khandai S, Agrawal B, Gulla A (2012) Visual merchandising as an antecedent to impulse buying: an Indian perspective. Int J Bus Manag Stud 1(1):267–277

locate their own preferred items, compare products, and make their own selection (Kotler & Armstrong, 2012)[4]. On the other hand, visual display of goods in the fashion retail trade can have a significant impact on sales as customers can see the color, fabric, styling, cut, and fitting of the displayed items and choose what catches the eye, and what better than to use mannequins to display products. The mannequins tempt customers to give a look while passing by the store which can promote a brand and its sales. Mannequins can become the most effective tools of visual merchandising because they can be used to display the latest apparel and fashion trends in the retail sector.

It is a natural phenomenon that passing-by customers see the window display of any store. Usually, the window display is the decision point whether or not to enter the store, based on the collection of items present in the display. Mannequins can be used to create a store display window that add value for the seller by drawing attention to the collection of the shop, encouraging customer visits, and thus generating the income. But mannequins are not usable only for the display purpose, rather they may be used to showcase multiple items (like different layers and style of clothes, jewelry, accessories, shoes, etc.). Customers can easily see the usage and visual appealing of the brand's items. Thus, mannequins are a valuable tool in apparel and fashion retail business, which allow customers to assess and judge all aspects of the products before even entering the store! In other words, mannequins have become an important determinant in the footfall or customer traffic of a particular store. Thus, the facade of the mannequins must add the zest and visual appeal that customers seek in terms of fashion and clothing. Because the mannequins are such important tools in visual merchandising, especially for the retail businesses, some improvements and innovations can definitely be considered to make them more appealing.

This is supported in the study by Christopoulu (2011) found that the showcases grab the major attention of shoppers and that motion and mobility are among the main factors in the desirability of a showcase[5]. It is easily understandable that a moving or animated object (s) would immediately grab the attention as compared to a static display. This was supported by a study performed by the Point of Purchase Advertising International (POPAI) organization, which indicated that live and

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[4] Kotler, P., Armstrong, G., Ang, S. H., Leong, S. M., Tan, C. T., & Ho-Ming, O. (2012). *Principles of marketing: an Asian perspective*. Pearson/Prentice-Hall.
[5] Christopoulou M (2011) Exploring shop window displays. Art Educ 64(3):25–32

active showcases attracted the customers. In fact, the same study reported that lively and motion features of in-shop displays can improve sales by about 310%[6].

Although the number of online consumers has drastically increased as online stores became more sophisticated, but still people hesitate due to quality, fitting, and a range of personal issues. Generally, the practice of "Buy what you can Try" is prevalent in the society, which renders a necessity for the fashion and clothing brands to establish their physical stores. Moreover, the factors such as trust, quality, delivery time, fitting assurance, returns and cancellations, etc. all factor in determining the online presence of fashion brands and the variety of products they possess. While every customer has their own experiences in purchasing clothes online, issues such as excessive delivery times, poor quality, product variety (cloth stuff, size or color) does not fulfill the consumer's desire, what is committed is not delivered, the time committed for delivery is not followed, and additional service charges, etc. push the consumers back towards physical stores where they have direct access to the clothes and other fashion items they need. The emergence of fashion shopping options online is also bringing about changes in the consumers' behavior. This is supported by a recent study which suggests evolution in retail is impacting the growth of fashion retailers and customer preferences at the outlets are also transforming (Shaari & Hong, 2018)[7].

Well informed customers now require more time, attention to detail, and knowledge about the product types, the differences in fabrics, colors, styles, cuts, fitting, and other personal preferences. This means that workers in fashion retail stores must spend more time per consumer in order to provide a satisfactory level of service, answer queries, and close the sale. This effort requires a stretch of available resources (including salesperson efforts and associated wages, etc.)[2]. Moreover, due to paucity of time, it is not in the favor of the retailers to have crowded or poorly organized stores as consumers will not deep dive into shelves of inventory, if they see the product in a display, they may enter the store. The effects of visual merchandising on customers' buying behavior have been researched extensively in past few years. Researchers posit that up-to-date and

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[6] Zibafar, A., Saffari, E., Alemi, M. *et al.* State-of-the-Art Visual Merchandising Using a Fashionable Social Robot: *RoMa. Int J of Soc Robotics* (2019). https://doi.org/10.1007/s12369-019-00566-3

[7] Shaari, A., & Hong, T. T. (2018). Evolution in fashion retail: Comparing fashion specialty store and department store in Malaysia. *International Journal of Academic Research in Business and Social Sciences*, 8(9), 1910-1918.

visually appealing merchandising and displays are crucial for increasing sales, improving operations, and projecting a proper brand image (Upadhyaya, El-Shishini, Aziz & Kumar, 2018)[8]. The presence of intense competition in the fashion retail industry necessitates adequacy of business models, point of sale layouts, and visual merchandising. Taking into consideration the importance of visual merchandising, and elements of visual merchandising it is clear that this method can stand out in attracting customers to retail stores.

People have various reasons for shopping, which vary upon personal taste, requirement, finances, and a host of other preferences such as trendy versus comfortable, etc. but mainly the reasons for shopping are: (i) being in the need of something, or being attracted by a product in terms of visual appeal, comfort, features, etc. (ii) unplanned or spontaneous shopping brought about by a number of factors, including stress reduction mechanism; (iii) source of enjoyment and happiness when buying goods because it restores some control in their lives, (iv) calming influence of shopping and distraction from negative feelings. People in different phases and conditions of life seek to have appropriately fitted clothing .The sellers must thus accommodate all of the above in marketing and visual merchandising to make the maximum number of consumers visit the store, and further apply some engagement and retention techniques that will help consumers choose products and return to the same vendors in the future. The dominant marketing technique used to promote products in the offline (traditional brick and mortar) stores is visual merchandising. It is generally a cemented concept that the products image or display must be promoted and presented in a manner that impacts a potential customer's mind and thus buying decision. Thus, branding an item alone is not as effective, nor is simply assigning an arbitrary price range, or meeting certain quality parameters; rather in addition to these factors, the display and presentation hold a crucial importance for customers. Further to this, in-store displays, shop window displays, showcases, and other arrangements which allow visual promotion of items, mannequins, etc. are all techniques of visual merchandising. Building on the aforementioned, Zulkurnain et al (2019)[9] proposed the following five elements of visual merchandising:

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[8] Upadhyaya, M., El-shishini, H. M., Aziz, W. A., & Kumar, V. (2018). Retailscape: An exploration of the relevant dimensions and their impact on consumers' behavioral intentions. *Journal of Business and Retail Management Research*, *12*(4).

[9] Iberahim, H., Zulkurnain, N. A. Z., Raja Ainal Shah, R. N. A., & Rosli, S. Q. (2019). Visual merchandising and customers' impulse buying behavior: a case of a fashion specialty store. *International Journal of Service Management and Sustainability (IJSMS)*, *4*(1), 1-24.

Window Displays:

It is commonly established and experienced that a store window display generally provides the first impressions of its product line, pricing, quality, etc. and becomes a deciding factor for customers. Window displays are useful in promoting different types of items, and allow positioning of merchandise in order to create visual appeal (Somoon & Sahachaisaree, 2018)[10]. Research by Seock and Young (2013)[11] concluded that store window displays are important visual communication aids which directly contribute to higher sales, especially for new products. Moreover, a window display can also be used for important announcements, promotions, sales announcements, notices, discounts, and special deals which may further attract customers. Another research on consumer behavior by Bastow-Shoop et al (1991)[12] posited that on average, each customer would spend 10 seconds or less to focus on a window display. Thus, it is safe to conclude that for retail stores, the window display needs to be arranged attractively for customers to stop, look, desire, enter and buy (Christopoulou, 2011)[13]. Research has noted that while interior design and decoration also play a part in sales, and also the window display creates a higher opportunity for sales and customer visits. Thus, we can conclude, that there is a significant relationship between the window display and purchasing or sales.

Mannequin Display:

Mannequins are simply the models of human bodies created and designed to represent the shape similar to human beings wearing some fashion apparel items to show the full design, quality, styling, cut, and fall of items. Mannequin displays allow to present all kinds of different merchandise which informs customers the stores' product line, branding, availability, and choices. Moreover, the displaying of mannequins creates similarity to the natural body style which creates

[10] Somoon, K., & Sahachaisaree, N. (2018). Window display targeting adolescent purchasers: Users' merchandising perceptual response. *Journal of ASIAN Behavioural Studies*, *3*(7), 183-188.

[11] Seock, Y. K., & Young, E. L. (2013). Understanding the importance of visual merchandising on store image and shopper behaviours in home furnishings retail setting. European Journal of Business and Management, 174-187.

[12] Bastow-Shoop, H., Zetocha, D., & Passewitz, G. (1991). Visual Merchandising; A Guide for Small Retailers, North Central Regional Centre for Rural Development. Unpublished Master's Thesis. Iowa State University, United States.

[13] Christopoulou, M. (2011). Exploring shop window displays. Instructional Resources, 25-32.

a personal and effective interaction with the consumers who can judge a product and creatively view its styling in order to make a purchasing decision (Strategic Direction, 2012)[14]. Viewing clothes on the mannequins creates a natural balance in which customers are able to effectively understand the visualization and outlook of fashion items, apparel, clothing, accessories, etc. This makes it easier for the customers to assess their need and suitability of the items on display. This can have a two-fold effect for the retailers; firstly it allows the retailer to display the range of their products for immediately effective merchandising; secondly, it conveys to the consumers the product range and inventory type held in a particular store. Furthermore, the visual merchandising by using mannequins increases the customer interest in products. (Xuefei & Peiwen, 2014)[15]. Similarly, Tidy (2012)[16] concluded that mannequins were "blank canvas" that can be used to display fashion apparel and accessories for customers' easy viewing, evaluation, and decision. Fister (2009)[17] described some qualities of effective mannequins in the domain of virtual merchandising; namely the customers should be able to "see the design", mannequins should "display entire outfits" and customers must be able to visualize "what clothes will look like on them". It is then, promising to explore further domains of improvement in mannequin displays to capture customer's attraction.

Floor Merchandising:

Floor merchandising refers to the in-store arrangement and layout of merchandise. This includes racks, positioning, height, clumping or grouping, contrasting, full item displays versus shelve stocking, etc. According to research by Law, Wong & Yip (2012)[18], floor merchandising impacts perception of customers through selective attention, distortion and retention of information. After several years, researchers have identified the easy access and pathways inside the store as a major factor in retaining customers and increasing time spent in the store. Floor merchandising is thus a

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[14] Strategic Direction (2012). Visual Merchandising Strategies, 28(10), 12-14
[15] Xuefei, L., & Peiwen, J. (2014). The Influence of Store Atmosphere on Shoppers' Impulse Purchasing Behavior. Unpublished Student Paper, Lund University.
[16] Tidy, J. (2012). The Silent Saleswomen; Mannequins, Visual Merchandising and Beauty for Sale. 1-15.
[17] Fister, S. E. (2009). Consumers' Shopping Value and their Responses to Visual Merchandise Displays in an In-store Retail Setting. Unpublished Master's Thesis, Oregon State University, United States.
[18] Law, D., Wong, C., & Yip, J. (2012). How does visual merchandising affect consumer affective response? An intimate apparel experience. European Journal of Marketing, 46(1/2), 112-133.

crucial component of the shopping experience that affects customers' purchasing behavior.

Promotional Signage:

Promotional signs are of different styles, shapes, colors, and varieties to inform the customers about product lines, varieties, prices, sales, special announcements, etc. Signage provides information which assists customers to find products easily. Promotional signage is an efficient tool to deliver message on products that are available in the store (Memon, Kazi, Zubedi & Ansari, 2019)[19]. It is important that signs are large, well-written and readable from a distance, and lit so that customers can easily read them. Low-end retailers may use hand written-signs whereas luxury brands can have specially designed graphically affected signage. Mopidevi and Lolla (2013)[20] concluded that "a sign acts as a silent salesperson, which must attract the customers' attention in less than 10 seconds by providing information about the business and what it intends to sell".

Lighting:

Lighting enhances the identity, visual presence, and appeal of a store. A well-lit store is more visually pleasing and therefore attracts and guides customers. Within a store, good lighting helps to show off products and items for the customers' satisfaction. Astrid & Mustika (2013)[21] concluded that lighting contributes to visual appeal of the displayed products and appeals to the customers through control of colors, temperatures, and appearance. Simply put, the items can be made to appear more attractive and brighter by selecting carefully a selection of spotlights, floodlights, and internal lighting combinations. Showcases, window displays, racks, and signage can all be made more attractive and prominent by using lighting. Lighting can be used to add complexity and a classy look for the retail stores. Customers shopping for fashion items, apparel, clothing, and accessories like to examine and observe their products in bright lighting to assess the colors, styles, and quality. Thus, lighting not only increase the foot traffic but also promotes visual

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[19] Memon, R. H., Kazi, A. G., Zubedi, M. Y., & Ansari, A. (2019). Factors affecting impulse purchase behavior in Hyderabad – Marketing perspective. International Journal of Entrepreneurial Research, 1(2), 20-24

[20] Mopidevi, R., & Lolla, S. R. (2013). Visual merchandising an impulsive reinforce of purchases leading to social imbalance: A case study on middle class families in Hyderabad. IOSR Journal of Business and Management, 9(6), 111-122.

[21] Astrid, N. R., & Mustika, S. P. (2013). Effect on Visual Merchandising in Fashion Store on Female Consumers' Purchase Intention. Proceedings of World Business and Social Science Research Conference, 24-25 October 2013. Bangkok, Thailand.

interest in a store.

In the past years, a great amount of research conducted on visual merchandising and its impact on the behavior of consumers. Today mannequins play a prominent role in the retail apparel business. They have undoubtedly become effective and commanding tool to attract customers for retailers worldwide. They add great value to the products and growth of retail business.

Visual merchandising is a creative exercise widely used in the fashion industry to grab the attention and preserve the name of a brand in the minds of customers. IN order to create an impressive display and lively visual marketing, the advantage of technology can be taken to create elements in motion. This can create a dynamic, eye-catching attraction for the customers. Studies show that an active, dynamic and vibrant showcase (with movements and interaction) can enhance the sales up to 310%[22]. The moving elements with interaction skills that are able to attract and engage the people, best defines the social robots (developed for various purposes including education and training[23], social services, therapy assistant[24] and visual merchandising[25]. One practical solution to achieve this is by using a motorized mannequin, which is the focus of this study. Using a motorized mannequin can create a simple and dull store display into an eye-catching attraction. Thus, many customers passing by the point of sale would be enticed to enter the store which will increase the footfall and potentially grow the customer base. These elements can change a simple, passive, and boring showcase into a dynamic and eye-catching one. It is extremely important in a retail operation that the merchandise is displayed and presented in an appealing and eye-catching manner. Only then will it draw the customers ' attention and encourage people to buy the products. In our case, we posit that a dynamic mannequin display will appeal more to clients and customers, as supported by the research Jain et al (2012) which

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[22] https://www.popai.co.uk/

[23] Meghdari, A., Alemi, M., Ghazisaedy, M., Taheri, A.R., Karimian, A., Zandvakili, M.: Applying robots as teaching assistant in EFL classes at Iranian middle-schools. In Proceedings of the International Conference on Education and Modern Educational Technologies (EMET-2013), Venice, Italy (2013)

[24] Meghdari, A., Alemi, M., Khamooshi, M., Amoozandeh, A., Shariati, A., Mozafari, B.: Conceptual design of a social robot for pediatric hospitals. In: 2016 4th International Conference on Robotics and Mechatronics (ICROM), pp. 566–571. IEEE, October, 2016

[25] Shiomi, M., Shinozawa, K., Nakagawa, Y., Miyashita, T., Sakamoto, T., Terakubo, T., et al.: Recommendation effects of a social robot for advertisement-use context in a shopping mall. Int. J. Social Robot. 5(2), 251–262 (2013)

showed that a majority of the sample (150) women purchased clothes showcase by mannequins[26]. However, a disadvantage of the traditional mannequin is the fixed base and fixed size. Mannequins are used widely in the global fashion, apparel, and textiles industry. For retail stores, well-dressed mannequins with latest clothing are used to make a visual merchandising attempt more effectively than other props or items.

We posit that a dynamic mannequin will act as a visual merchandising agent for the fashion industry and attract attention through movements which will instantly catch the eye of passers-by. The Mannequin can be used as a platform on which apparel size, colors, cuts, shapes, styles, and latest fashions can be used to fit and give customers visual merchandising presentation in order to substantially increase the business and sales. Mannequins in display windows and in retail stores can be used to represent the latest fashionable trends to attract customers. Customers may also look at the mannequins to understand combination of apparel, colors, contrasting, and accessorizing techniques and trends. Mannequins also demonstrate the different colors, cuts, textures, and outlook of apparel and accessories so that the viewers can make an easy judgement to opt for the outfit. In this regard, generally, the mannequin should be in a body shape similar to the customers; so, we may opt for different mannequins for the male customers, female customers, and children customers. This is because each size and fitting of clothing will create a unique image of wearing the item in their customer minds. Hassani et al. (2019)[27] conducted a detailed study on the impact of using a robot mannequin in visual merchandising and found that:

> "Customers were also asked if they would buy a dress without
> trying it on. Answers showed that only 32% of people said they
> might buy clothes without trying it or seeing it on a body. From the
> review of comments, it is concluded that people pay much more
> attention to the way the dress fits the ins and outs of the body. This
> factor can easily be shown to the customer by the mobile robot
> mannequin. The advantage of the robot mannequin is that it displays

[26] Jain, V., Sharma, A., Narwal, P.: Impact of visual merchandising on consumer behavior towards women's apparel. Int. J. Res. Manage. 5(2), 106–117 (2012)

27 Hassani, A., Saffari, E., Alemi, M., & Meghdari, A. (2019, August). The Impact of Using a Robot Mannequin (RoMa) in Visual Merchandising. In RAIS Conference Proceedings, August (pp. 19-20).

a myriad of upper body shapes and movements allowing the potential customer to easily imagine the dress on their own body.

In this study, cameras located inside the store filmed the behavior of pedestrians outside the front showcase during two periods before and after the installation of the RoMa mannequin. The data recorded was examined for different hours of the day. The results recorded before the installation of the RoMa showed on average about 5 people per hour looked at the store's showroom. After placing the robot mannequin in the showcase, that number increased to 19. This shows the creation of the mobility factor in the showcase drew people's attention to the shop windows. Data recorded from the microphone installed in front of the showcase store where pedestrians crossed in front of the showcase was also remarkable. Most people were surprised at the presence of the moving object simulating human movements inside the showcase."

The same research further mentions that, "the use of the robot mannequin in the showcase of a store and the smartness of the showcase caused it to increase the number of people who looked at the showcase by 280% during the day." The results of that study also mentioned that the customer's priority was fitting the ins and outs of the body and clothing style. Furthermore, customers wish to see clothing and apparel in person. The results recorded "showed on average about 5 people per hour looked at the store's showroom, but after placing the robot mannequin in the showcase, that number increased to 19."

These results indicate the significance of using a motorized or dynamic mannequin to display apparel to the customer. The mobility factor draws people's attention to a shop's windows, and potential customers can easily imagine the apparel on their own body.

MECHANICAL/TECHNICAL SPECIFICATION

"Failing to plan, is planning to fail"

Alan Lakein.

In the context of development, technical specifications are the key for planning and laying out required functionality/specifications. Technical specifications are not merely measurements to construct or functionalize an equipment or machinery; rather they reflect the complexity, creativity, and scope to which an equipment may be utilized, its maintenance, usability, and cross-functionality across various domains. Moreover, the technical specifications also provide developers, technicians, and workers with clearly defined goals and direction, ultimately facilitating the production, manufacturing, maintenance and operationalization of the equipment. In the case of the motorized mannequin under examination, the design is envisioned as a modular and detachable mechanism that can be easily fit into the traditional mannequins in wide use, by performing minimum machining/alteration. In this chapter, the main technical and mechanical specifications of the mannequin are under discussion, in order to elaborate its working.

Key Features:

There are 5 joints in the mechanical design:
  i.   Right shoulder joint
  ii.   Left shoulder joint
  iii. Right wrist joint
  iv.   Left wrist joint
  v.   Torso joint

Technical Specifications:

The following technical specifications of each joint are outlined below:

  i.   **Right Shoulder Joint:**
        A servo motor is fixed in right shoulder with detachable mechanism.

Max Torque Req = Max Load Torque + Max Frictional Torque

Max Torque Req = m_sg *r*sin(90) + μm_dg*l*cos(0)

Where m_s = Mass of the shoulder = 0.45kg

Where m_d = Mass of the dress at shoulder = 0.075kg

Where μ = Coefficient of friction of wool = 0.8

Where r = Distance between axis of rotation and center of mass = 0.2159m

Where l = Arm length = 0.4318m

Max Torque Req = (0.45*10*0.2159*1) + (0.8*0.075*10*0.4318*1)
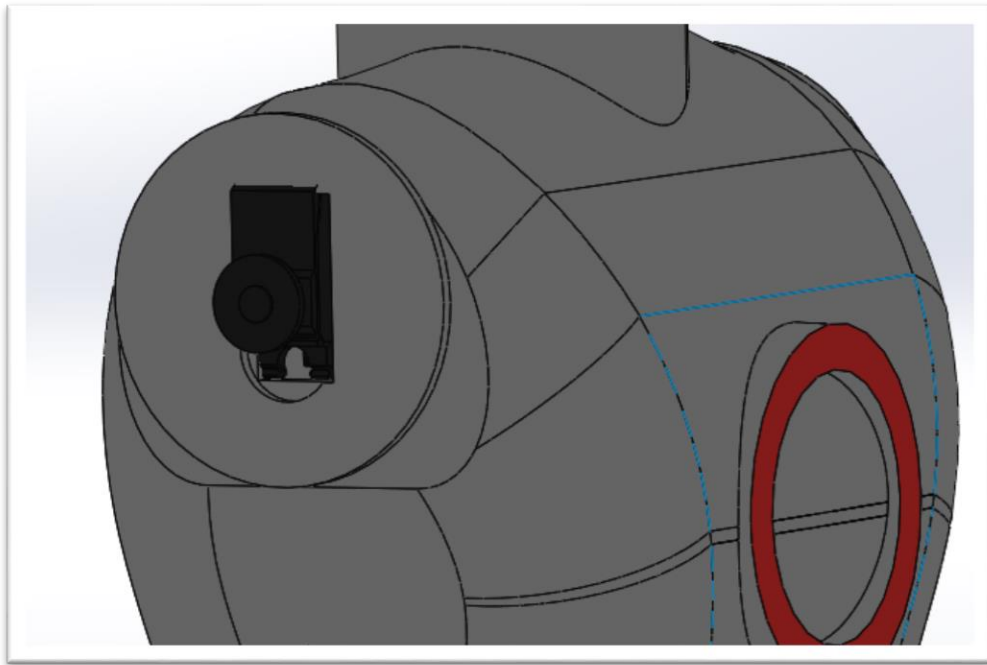
Max Torque Req = 1.23Nm or 12.54kgcm

Figure 1: Right Shoulder Joint

ii. **Left Shoulder Joint:**

A servo motor is fixed in left shoulder with detachable mechanism.

Max Torque Req = Max Load Torque + Max Frictional Torque

Max Torque Req = $m\_sg*r*\sin(90) + \mu m\_dg*l*\cos(0)$

Where m_s = Mass of the shoulder = 0.45kg

Where m_d = Mass of the dress at shoulder = 0.075kg

Where μ = Coefficient of friction of wool = 0.8

Where r = Distance between axis of rotation and center of mass = 0.2159m

Where l = Arm length = 0.4318m

Max Torque Req = (0.45*10*0.2159*1) + (0.8*0.075*10*0.4318*1)
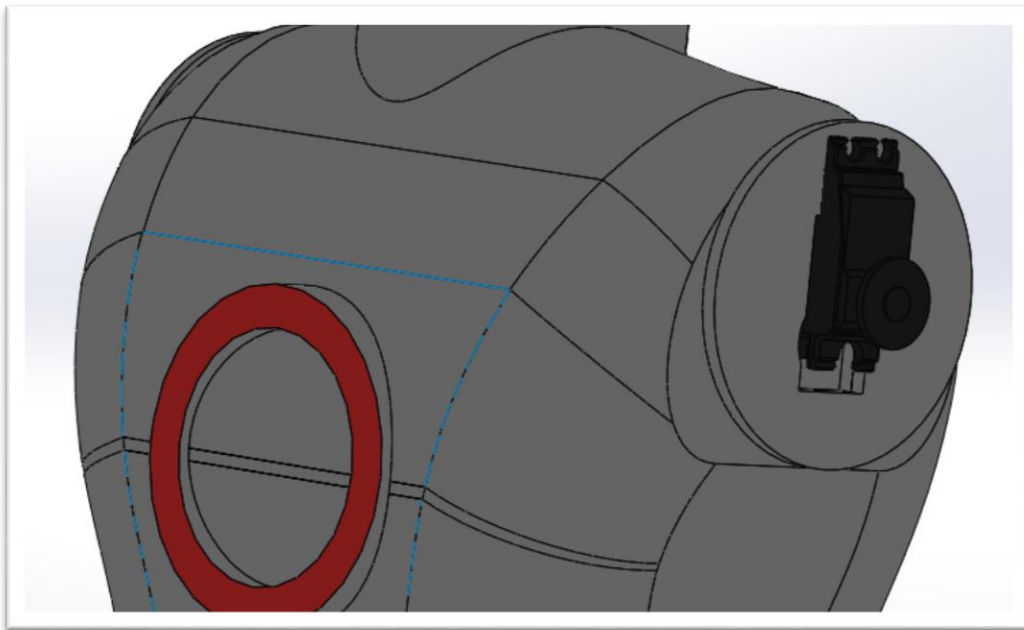
Max Torque Req = 1.23Nm or 12.54kgcm

Figure 2: Left Shoulder Joint

iii.   Right Wrist Joint:

Servo motor is fixed in left wrist with detachable mechanism.

Max Torque Req = $F*r\sin(90)$

Max Torque Req = $m\_wg*r*\sin(90)$

Where m_w = Mass of the wrist = 0.045kg

Where r = Distance between axis of rotation and center of mass = 0.0635m

Max Torque Req = 0.045*10*0.0635*1

Max Torque Req = 0.0286Nm or 0.29kgcm

Figure 3   Right Wrist Joint

iv.   **Left Wrist Joint:**

Servo motor is fixed in left wrist with detachable mechanism.

Max Torque Req = F*rsin(90)

Max Torque Req = m_wg*r*sin(90)

Where m_w = Mass of the wrist = 0.045kg

Where r = Distance between axis of rotation and center of mass = 0.0635m

Max Torque Req = 0.045*10*0.0635*1

Max Torque Req = 0.0286Nm or 0.29kgcm

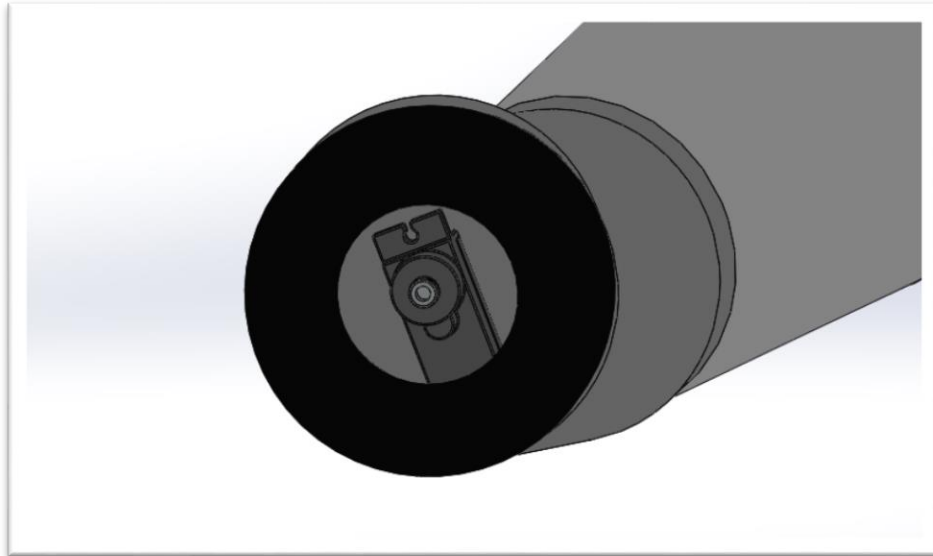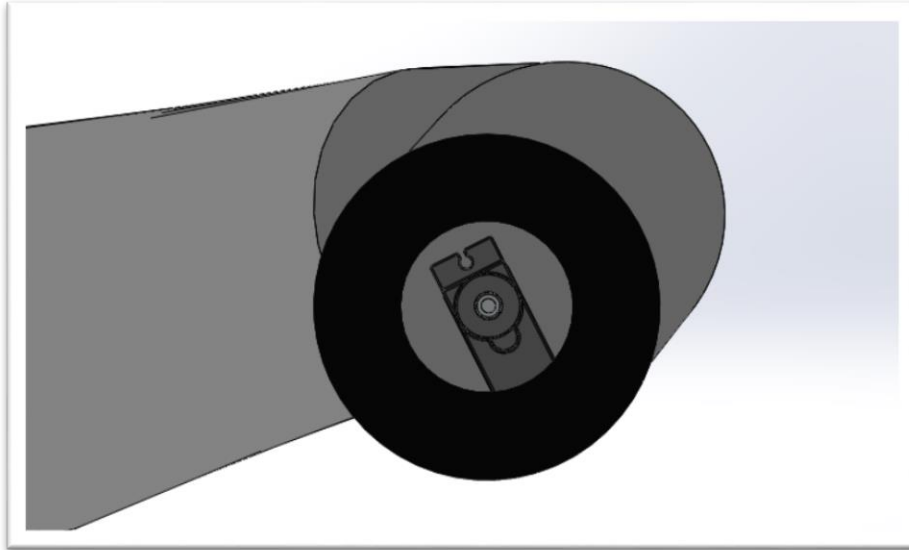*Figure 4   Left Wrist Joint*

v.   **Torso Joint:**

A high torque servo motor is attached to the torso joint through a roller bearing mechanism. Roller bearing mechanism is utilized as a robust, strong mechanism for the smooth and coordinated movement of the torso joint which will allow not only the mannequin to move from side to side, but also ensure that the fabric which is draped on the mannequin smoothly transitions without any stress.

Max Torque Req = I*α

Where I = Moment of Inertia

Where α = Angular Acceleration

I = ½*m*r^2

I = ½*3.5* ⟦0.2286⟧ ^2

I = 0.09145kg$m$^2

Let's say we want to complete 1 revolution in 2 secs

Angular Speed = 0.5 rev/sec

Angular Speed (rad/sec) = 0.5 * 2π

Angular Speed = π rad/sec

Let's say we want to achieve the speed in 0.25sec, then:

$\alpha = \Delta w / \Delta t$

$\alpha = (\pi - 0)/0.25$

$\alpha = 4\pi \ rad/ \llbracket sec \rrbracket \ ^2$

Max Torque Req = I*α

Max Torque Req = 0.09145 * 4π
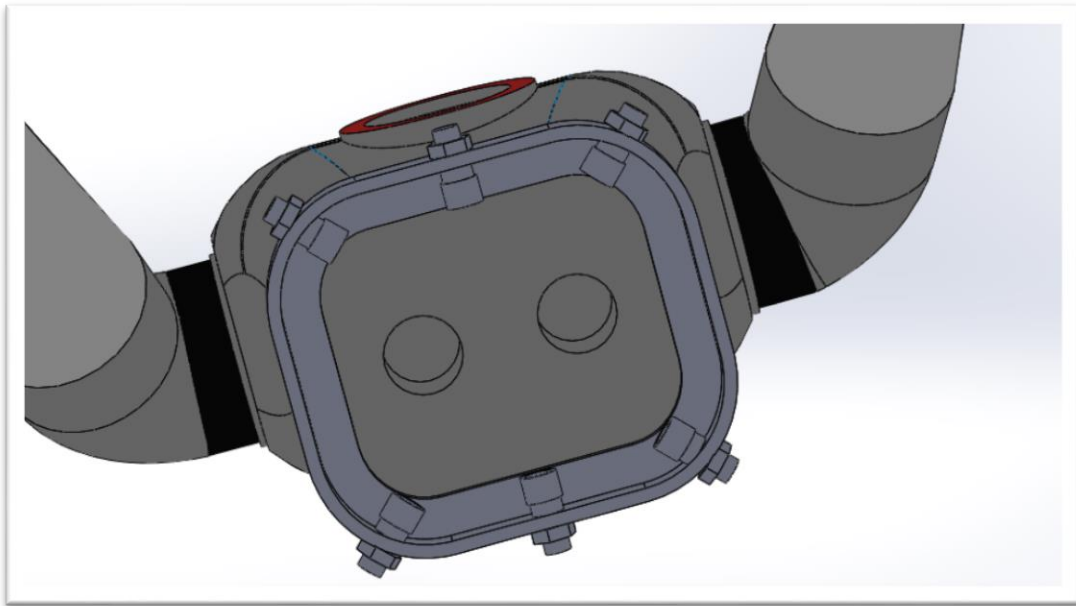
Max Torque Req = 1.15Nm = 11.7Kgcm

Figure 5   Torso Joint

ASSEMBLY, MOTORIZATION AND OPERATIONALIZATION OF THE MANNEQUIN

This chapter focuses on the main specifications of the robotic mannequin design. The specifications state the major features and functions for the design of the robotic mannequin.

In this chapter, the assembly, components, motorization and operationalization of the mannequin are discussed. This chapter covers the variety of processes and assemblage of the mannequin, and it is critical to have a complete understanding of the mannequin assemblage in order to ensure safe and efficient operation.

General Components Used:

The mannequin uses a variety of different high-quality electrical components used for automation and control:

i.   Arduino Mega 2560
ii.   Power supply 12 V
iii.   Five servo motors.
iv.   Motion sensor
v.   Voice sensor
vi.   Speaker
vii.   Amplifiers, resistors, wires etc. for circuitry purpose

The architecture of the mannequin may be divided into two parts, namely (i) design and development and (ii) smart control and automation. Design and development include assembly and motorization of the mannequin; whereas smart control and automation includes sensors integration and motion control.

Design and Development:

Mechanically, the basic aim was to develop a modular and detachable mechanism that can be easily fitted and detached with minimum machining in case you want to change a specific part or install a motor in a different or static mannequin. For our left shoulder joint we developed a detachable mechanism. Now in order to determine what motor torque rating is needed we calculated the maximum torque that will be required. We also took into account the friction factor between the clothes and the mannequin body. The required research was carried out, although I couldn't find the frictional properties between fiber glass and different fabrics but I did find a paper in MDPI (Molecular Diversity Preservation International) journal[28] about friction of human skin against different fabrics and since human body contain hair, it produces more friction than fiber glass. So, we can consider that factor in order to calculate the max torque required.

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28 Vilhena, L., & Ramalho, A. (2016). Friction of human skin against different fabrics for medical use. Lubricants, 4(1), 6.

According to that paper the fabric wool produces the highest COF of approx. 0.8 in human body. So, in calculation with normal force we also added the frictional force and the max torque required calculated was 12.3 kgcm. For the case of the torso we attached it to an oversized high-quality servo motor through a roller bearing mechanism in order to ensure smooth movement.

Smart Control and Automation:

The mannequin motors can be motorized via three ways. A user can send the command via GUI to activate the mannequin. Moreover, the mannequin can also be activated with the help of the speech and motion sensor. In order to attain a smooth motorization of the mannequin we used cubic spline function. In simple terms, cubic splines are piecewise-cubic functions allowing smooth movements. The optimal movement of any motorized item like mannequin requires smooth functions, they can be approximated by cubic splines with only a few parameters. Through cubic spline, by varying the time period of the movement we are controlling the speed of the motion which ensures smooth movement.

Breakdown of Child Sized Mannequin Components:

Now we examine in detail a single child-sized mannequin to elaborate its components. First we overview what are the specifications of the mannequin:

Specification:

- Quantity: 1
- Body Material: Fiber Glass
- Weight: 4.5kg
- Height: 3.5ft (42inch)
- Arm Length: 17inch
- Shoulder Distance: 9inch

Components:

Torso Motor - Quantity: 1 - Motor: MG959 Servo Brushed Motor - Torque: 30kg.cm - Operating Voltage: 4.8V – 6V - Weight: 78g	
Shoulder Motors - Quantity: 2 - Motor: RDS3135 Servo Motor - Torque: 35kg.com - Operating Voltage: 6 – 8.4V - Weight: 60g	
Wrist Motors - Quantity: 2 - Motor: Tower Pro SG90 Servo Motor - Torque: 2.2kg.cm - Operating Voltage: 4.8 – 6V - Weight = 13.4g	
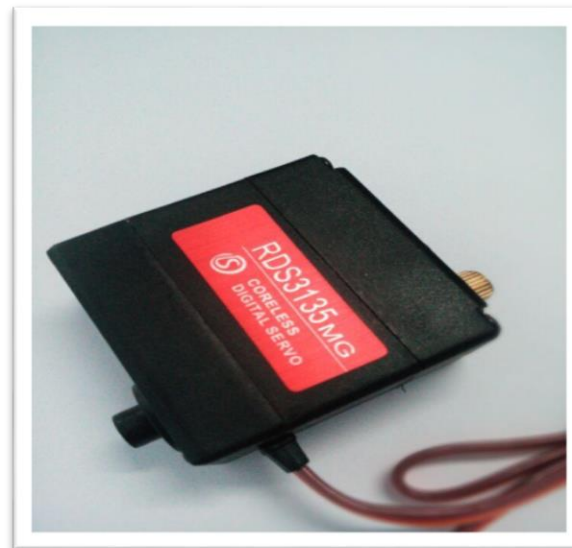
Processor • Quantity: 1 • Processor Used: Arduino Mega 2560 • Microcontroller: ATmega2560 • Operating Voltage: 7 – 12V • Weight: 37g	
Speech Sensor • Quantity: 1 • Sensor: Voice Recognition Module V3 • Operating Voltage: 4.5 – 5.5V • Recognition Accuracy: 99% (under ideal environment) • Support: 7 commands at same time	
Motion Sensor • Quantity: 1 • Sensor: HC-SR501 PIR Motion Sensor • Operating Voltage: 4.8 – 20V • FOV: 120deg • Range: 7m	
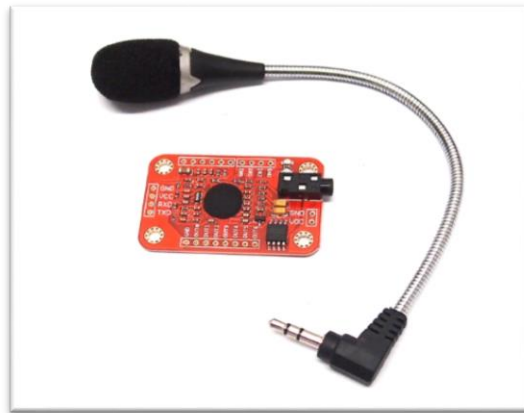
Motorization of the Mannequin:

All the functionalities of I Mannequin is controlled by Atmega 2560 Microcontroller.

I-mannequin is activated in three ways.

i. Graphical User Interface
ii. Speech Sensor.
iii. Motion Sensor.

After activation, the current and desired position of each joints are determined by the processor. The position gap is fed back to the system which then computes the desired speed of the motor to achieve the target position.

Smooth Motion Control Using Cubic Spline:

A cubic spline is a piecewise cubic function that interpolates a set of data points and guarantees smoothness at the data points.

The following pages include an exemplified working for only one dimension of the motorized mannequin. However, it must be pointed out that, this similar function can be applied across the remaining joints angle motions. It is worth pointing out that the motorized mannequin can rotate around the torso, wrists and shoulders. On the other hand, if the degrees of freedom of the system is increased, the similar function can be replicated. Moreover, it is important to point out that the below working is only to provide a reference point or example of our model; whereas it is applied across multiple dimensions of motion. However, the working has only been reflected once to conserve the space and avoid repetition. Hence it must be emphasized that the working of the motorized mannequin is based completely on the below working which is applicable to other dimensions of motion as well.

Working:

$y(x)=ax^3+bx^2+cx+d$

Conditions, where x represents the time:
At x = 0; Initial Angle, $y(0) = 0$
At x = 1; Desired Angle, $y(1) = \pi/2$
At x = 0; Initial Velocity, $y'(0) = 0$
At x = 1; Final Velocity, $y'(1) = 0$

Substituting x = 0, we get:

$$y(0) = d$$

Since y(0) = 0:

$$d = 0$$

Substituting x = 1, we get:

$$y(1) = a + b + c + d$$

Substituting d = 0, we get:

$$y(1) = a + b + c$$

Since y(1) = π/2:

$$a + b + c = \frac{\pi}{2} \qquad \text{(Eq: 1)}$$

For Velocity, differentiating:

$$y'(x) = 3ax^2 + 2bx + c$$

Substituting x = 0, we get:

$$y'(0) = c$$

Since y'(0) = 0:

$$c = 0$$

Substituting x = 1, we get:

$$y'(1) = 3a + 2b + c$$

Substituting c = 0, we get:

$$y'(1) = 3a + 2b$$

Since y'(1) = 0:

$$3a + 2b = 0 \qquad \text{(Eq: 2)}$$

Substituting c = 0 in Eq: 1

$$a + b = \frac{\pi}{2} \qquad \text{(Eq: 3)}$$

Simultaneously solving Eq: 2 and Eq: 3, we get:

$$a = -\pi$$

$$b = \frac{3}{2}\pi$$

Substituting the values of a, b, c and d in position equation, we get:

$$y(x) = -\pi x^3 + \frac{3}{2}\pi x^2$$

Substituting the values of a, b, c and d in velocity equation, we get:

$$y'(x) = -3\pi x^2 + 3\pi x$$

Plotting:

Case 1

Initial Angle = 0 rad

Desired Angle = π/2 rad

Time = 2 sec

```
prev_pos=0;
for x = 0:0.008:2
    y = (-pi*(x/2).^3) + (3/2*pi*(x/2).^2);
    current_pos = y;
    vel = (current_pos - prev_pos)/0.008;
    prev_pos = current_pos;
    subplot(2,1,1);
    plot(x,y,'.');
    xlabel('Time (Sec)');
    ylabel('Joint Angle (rad)');
    title('Position Curve')
    hold on
    subplot(2,1,2);
    plot(x,vel,'.');
    xlabel('Time (Sec)');
    ylabel('Speed (rad/s)');
    hold on
    title('Velocity Curve')
end
```

Position Curve

Velocity Curve

Plotting:

Case 2

Initial Angle = 0 rad

Desired Angle = $\pi/2$ rad

Time = 4 sec

```
prev_pos=0;
for x = 0:0.008:4
    y = (-pi*(x/4).^3) + (3/2*pi*(x/4).^2);
    current_pos = y;
    vel = (current_pos - prev_pos)/0.008;
    prev_pos = current_pos;
    subplot(2,1,1);
    plot(x,y,'.');
    xlabel('Time (Sec)');
    ylabel('Joint Angle (rad)');
    title('Position Curve')
    hold on
```
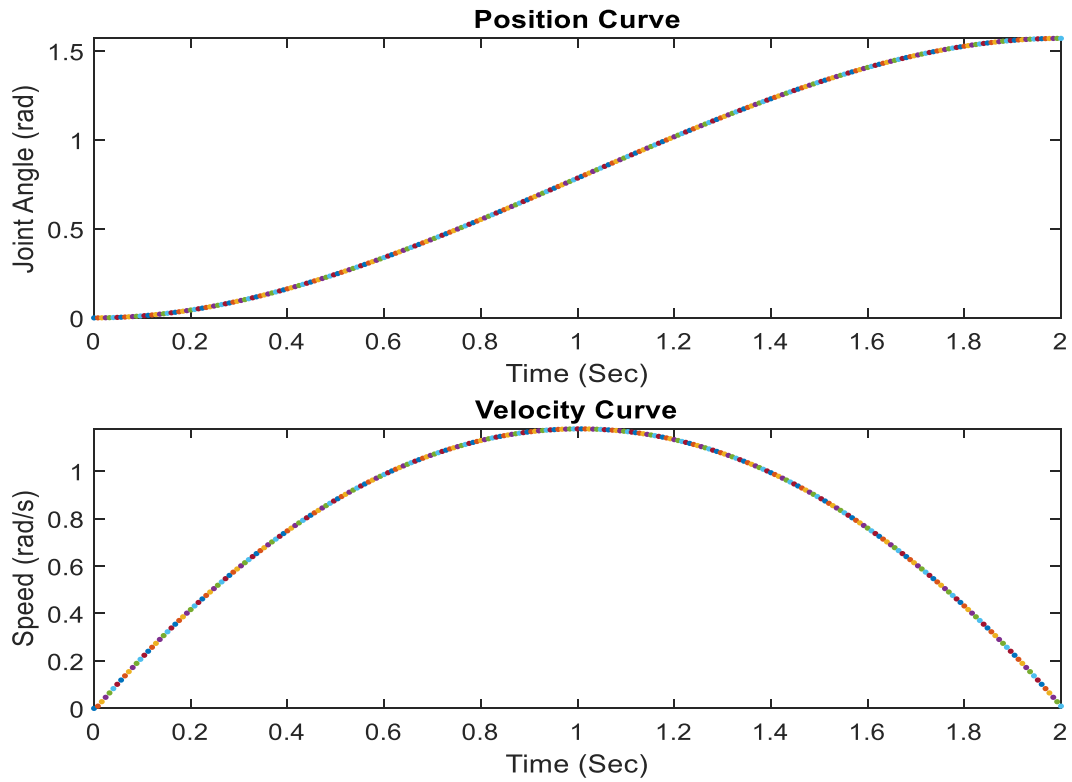
```
    subplot(2,1,2);
    plot(x,vel,'.');
    xlabel('Time (Sec)');
    ylabel('Speed (rad/s)');
    hold on
    title('Velocity Curve')
end
```
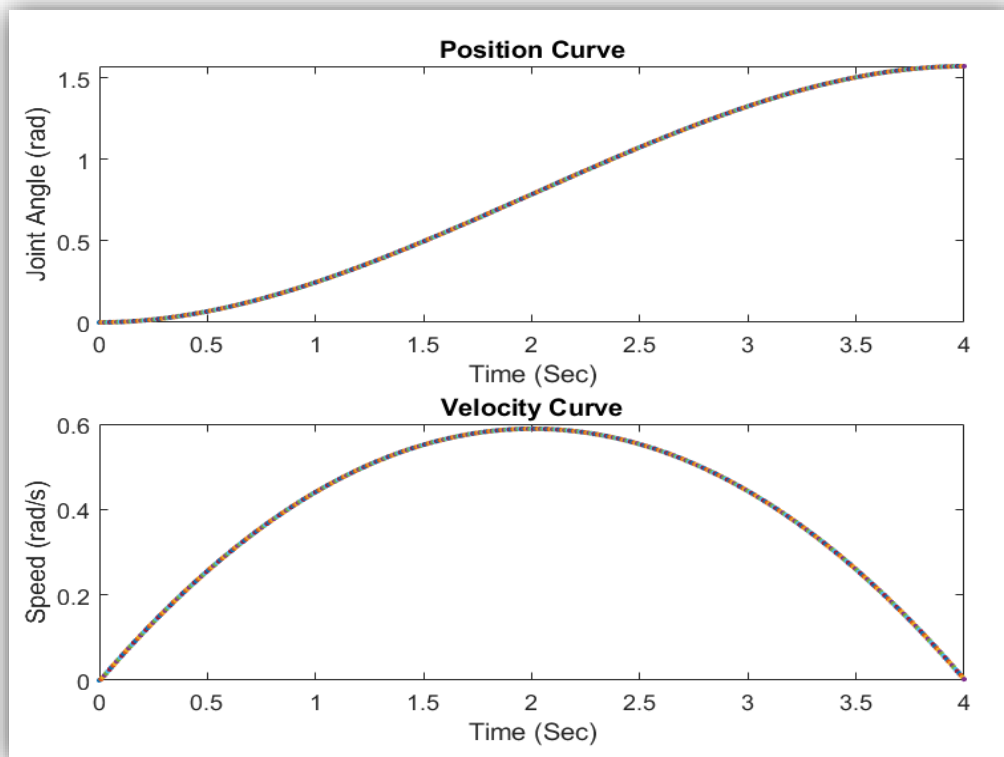

OPERATIONALIZATION (POSES):

The motion of the discussed robot mannequin is controlled by the processor which first determines the current position of each joint and desired motion. The position gap is fed back to the system which then computes the desired speed of the motor to achieve the target position. The robot interacts with the customer via motion sensor and starts its speech module to greet them accordingly. It accepts the questions of the customers and answer them (as programmed). Different gestures of the mannequin can be seen in the following page.

KEY OPERATIONAL FEATURES:

Following are some of the key operational features of the mannequin:

- I- mannequin has five degrees of freedom (but it can be extended more to 8 degrees or even higher)
- It performs different stylish poses within its degrees of freedom to attract customer.
- It has motion sensors to detect customers passing nearby.
- With built in speaker module it greets customer using a customizable message.
- To amuse customer mannequin can play audio file for example any song or music.
- It comes with a voice sensor so that customers can get verbal response to some basic questions, like price, range, etc.

A. Poses:

The mannequin may be programmed for the following poses:

1) Greeting: This interactive mannequin is programmed to greet the customers by welcoming them verbally along with physical human-like waving motion.

2) Style: The mannequin performs a number of stylish poses by using various combinations of the upper body, shoulders, and hands movement. In doing so, the mannequin showcase the clothes and accessories it is wearing.

B. Audio Responsiveness & Visual Merchandising Details:

1) Hi, Hello, Hey: Respond to the aforementioned phrases by proper verbal response saying "Hello and welcome to {Store Name}, how may I help you?"

2) Product details: The mannequin conveys the details of the dress on it such as the material and price of the clothes.

3) Available sizes: The mannequin responds with the information of all available sizes (Small, Medium, and Large) in-store stock.

4) Available colors: The mannequin responds with the information of all the different colors the dress is available for you to buy.

DRESSING AND PREPARING:

A dress form is three dimensional hence, the mannequin can be used to fit the garments with ease. Retailers and shop staff can fit the garment on the mannequin so as to authentically and accurately visualize the appearance as on a body. Easily, the mannequin can be fitted with clothing items of different appeals, for example trousers, shirts, traditional clothing of *kameez shalwar,* dresses, and females suits in a few minutes. Care is taken so the overall surfacing of the mannequin is smooth so any fabric or item is not torn or damaged when putting on or when taking off. The mannequin allows easy movement of the limb's parts for easy dressing and adjustment. Any fashion items must be checked for loose threads, clips, buttons, etc. which may hinder the operation of the mannequin. After the first phase of dressing, the final touches, like accessories, fashionable items like belts, hats, clips, handkerchiefs etc. can also be added in a stylish pose. This will allow the retail stores to demonstrate their product range of accessories which can entice the customers to enter the store. The mannequin can be easily mobilized and placed in the shop window display, near to entrance or checkout area, or within the store in an appropriate location. It is important to take care of the lighting so that the walkers can easily observe the mannequin and its movement from a fair distance. Upon motorization of the mannequin, specialized movements and poses will occur which will demonstrate the style, fall, cut, and quality of the apparel. However, the individuals responsible for preparing the mannequin must ensure that the fitting of the clothes is not very tight otherwise movement for the mannequin will become constricted. It is advisable to have a test run of the mannequin with viewing from all angles to ensure that the intended visualization of clothing and apparel is taking place without any stretches, limitations, or other possibility of damage to the fabric.

SURVEY

In this section, we will discuss the use of survey method to frame the challenging problem. A survey is a simple data collection tool for carrying out survey research. Survey can be used to gather information about the preferences, opinions, and choices of people. This allows surveys to be used for need assessment, market research, demand evaluation, and impact assessments. Survey is widely used on the research to understand perceptions, answer some basic questions, assess needs, determine goals and solutions, etc. There are many advantages of survey, such as it can quantitatively describe specific aspects to frame a problem within various contexts, provide subjective data and authentic information from the population, and mostly the findings can be generalized to the wider communities. Major advantage of surveys is they can be inclusive of all types and number of variables. Moreover, they require minimal investment in development and completion. It is also relatively easy to make generalizations about the concepts.

For our study, we first, created a sampling plan. The sampling plan described the approach to be used in order to assess the publics' views on mannequin's usage in shopping and apparel industry retailers. Verbal surveys were administered as face-to-face interviews allowing exchange of information with the respondents. The face-to-face interviews are particularly flexible tool to capture verbal cues, gestures, and body language. Face-to-face interviews were used as shoppers and retailers are unlikely to respond to written survey for paucity of time and attending to other tasks. Our method suited the audience for reaching the respondents both shoppers and retailers of fashion apparel. In order to eliminate chance of error, survey questions used words consistent with easily understandable conversation so that intended respondents don't have any doubts or discrepancies. Hence the questions were made clear to both the respondent and the researcher. Care was taken to avoid questions that involve double negatives and long questions. Undefined abbreviations, acronyms, and jargon were avoided and tone of survey questions was kept open and congenial to facilitate collection of responses.

The survey combined both open and closed ended questions. Reason for opting open-ended survey questions was to allow respondents to answer in their own words. Open-ended questions allowed to explore shoppers' thoughts and ideas. This allowed to cover broad range of responses that are detailed in the following pages. Closed-ended questions are useful for collecting and analyzing places such as retail stores and apparel shops; response to ideas about window displays, visual merchandising, and mannequin; and preferences about purchasing habits. The closed-ended questions required respondents to choose from given set of responses on a scale of likelihoods. The availability of ordered choices created independent answers from other questions. It was ensured that respondents were given a comprehensive selection of responses and explanations.

In order to measure responses to ideas and proposals, questions asked respondents to compare their own views to the ideas presented in the question statement. For this reason, questions were clear and unambiguous. The researchers were careful to present one idea at a time.

SHOPPER SURVEY:

The survey was conducted in a popular shopping area of Islamabad, called The Centaurus Mall, which is having many fashion stores. 30 individuals were interviewed among them 17 were female respondents and 13 were male respondents. In order to build rapport, the researchers began the survey with some interesting questions, like, "Do you like watching movies?" and "Do you like watching movies related to Robotics & AI?". Once the researchers captured the shoppers' attention the survey was continued with questions that were more specific to the project. Towards the end of the survey, open ended questions regarding shopping experiences were asked which allowed the participants to freely speak their mind and express their opinions about the challenges and issues that mattered to them. The details of the survey and summarized responses are appended below:

Question	Response	Percentage %
Do you like watching movies?	Yes	93.3
Do you like watching movies related to robots and AI?	Yes	73.3
How likely, would you like to see an interactive mannequin welcome you to the store by waving at you?	Very likely	96.7
How likely, would you like to interact/communicate with a mannequin while browsing for a dress?	Very likely	90
How likely, would you like to see a mannequin showcase the dress by performing different poses automatically?	Very likely	93.3
How likely, would you recommend the interactive mannequin to the attire stores?	Very likely	86.7

How likely, would you prefer a store with interactive mannequin than without one?	Very likely	86.7

In the following questions, shoppers were given open-ended option to comment about their shopping experiences. The top/most common comments are reproduced below:

    i. Unorthodox positioning of mannequins makes it harder to reach out for price tags and conduct fabric inspection.

    ii. During sales/holidays, approaching sales representatives for general queries always get tedious which may make customers feel ignored and they leave the store without shopping.

    iii. Traditional visual merchandising technique is turning shopping into a boring activity.

    iv. The whole shopping process requires separate time allocation in a person's schedule.

    v. Comparing to other industries, lack of technology in shopping domain is a point of concern.

    vi. Decrease in footfall is primarily due to lack of new visual merchandising techniques.

QUALITATIVE PERSONA-BASED SURVEY:

We gathered the personas of 3 individuals. While keeping in mind our business idea, we collected the personas of 2 customers and 1 shop manager. The customers are 2 subjects; 1 male and 1 female, belonging to different age group. The question posed by us to the customers was "How do you describe your shopping experience?" and to the shop manager was "How do you think your sale will improve and which factors can improve the customer footfall?"

Persona 1

Subject: Female

Age: 32 years

Occupation: Housewife

She told us that she is a shopaholic, just like all other females according to her. She spends a good amount on keeping her wardrobe up to date. While describing her shopping experience, she told us that lately; her shopping experience has become stressful and boring, well, what she would like to call "Less fun". She highlighted some aspects for improvement. She said the lack of workforce in the shops, especially during "sale-season" increases the stress and frustration. In order to confirm about the required size and queries regarding different colors of a specific dress, the unavailability of sales representative in a specific shop adds to her irritation and frustration. She had an interesting take on mannequins. She thinks that the clothes displayed on the mannequins are usually the best articles of a brand. However, shop management usually does not care about the position of a mannequin and even the price tags are sometime hard to reach. She also thinks the number of mannequins in a shop is also a factor that can be improved. She told us that if the number of mannequins is increased in a shop, that will enhance the number of displayed clothes and will make her shopping experience a little easy. She added at the end that the poses by the mannequins are not

natural and does not give a proper idea of how the dress will look on her. She said the poses and the dynamics of a mannequin should be more human-like.

Persona 2

Subject: Male

Age: 24 years

Occupation: Computer Scientist

He mentioned at the start that we are lucky to find him in a shop as he likes to buy things online usually. He described his shopping experience as an immensely boring process. He added and we quote "I would rather buy things online than coming all the way to a shop to buy something. I find no attraction in coming to a retail shop and spend my valuable time in something that is boring." As he was a technical graduate, he thinks that the field of visual merchandizing is yet to be touched by modern technology and an improvement in this field can yield a lot of positives. He thinks the inclusion of technology in this area will surely get his attention and will make this process more interesting for him.

Persona 3

Subject: Male

Age: 49 years

Occupation: Shop Manager

He is working in this field for nearly 3 decades. He said he started as a general shop boy and made his way up to a managerial post. He described his early times entirely different to what they are now. He said the shopping experience has changed quite a lot understandably. He told us that the change in visual merchandising has always produced positive results no matter what the change was. He stated when the mannequins were introduced, interest of customers increased. The footfall as a result also elevated. He also said that other additions such as the inclusion of the price tags on the dresses and the change in the way clothes are displayed now made things easier for him as a shop manager. He added, the modern way of interior decor of the shops has also helped in upselling. While mentioning his concerns, he explained that the above mentioned visual merchandising ways are now ancient. He thinks that this market requires new innovation in visual merchandising. Customers are getting bored and with the inclusion of online shopping, this way of selling is becoming less attractive.

IDENTIFIED PROBLEMS:

The aforementioned were asked to highlight the problems, in their opinions, of the fashion and apparel industry:

Persona 1

- The unorthodox positioning and sizes of mannequins in the shop makes it harder for the customer to reach for price tag and other purposes such as fabric inspection etc.
- During weekends and sales season, customers' traffic increases and since majority of the shops lack workforce, approaching sales representatives for general queries always get harder.
- Shop owners more often than not assign unnatural poses to the mannequins which makes it harder for customers to visualize how the displayed dress will look on them.
- Due to the traditional and ancient visual merchandizing techniques shopping experience is turning into a boring activity.

Persona 2

- The whole shopping process in itself is a time-consuming activity and requires separate time allocation in a person's schedule.
- In addition to time constraints, shopping is also a boring process.
- As compared to other industries, lack of technology in shopping domain is a point of concern.

Persona 3

- Decrease in upselling factor is primarily due to lack of new visual merchandizing techniques.
- Keeping in mind the lack of workforce, queries by customers are sometimes so naïve that it increases frustration among sales representatives.
- Decrease in average footfall due to the lack of attraction is affecting the overall sales.

According to the comments, the feedback is generally positive and customers and retailers are receptive about the idea of visual merchandising by using motorized mannequin to make interactive displays. For the fashion industry, mannequin can be a useful, cost-effective, and efficient method of visual merchandising, increasing sales, and demonstrating range of products and quality of the apparel.

We can thus conclude that the motorized mannequin can be used in retail stores for attracting customers.

It can actually show the fall, cut, design, color, and layout of the apparel to customers for easier judgement and decision making of purchases. This makes it useful for fashion retailers, apparel shops, garment manufacturers, and boutique stores, etc. Moreover, the mannequin can be varied to show off and display various kinds of garments. Due to its realistic shape and moving parts, the latest fashion design can be used to attract passersby and increase the foot traffic and in turn drive up the sales. Because it requires minimum machining and adjustments, this model can be applied across the spectrum of the traditional static mannequins currently already in use in the fashion market. On the other hand, the movement of the parts

will display the shifting and movement of the fabric which will prove its high quality. By visualizing the look of the clothes, mannequin will help customers choose their best fit even if they cannot try it on immediately, they will be attracted to the retail point. Moreover, care has been taken so that the torque force of the actuators is in a limited range so as not to damage the clothes which are draped over the mannequin.

CONCLUSIONS

This chapter presents a summary of the research project, discuss contribution and limitation of this research and identifies the major implications of the research for both academic and industrial application. In the first section, the discussion revolved around visual merchandising and its visible importance in the fashion industry. In the second portion, we discussed the mechanization and technical aspects of the mannequin. In the third section, the shoppers' survey was discussed and in the next section, the future directions will be briefly outlined.

SUMMARY OF THE RESEARCH:

In a cut-throat business environment, the rapidly changing fashion trends around the world necessitate a strong marketing and outreach component in the apparel market. Both major retail points and small stores must adapt new technology that will allow the consumers shopping experience to be more enjoyable and ergonomic. To escalate the footfall, one of the biggest challenges faced by the apparel market is to develop fresh and effective visual merchandizing techniques. In recent times, one of the most successful and striking tools of visual merchandizing is the use of mannequins as indicated by a growing body of research. However, customers are jaded with the traditional static mannequins. In order to counter this situation, the apparel market must adapt to new technology that will allow the consumers shopping experience to be more enjoyable and convenient. Nowadays, with the great achievements in the fields of computer hardware, control, automation, material, actuator, communication and relative technologies, it has become possible to take this concept one level further.

This research proposes the creation of a mechanized and motorized mannequin that will display multiple moving poses and voice interaction for the visual merchandising function. Using the most effective visual merchandising technique, i.e., the mannequin and infusing it with modern technology will create a dynamic mannequin that autonomously moves and performs various poses. Furthermore, it is equipped with customizable speech and motion sensor features which enables it to interact with customers and inform them about the product details. This study describes in detail the concept of "I-mannequin" which is developed for the fashion industry to promote visual merchandising and escalates the sales of the business. With the change in time and technology, humans' perspective towards their shopping experience is changing and requires more interactivity and visual elements. There is a great need to involve technology in business for growth and having a better buyer-seller relationship. The proposed humanoid mannequin robot requires a low investment in terms of development and maintenance. It has an appealing appearance, interactive, engaging body movements, and it is lightweight (portable) and user-friendly. The initial survey of

introducing the interactive mannequin in stores has gained positive responses from shoppers and store workers alike, but there remains much to be explored in this realm.

CONCEPT:

The main concept behind this project was to merge the commercial aspect with high tech innovation and develop a workable technology-based solution to increase visual merchandising for the local fashion industry.

Currently mannequins are playing an integral part in visual merchandising of fashion items and apparel. They are used by retailers and manufacturers to display the styles, cuts, fabrics, colors, and fit of their clothing. This can complement the clothing stores by providing value such as boosting sales, providing a better shopping experience, attracting shoppers to a particular product and by filling empty spaces.

CORE PROBLEM:

The problem to which we are addressing with the help of this project is currently one of the biggest challenges being faced by the apparel industry and that is to introduce new and fresh visual merchandising technique to boost sales and increase footfall. Although mannequins have always been the most successful tool of visual merchandising in recent times but consumers are bored with the traditional static mannequins. So, in order to keep consumers interested, the apparel industry must adapt to new technology that will allow consumers shopping experience to be more enjoyable and convenient.

FINDINGS OF THE SHOPPERS SURVEY:

In order to validate the problem, a survey of 30 shoppers were conducted the details of which are presented in the relevant chapter. The respondents generally inclined to see a product like motorized mannequin in fashion retail stores. The survey included two questions which were open-ended so that shoppers could respond with their own shopping experiences and the challenges they considered in their experiences.

CONCLUDING REMARKS:

In recent times the most effective visual merchandising technique has been the use of mannequins but the traditional static mannequins are no longer that desirable so infusing it with the modern technology we came up with the motorized mannequin. Briefly, its key features include the motion of 5 degrees of freedom (degrees of freedom can be increased to 8 or more), various poses to attract customers, motion sensor activated voice mechanism for interaction, and speaker which can be used to interact with customer and

answer general queries.

Fashion shoppers prefer to see the dress style, fall and outlook of the fabric, and the way the outfit fits the body for which motorized mannequin is an ideal solution. A motorized mannequin is the ideal addition for a showcase or window display which will allure the customers from far by providing a humanlike motion of the mannequins. It is clear that, shoppers will consider a motorized mannequin as a unique feature and retain the store's memory. They will also enter the store if the products on the mannequin are attractive or in line with their shopping preferences.

COMPETITIVE ADVANTAGE:

So far, there are no motorized or dynamic mannequin manufacturers in the region, rather they only manufacture static mannequins. This gives access to untapped fashion and apparel retail market in the country.

FUTURE DIRECTIONS/RECOMMENDATIONS

The motorized mannequin fulfils the project objectives; however, it is limited by the funding, time, and marketing at a large level. It is only a prototype but it has massive potential to capture the market, especially as this is a niche market with no other competitors in South Asia! Moreover, the low-cost modules adopted into the process make it a worthwhile endeavor considerable of pursuit. A product is ranked as a necessity, on not only by its features but also on its appearance. It is important to realize that while going for a specific look, there is always a trade off in terms of its features.

When we started to make the prototype, we carried out a vast search of the local market, in terms of production. The labor here, in terms of production is cheaper when we compare it to the western world, but to make this product even more economically feasible for the end user, we need to cut down our production cost by outsourcing for manufacturing parts of the product. A potential production source may be China.

In order to further build upon our work, the following recommendations are posited:

1. First of all, the mechanism can be refined further for commercial viability.

2. More body shapes and sizes can be considered to expand the range of the mannequins.

3. The GUI can be improved to include more user friendly and functionalities.

4. A control software on other platform, such as IOS or Android can be developed so the user can use smart phone to control the system.

5. Potential to increase degrees of freedom. Our prototype has 5 degrees of freedom, but they can be increased to 8 degrees of freedom to include movement of head, arms, legs, and torso. With further extensive modifications, degree of freedom can be increased higher than 8 degrees also.

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