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# APPLICATION OF FUZZY LOGIC BASED APPAREL SIZE FINDER IN ONLINE MARKETING

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***Abstract:*** *The emergence of online retailing has been one of the most significant developments in business history. Altough proportion of apparel sales in online retailing also has been shown rapid increase, there are some significant barriers to overcome for expanding this market share. It is seen in literature that there are many researchers point out that finding right size apparel is the one of the most significant problems in online retailing. There are many study to solve this problem but still there is not an exact solution yet. Creating 3D avatars for virtual try on or scanning body measurements of consumers have been used to solved this problem but any study has not come up with a reliable solution. In this study, a fuzzy logic based apparel size finder website is proposed. The benefits and working princible of this website are also explained. In this website, both of consumers and retailers can create a profile page for sharing products or following each other. Once consumers follow a profile of retailer, they can see the right size of any shared apparel. On the other hand, retailers can also directly send message to certain users for certain size apparel. This system brings advantages for both parties. Consumers can reach the correct size of apparel and retailers can reach to target customer. It is assumed that creating website alike this or application of existing online retailers will help to reduce return in apparel online retailing as well as it may help to expand online retailing.*

***Key words:*** *Fuzzyy Logic, Online marketing, Apparel online marketing, Fuzzy relations*

## 1.INTRODUCTION

The emergence of online retailing has been one of the most significant developments in business history. Altough proportion of apparel sales in online retailing also has been shown rapid increase, there are some significant barriers to overcome caused by lack of physical experinece. It is noted in literature that finding right size is one the most significant obstacle for online retailing [1], [2]. Apparel size is directly related with consumer satisfaction and usage rate [3], [4]. Once consumers are not happy with the size of the apparel that bought online, they most likely to return it. On the other word, when consumers return the apparel, it means additional cost and waste of time either suppliers or consumers [5].

There are some studies to find suitable body size for apparel in online marketing. Creating 3D avatars with the body measurements of users or scanning bodies in offline store are some of

these methods [6]. However, these methods may negatively affect the shopping behavior of the people [7]. Besides, some new methods use body size that classically measured by users [8].

Fuzzy logic has been using for many textiles related problems and one of its example was application for choosing right apparel size [9]. In this study fuzzy logic based apparel size finder which is works with classically taken body measurements is applied a website and prospective benefit was evaluated either for users or retailers. In this website, both of consumers and retailers can create a profile page for sharing products or following each other. Once consumers follow a profile of retailer, they can see the right size of any shared apparel. On the other hand, retailers can also directly send message to certain users for certain size apparel. This system brings advantages for both parties. Consumers can reach the correct size of apparel and retailers can reach to target customer.

## 2. FUZZY LOGIC BASED APPAREL SIZE FINDER WEBSITE

### 2.1Finding right size for apparel via fuzzy logic

In this study, each size of a brand is considered as a separate product, and all separate products are numbered as *1, 2, …, p*. As an example, a specific brand *X* (a product) supposed to have different sizes as "Small", "Medium", "Large" and "XLarge". The measurements for these size of brand X are given in Table 1.

***Table** 1: Size Measurements for brand X*

| | **Small** | **Medium** | **Large** | **XLarge** |
|---|---|---|---|---|
| **Collar** | 35-38 | 39-40 | 41-42 | 43-44 |
| **Shoulder** | 38-42 | 43-44 | 45-46 | 47-48 |
| **Chest** | 90-98 | 99-104 | 105-110 | 111-114 |
| **Waist** | 40-46 | 47-52 | 53-54 | 55-56 |

The following rules are considered for constructing suitable fuzzy intervals;

- Measurements that smaller than client's attribute value is **not** suitable for the client's body size.
- Most suitable size for the client is the value of 96.5% of upper value of the related size (counting into account of ease).
- Loose sizes for a client also have some fitness degree, but smaller sizes are considered as NOT suitable for a client.

The fuzzy numbers constructed for sizes "Small", "Medium", "Large" and "XLarge" are in form of triangular fuzzy numbers defined as T (a, b, c), where T denotes one of the sizes of "Small", "Medium", "Large" or "XLarge", *a* is the bottom limit of the all sizes, *b* is the optimum measurement for the handled size and *c* is the upper limit of the related size (see **Fig**. 1). The following figure is an example of membership function used for collar circumference for all sizes in a brand. Functions for shoulder, chest and waist have similar shape but different lower and upper limit and core point values.

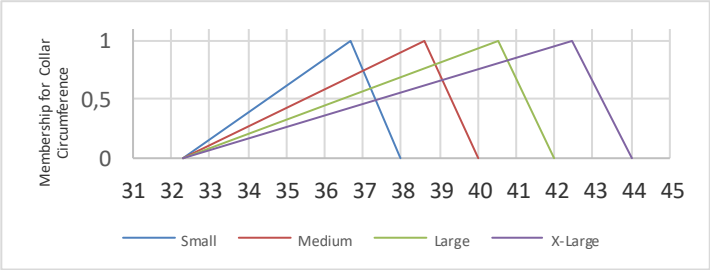



***Fig.** 1: Membership function example for collar circumference*

In the study, a web interface is constructed for the users to enter their body size measurements (weight, length, collar circumference, shoulder width, chest width, waist circumference, arm length). Also, the measurements of shirts of certain brands are kept in a database. In order to find the optimum size of product for a user, a triangular membership value is computed using the measurements of the user and the size measurements of the apparels.

The system calculates all the class membership values using measurement values of the user (collar, shoulder, chest and waist measurements in cm) comparing with all sizes. For all sizes, the minimum membership value is considered. The user is assigned to the size with the maximum membership degree among these minimum membership values.

As an example, suppose that a client *C* has measurements as *C* (collar = 38cm, shoulder = 44cm, chest = 104cm, waist = 94cm). By default, the lower limit of the size is calculated as 85% of the upper limit for convenience. This lower limit value is used as the lower limit for all sizes in related measurement. The most fitting value of the size is assumed 3.5% less than the upper limit. For example the parameters for "Small" size of "Collar" measurement is (32.3, 36.67, 38). The parameter table for "Collar" in "Small" size is shown in Table 2.

***Table** 2: Parameters for "Small" size in "Collar" attribute*

| Size (Collar) | a | b | c |
|---|---|---|---|
| Small | 32.3 | 36.67 | 38 |
| Medium | 32.3 | 38.6 | 40 |
| Large | 32.3 | 40.53 | 42 |
| X-Large | 32.3 | 42.46 | 44 |

With triangular membership for "Small" size with parameters (32.3, 36.67, 38), we get $\mu_{Small,Collar}(38)=0$.

$$\mu_{Small,Collar}(x)=\begin{cases}\frac{x-32.3}{36.67-32.3}, & 32.3<x\leq 36.67,\\ \frac{38-x}{38-36.67}, & 36.67<x\leq 38,\\ 0, & otherwise.\end{cases} \quad \textbf{(1)}$$

If the membership of this client to "Medium" size class is calculated, the parameters (32.3, 38.6, 40) is used. For medium size of client *C*, we get $\mu_{Medium,Collar}(38)=0{,}905$.

$$\mu_{Medium,Collar}(x)=\begin{cases}\frac{x-32.3}{38.6-32.3}, & 32.3<x\leq 38.6,\\ \frac{40-x}{40-38.6}, & 38.6<x\leq 40,\\ 0, & otherwise.\end{cases} \quad \textbf{(2)}$$

In the same way, values for "Large" and "XLarge" ( $\mu_{Large,Collar}(38)$ and $\mu_{XLarge,Collar}(38)$ ) are also calculated. This operation is applied for the other attributes of the user. The degree of fitness for this client *C* to size class "Small" is computed as:

$$\mu_{C,Small} = min\{\mu_{Small,Collar}(38), \mu_{Small,Shoulder}(44), \mu_{Small,Chest}(104), \mu_{Small,Waist}(94). \quad \textbf{(3)}$$

After computing class membership values for each product (i.e. “Small”, “Medium”, “Large”, “XLarge”) for client *C*, the product (size) with the highest membership value is assigned as the most suitable product (size) for the client. In other words, size that provides

$$max\{\mu_{C,Small}, \mu_{C,Medium}, \mu_{C,Large}, \mu_{C,XLarge}\}, \quad \textbf{(4)}$$

is the best fitting size for the users within the given parameters.

Table 3 shows an example classification for a user. The user is said to be best fitted in "Large" size of this brand.

***Table** 3:Membership values for a user*

| Measurement | Small | Medium | Large | X-Large |
|---|---|---|---|---|
| Collar (38 cm) | 0,00 | 0,42 | 0,32 | 0,26 |
| Shoulder (44 cm) | 0,00 | 0,00 | 0,55 | 0,45 |
| Chest (104 cm) | 0,00 | 0,00 | 0,55 | 0,45 |
| Waist (94 cm) | 0,00 | 0,39 | 0,33 | 0,29 |
| Member to | 0,00 | 0,00 | **0,32** | 0,26 |

### 2.2 Website implementation

In website implementation of this system, each user or retailer can create a personal profile page using with basic informations of body or apparel measurements. While creating account, guiding picture also appears for measuring correctly the right size of body part (**Fig**. 2). It is a key point that, for getting size suggestion, users body measurements and given apparel measurements have to be matched.

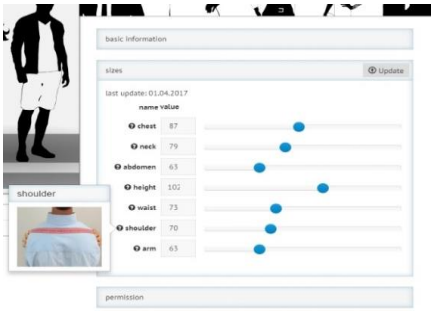



***Fig. 2:** Creating user profile*

Once users start to follow desired retailers, they are able to see best fitted size suggestion on the bottom of the any product that shared by retailers (**Fig**. 3).


***Fig. 3**: Size suggestion*

On the other hand, retailes can classified users based on their body size or degree of fitness for each product. By this way, each retailer able to reach target consumer. The amount of classified users is also reported to retailer (Fig. 4).

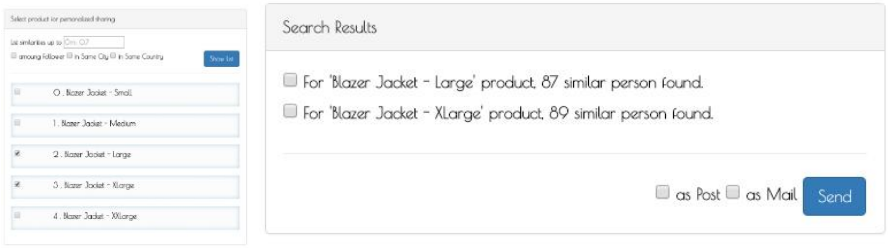
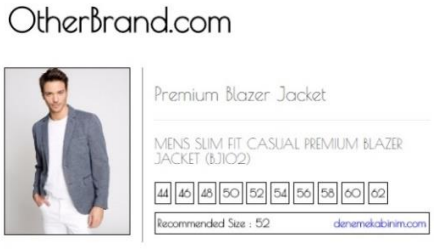



***Fig. 4:** User classiffication for retailers based on body size*

The other method of using fuzzy logic based apparel size finder system, existing online retailers can adapt this system into their website with javascript. If any online retailers share measures of apparel with designed fuzzy based system, registered users can reach right size via this system (Fig. 5).


***a.***

***Fig. 5: a.** Webpage screen of other retailes before fuzzy system implementation.*




***b.***

***Fig. 5: a. b.** Webpage screen of other retailes after fuzzy system implementation*

## 3. CONCLUSIONS

In the previous part of this study, working princible of fuzzy based apparel size finder was showed. In this part of study, implementation of this system in a website or adaptation of existing retailer's website were showed. There are two basic circumstances for success of this system. First, the success of this system is directly related with right body measurements. Therefore, while users

create profile with their body size, each mesuremenets illustrates with pictures that explain how and which part to measure. Second, retailers share their products with measurements of exact part. End of these two crticial steps we are able to store measurements of bodies and apparels.

There are also two important ways to use this system for either users or retailers. First, users can reach the right size of desired apparel. Second, retailers classified users based on their body measurement or degree of fitness.

The most significant benefit of this system is helping to choose right size to overcome the biggest barrier in apparel online retailing. It is assumed that this system will help to expand market share of apparel online retailing. When consumers are satisfied with the size of purchased apparels, it will help to decrease amount of return products. By this way, extra costs for users and retailers will also be prevented.

This system can also be used for strategic marketing. With this system, retailers are allowed to classified users based on their body size or the rate of fitness for any product. By this way, retailers are able to reach target consumer and it may help to increase rate of purchase.

## ACKNOWLEDGEMENT

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- All above mentioned features will be published at *www.denemekabinim.com* .

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