Construction of a Female Shape-Changing Robotic Mannequin

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***Abstract*—This paper describes a shape-changing robotic mannequin. It is designed to imitate shapes of different people to be used in online clothes retail and made-to-measure garment industry. We discuss the challenges related to creation of a female robotic mannequin and describe the technical solutions.**

***Index Terms*—Robotic mannequin, Humanoid robot, Shape changing robot, Tailoring**

I. Introduction

The robotic mannequins presented in this paper have been designed to substitute real people during clothes try-on. There are two main applications – made to measure garment industry and online clothes retail.

In made to measure garment industry numerous try-ons are needed in order to ensure proper fitting of clothes. This fact limits a choice of a tailor to the region geographically close to a customer. In countries with higher income, where made to measure tailor services are used more widely, there is a lack of qualified tailors. In countries with lower income, on the opposite, even the most qualified tailors can suffer from the lack of clients. This imbalance can be overcome by using the robotic mannequins, which substitute people during try-ons. This way a tailor does not need to be close to a customer – a 3D scan of a customer needs to be sent to a tailor and the robotic mannequin takes the shape of the client.

The other major application is online clothes retail industry, which suffers from huge return rates. The main reason is that a client has no way of seeing how a given piece of clothing would fit him or her. A high probability of returns reduces trust of a customer towards the whole concept of online clothes retail, further complicating the situation. Usage of the robotic mannequin can provide a customer with the visual feedback required to make a correct choice. In this case no 3D scan is needed – a customer enters his dimensions and the image of the robotic mannequin, taking clients shape is shown with clothes put on to it. This reduces the rate of returns thus lowering the risks for retailers, reducing the cost for clients and assuring people that a correct choice can be made when buying clothes online.

This business model is implemented in a start-up company Fits.me [1]. It currently provides virtual fitting rooms for online retailers using robotic mannequins.

Previously we have concentrated our effort on male mannequins, because they are simplier to design and control. However, women are more active buyers on the internet and even more active when it comes to clothes. For those reasons we have developed also female robotic mannequins.

In our previous papers we have discussed the problem on comparing shape of a client to a shape of a mannequin [2]. Then the problem of adjusting the shape of the mannequin to match the shape of the client was addressed [3]. In this article we present the design concept and the prototype of a female mannequin.

II. Related Work

There are several topics related to robotic mannequins but to the best of our knowledge none addressed a shape-changing mannequin so far.

First of all, the robotic mannequin is a humanoid robot, but the term humanoid robotics usually refers to other kind of problems. Humanoid robots mostly are designed to walk, hold tools or mimick some human-like behaviour [4]. Some humanoid robots express emotions [5]. Our mannequin on the other hand is made to mimick the shapes of different people.

The robotic mannequin seems related to reconfigurable robots [6]. This topic mostly deals with a colony of identical blocks that can interconnect to form complex structures.

The robotic mannequin is also an industrial robot, but industrial robotics mostly focuses on serial manipulators with the emphasis on control.

Finally, robotic mannequins are related to virtual mannequins and virtual try-on fitting rooms [7]-[9]. During the recent years this topic has become popular, and it is widely believed that virtual fitting rooms will be able to substitute real try-ons. This method however has its disadvantages. First of all to make an accurate model of the garment a very specific data on cloth properties

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and cutouts is needed. This data is very hard to obtain for the retailer. The second disadvantage is that computer generated images do not look trustworthy and realistic to the customer. The robotic mannequin is free from those disadvantages.

III. THE COMPARISON OF MALE AND FEMALE MANNEQUINS

Previously we have created a set of 3 male robotic mannequins. It is very hard technologically to create a single mannequin capable of covering 95% of the target group. We cover this range by 3 separate mannequins of different sizes, which simplifies the design of the mannequins. The construction of the male mannequin is shown in Fig. 1 and Fig. 2.

Figure 1. The construction of the male robotic mannequin. The internals of the mannequin can be seen.

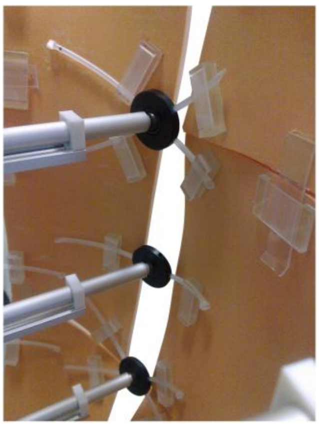

Figure 2. The construction of the male robotic mannequin. The joints connecting actuator to cover pieces can be seen.

The mannequin permits imitating closely parts of the body crucial from the viewpoint of tailoring formal wear. For this reason it allows changing the slope and the width of the shoulders, as well as changing the shape of the lower body. The male mannequins consist of the rigid skeleton, computer controlled actuators, and flexible cover pieces. The cover pieces are connected to each other and to actuators by specially designed joints.

The male mannequin contains about 50 actuators. Some of them are moving parts of the skeleton, e.g. changing width and height of the shoulders. Other actuators move the cover pieces to imitate the shape of soft tissues, e.g. stomach. The sides of the mannequin are controlled independently allowing imitation of asymmetry of a human body.

The construction of a female mannequin is similar. It also has a skeleton, actuators and a cover.

One of the main differences is the new construction of a cover. The cover of the female mannequins is made of two layers. The first layer is composed of circular horizontal rods and determines the shape of the horizontal sections of the mannequin. On top of it the second cover layer is located which defines the shape of the mannequin. It consists of stretchy cloth with vertical thin elastic plates sewed in to it. These two layers slide relative to each other. The cover can be seen in the lower body region of the mannequin shown in Fig. 3.

The female mannequins have a wider movement range, due to specifics of the female body shape. Different dimensions of female body have smaller co-variance than the same dimensions of the male body. Thus a mannequin restricted in one dimension to some range (e.g. waist girth 79-99) still must have relatively wide movement ranges in other dimensions. Therefore, in order to cover 95% of the female shape space by 3 mannequins, each mannequin has a movement range significantly larger than 1/3 of the total range.

Figure 3. The new cover design and the prosthesis used for breasts of a female robotic mannequin.

Finally, one of the most significant differences is the imitation of breasts. Breast region is very important from perspective of target applications and the creation of shape-changing naturally looking breasts is a complex engineering problem. We use simplified approach – for mimicking breasts we use breast prosthesis. They look very natural, but their size cannot be changed. The effect of changing the breast size is achieved by moving the prosthesis in or out of the body. The female mannequin breast construction can be seen in Fig. 3.

Finally a decorative cover is put on to a mannequin. A set of three female mannequins in different shapes is shown in Fig. 4.

Figure 4. Set of three female robotic mannequins. Each row represents one mannequin in different shapes.

The ranges of main dimensions achievable by the mannequins are shown below in Tab. 1. These ranges were selected by analyzing distributions of different measurements of the target client group. It can be seen that, in order to imitate all required measurement combinations, hip girth ranges of different mannequins intersect largely, although waist girth ranges are non-intersecting.

TABLE I. MEASUREMENT RANGES ACHIEVABLE BY FEMALE MANNEQUINS

Mannequin	Bust Girth	Waist Girth	Hip Girth
Small	82-98	63-79	91-106
Medium	94-106	95-119	95-119
Large	102-118	103-119	106-126

IV. SUMMARY

A set of three female mannequins has been created. It covers bust girth range of 82-118 waist girth range of 63-119 and hip girth range of 91-126.

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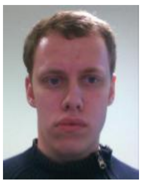

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