INTERACTIVE MIRROR RECOGNITION SYSTEM IN SHOPPING MALLS BASED PATTERN RECOGNITION AND BACK PROPAGATION

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ABSTRACT:

In this paper, we present a theoretical framing of the functions of a mirror by breaking the synchrony between the state of a reference object and its reflection. This framing has problems when it displays an image on mirror. These problems are technical problems and illustrate the technical challenges in two different forms of electronic mirror systems for apparel shopping. The first example, the responsive mirror, is an intelligent video capture and access system for clothes shopping in physical stores that provides personalized asynchronous reflections of clothing items through an implicitly controlled human-computer interface. The responsive mirror employs computer vision and neural network techniques such as Back propagation algorithm to correct the errors and show the interpret the visual cues of the customer’s behavior from cameras to then display two different reflections of the customer on digital displays: 1) the customer in previously worn clothing with matching pose and orientation. So there is a problem of error occurring in matching of samples inside the database. To optimize or solve the error we are using back propagation algorithm. 2) For searching the sample pattern of clothes in the database. We are using hash function to increase the search speed of identification dimensions and match the clothes according to that dimensions. In countertop responsive mirror that differs from the first in images do not respond to the real time movement of the customer but to frames in a recorded video so that motion of the customer in the different recordings are matched and searched in the database non sequentially. These instantiations of the mirror systems in fitting room and jewelry shopping scenarios are described, focusing on the system architecture and the intelligent computer vision components. The paper contributes a conceptualization of reflection, error correcting and searching the samples in the database through back propagation algorithm and hash function algorithm.

Key Words: Intelligent user interface, responsive mirror, pattern recognition, computer vision, back propagation, hash function.

1. INTRODUCTION:

Mirrors, physical objects that perform specula reflection of light (or other waves), are used for a variety of purposes: telescopes, lasers, cameras and perhaps most obviously for seeing oneself. There are a number of reasons one may desire to one self including grooming, personal health, athletic training, or shopping for apparel (clothing, jewelry, hats, sunglasses and other accessories). In all of these situations, the mirror (or “looking glass”) is acting as an information appliance, providing information to the observer of what they look like to others. Generally, we use our reflections to check that the image matches our expectation of appearance or to make a choice among options. For example, a common practice when apparel shopping in a physical store is to search the inventory for items of interest, select a few for comparisons and try them on in front of a mirror to decide which, if any, to purchase. The customer evaluates the items according to how well they fit, physically, and also how well they fit the image of herself that she wants others to perceive. That is the customer not only checks whether a garment fits her body, but also whether it fits her style. To improve the quality of interactive mirror recognition our research objective is twofold: 1) the image recognizing and their matching samples (sunglasses, clothes, jewelry, and other accessories) is to done without any error. 2) Second research work focuses on matching the samples to image body dimensions with fast and speed functions in database. We proposed a scheme, named interactive mirror recognition system, which
improves the quality of recognizing and searching for images and samples without any extra delay and errors. The general concept behind our scheme is to satisfy the customer and shop seller with good service providing for them without any extra delays and errors. Our scheme allows the customer with all samples on the responsive mirror. Consequently when the customer standing in front of the mirror the customer dimensions or measures of the body has been taken by responsive mirror by using the cameras, waves and then this measures or dimensions should match in the database samples dimensions such as sunglasses, jewelry, clothes etc. matching should be done in less time. So that without any extra delay. The rest of this paper is organized as follows. In section 2, we provide the back ground information of interactive mirror recognition system and neural networks. Motivated and related works are presented in section 3. The proposed scheme is presented in section 4. The analysis of the proposed scheme is placed in section 5.

2. BACK GROUND ANALYSIS:

The interactive mirror comprises of a dielectric coated mirror mounted over a LCD display, a camera for capturing the customer image, load sensors for measuring customers weight, waves, radio frequency identification (RFID) reader and RFID tags for identifying the garment worn by the customer. The mirror gets the inputs from all these sensors, processes it and provides output by displaying video output.

INTERACTIVE MIRROR = MIRROR + SENSORS + DATABASE + NEURAL NETWORKS + DISPLAY

Neural networks are a learning network which it contains back propagation and mostly the neural networks are used for recognition tasks. It is made up of artificial neurons with inputs and synaptic weights and interconnection of networks. Simple we can call as artificial brain. The back propagation algorithm has the neurons, hidden layers and changing the weights and inputs. Hash function is used for searching the position of the location in the database.

3. MOTIVATIONS AND RELATED WORKS:

Interactive mirror recognition system uses back propagation algorithm in neural networks for correcting the errors to provide the quality of service for customers and sellers. When image is captured by responsive mirror with the help of cameras and same image should be display on the mirror. Due to the quality of applications, it is very difficult for the responsive mirror to recognize the image and reflect same on the mirror. It is possible that the images have recognized by interactive mirror (or) responsive mirror has been checking for errors and correct the errors through back propagation technique which the inputs and weights are back propagate in the network. This improves the quality of interactive mirror recognition system. Moreover since the samples (clothes, sunglasses, jewelry) should match the body dimensions given by the responsive mirror image in less time in the database. Here for implementing the searching technique we are using hash function. Many research works related to interactive mirror recognition system improvement have been proposed in the literature. In [1] the task is proposed is the shopper in previously worn clothing with matching pose and orientation and other people in similar and dissimilar shirts with matching and orientation. In [2] the paper is proposed a the mirror aims at recognizing the user based on image processing techniques and provides personalized services like emotion recognition, health progress representation. Event remainder and mirror usage time. In [4] the paper is proposed some preliminary results of our ongoing project on digital mirror interfaces. Here it describes the works on both ends, image processing from the camera and image output to computer screen. In [5] they proposed the development of an innovating appliance that incorporates interactive services of leisure and information, offered through a high quality user interface on the surface of a mirror. In [6] they proposed the necessity of biometric
systems for network data and information security. In [7] they proposed the face is detected using the
viola and Jones techniques and simple architecture for human facial expression recognition

4. PROPOSED SCHEME:

The objectives of our research are twofold: 1) The image recognizing and their matching samples
(sunglasses, clothes, jewelry, other accessories) is to done without any error. 2) our research work
focuses on matching the samples to image body with less time in database. To achieve these
objectives, our scheme named efficient interactive mirror image recognition systems is proposed. The
main idea of the proposed scheme is to optimize and correct errors in the database through the back
propagation algorithm. The system has the ability to detect and correct errors where image is
recognized by the interactive mirror using cameras here in this paper using back propagation algorithm
for checking and correcting the errors and hash function for using searching and matching the samples
in the database with given input. Image recognition has been done in the past using image pixels to
train a neural network via back propagation. A typical ANN has N inputs and one or more output as
shown in fig.1. The input layer is composed not of full neurons, but rather consists simply of the
values in a data record, that constitutes inputs to the next layer of neurons. The next layer is called a
hidden layer and there may be several hidden layers. The final layer is the output layer, where there is
one node for each class. A single sweep forward through the network results in the assignment of a
value to each output node and the record is assigned to whichever class node had the highest value.
These actual pixels are fed into the networks as the inputs. This approach works great when trying to
recognize textures or objects with fixed orientation and scale. However at different scale and
orientation, it does not give encouraging results. Therefore tokens of an image used during training the
network are trained to associate outputs with input patterns. When the network is trained, it identifies
the input patterns and tries to the output the associated output pattern. In order to train a neural
network to perform some task, we must adjust the weights of each unit in such a way that the error
between the derived output and actual output is reduced. This process requires that the neural network
to compute the error derivative of the weights (EW). In other words, it must calculate how the error
changes as each weight is increased or decreased slightly

![Backpropagation Network Architecture](image-url)
The back propagation algorithm is the mostly widely used method for determining the EW. In this Interactive mirror technology if any error found. While matching the patterns of the sample in the database. So to update and correcting the errors of matching patterns by changing the weights for given same inputs. For performing this method we are implementing the back propagation algorithm. This algorithm will back propagate in the layers of the network by adjusting the weights to the inputs. The primary objective of this paper finding the error and solve it with back propagation algorithms. When error found the error propagation will perform such as

\[
E = \frac{1}{2} \text{Err} = \frac{1}{2} (y-h_w(x))^2 = \frac{1}{2} (y-a_i)
\]  

In equation (1) \( y \) is a true output which it comes on the responsive mirror; \( h_w(x) \) is a function which it calculates the total input functions. \( (y-a_i) \) is a bias function for true output minus bias value we will find an error.

\[
\frac{\partial E}{\partial w_j} = \frac{1}{2} \frac{\partial}{\partial w_j} (\text{Err}^2) = \text{Err} \frac{\partial}{\partial w_j} \text{Err} = \text{Err} \frac{\partial}{\partial w_j} (y-a_i) = \text{Err} \frac{\partial}{\partial w_j} g(\sum_j w_j x_j)
\]

In equation (2) where we have the error has to change in the weight. We have the found the error in responsive mirror in shopping malls when it reflects the same image with errors. If any error has occurred this equation is going to find when reflecting image matching is going on with actual image. \( \frac{\partial E}{\partial W_j} \) are used as change in Error E and change in weight \( W_j \). Where \( g(\text{in}) \) used in equation is \( g(\sum_j W_{ji} \text{I}) \) by above equation we have found the error. now updating of weights will start below equations. Such that correct the errors with new updating weights. Then exact mirror image is going to display without any errors.

\[
W_j = W_j + \alpha \times \text{Err} \times g(\text{in}) \times X_j \\
\text{Where } \Delta_j = \text{Err} \times g(\text{in}) \times X_j
\]

In equation (3) using gradient descent to update the weights. \( \alpha \) is used as learning rate parameter. If we are computing with value \( W_j \) the error will come closer to \( y \). this algorithm will work on single layer learning algorithm. For multilayer learning algorithm

\[
\Delta_j = g(\text{in}_j) \sum_i W_{ji} \Delta_i \\
W_{k,j} = W_{k,j} + \alpha \times a_k \times \Delta_j
\]

We compute the errors in this equations for multi-layer learning algorithm.

\[
\Delta_j = g(\text{in}_j) \sum_i W_{ji} \Delta_i \\
W_{k,j} = W_{k,j} + \alpha \times a_k \times \Delta_j
\]  

Here we are using back propagation for \( \Delta_j \) and \( \Delta_j \) different layers of the neurons. Derivation of the equation (4):

\[
\frac{\partial E}{\partial W_{k,j}} = -\sum_i (y_i - a_i) \frac{\partial a_i}{\partial W_{k,j}} = -\sum_i (y_i - a_i) \frac{\partial g(\text{in}_j)}{\partial W_{k,j}}
\]
In equation (5) is a updating rule for layers. These equations are going to update the weights for given number of inputs and with hidden layers.

Algorithm:
Step 1: apply the input example to the input units
Step 2: calculate the net input values to the hidden layer units
Step 3: calculate the outputs from the hidden layer
Step 4: calculate the net input values to the output layer units
Step 5: calculate the outputs from the output units.
Step 6: calculate the error term for the output units but replace new $W_i$ with $W_j$ (in all equations).
Step 7: calculate the error term for the output units, using New $W_k$ also.
Step 8: update weights on the output layer
Step 9: update weights on the hidden layer
Step 10: repeat steps from step 1 to step 9 until the error ($y_a$) is acceptable small for each training vector pairs.

In this network, here set of samples patterns (clothes, sunglasses, jewelry…) are captured as training set in the files. Once the body dimensions are captured it automatically monitors the exact samples patterns to match these in the database. Actually the database stored files are having large bulk of training data samples. So we are using pattern matching. The pixel value equivalent of the sample patterns and these files are stored. Pattern matching is carried out to find out the convergence will of the body dimensions. Maximum convergence will occur for a non-pattern matching algorithm. In pattern matching the trained data is stored in form of pattern samples. So this paper we propose body dimensions to preprocess the input string. So we are taking six basic patterns of body dimensions such as neck, sleeves, and eye, length of pant and shirt, chest, collar. Suppose we are trying to find a pattern string ‘p’ in a long document D, hash the pattern ‘p’ into a say a 16 bit value. Now run through the file, hashing each set of P consecutive characters into a 16 bit value. If we ever get a match for a pattern, we can check to see if it corresponds an actual pattern match (in the case we want to double check and not report any false matches). Otherwise we can just move on. We can use more than 16bits, too; we would like to use enough bits so, that we will obtain few false matches. This scheme is efficient as long as hashing is efficient. Of course hashing can be very expensive operation, so in order for this approach to work, we need to be able to hash quickly on average. In fact a simple hashing technique allows us to do so in constant time for operation. The easiest way to picture the process is to think of the file as sequence of digits and the pattern as a number dimensions. Then we move a pointer in the file one character at a time, seeing if the next P digits give us a number equal to the number dimensions corresponding to the samples pattern. Each time we read a character in the file, the number we are looking at changes is a natural way; the left most digit ‘a’ removed and the new right most bit ‘b’ is inserted. Hence, we update an old number ‘N’ and obtain a new number N

By computing

$$|N| = 10.(N-10^{p-1}.a)+b$$

When dealing with a string, we will be reading characters instead of numbers. Also, we will not want to keep the whole pattern as a number. If the pattern is large then the corresponding number may be
too large to do effective comparison. Instead, we hash all the numbers down into say 16 bits, by reducing they modulo some appropriate time $P$. we then do all the mathematics (multiplications, addition) $P$

$$|N| = [10.(N-10^{p-1}.a)+b]mod p$$

All operations mod $p$ can be made quite efficient, so each new hash value takes only constant time to compute. The idea is that the hash of the pattern creates an almost unique identifier of the pattern like a body dimensions. If we ever find body dimensions and samples dimensions that match, we have a good reason to expect that they must come in the same pattern. We will need to check for false matches, but since false matches should be rare, the algorithm is very efficient. A natural approach is to choose the prime $P$ randomly. This way no body can set up a bad pattern and document in advance, since they are not sure what prime we will choose.

$P=179358$
$p=1011$
$P mod p=114$
$32422232161720$...........
$324222 mod p=702$
$242223 mod p=239$
$422232 mod p=645$
$222321 mod p=912$
$223216 mod p=896$

This pattern $p$ is a six digit number. Note successive calculations take constant time. 242223 $p$ =$(324222 \mod p)-(300000 \mod p)$. $10+7 \mod p$. also note that a false matches are possible(but unlikely):$161720=179358 \mod p$. 

![Fig 1](image1.jpg)

![Fig 2](image2.jpg)
Fig 1, 2, 3 are the Interactive mirror prototype

**Interactive Mirror**

- **Sensors**
  - **Display**
  - **Database**
- **Intelligence**
  - **Mirror**
  - **Neural network**
    - **Back propagation**
    - **Pattern Recognition**
      - **Hash function**

**Features**

<table>
<thead>
<tr>
<th>Features</th>
<th>Dress matching</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Recognition</td>
<td>Sun glasses matching</td>
</tr>
<tr>
<td></td>
<td>Jewelry matching</td>
</tr>
<tr>
<td></td>
<td>Shoes matching</td>
</tr>
</tbody>
</table>

Fig 4: Services of Interactive Mirror Recognition system
5. ANALYSIS:

The complexity of the pattern in the shirts, pants was also indicated as valuable for clothes recognition. We took an example a color full shirt with shades usually considered less suitable for a formal event than a solid colored one. So we were trying to recognize three pattern classes: 1) solid: shirts which are plain in color and texture, no large area patterns; 2) patterned: shirts that are either colorful or patterned. For example, the block patterned shirts. 3) patterned: pants that are either short or large or patterned. For example, the short length patterned pants. The pattern complexity recognition algorithm achieved 89.9% accuracy on our samples dataset.

<table>
<thead>
<tr>
<th>TABLE 1:</th>
<th>CLASSIFIED AS</th>
<th>T-SHIRT(COLLAR)</th>
<th>T-SHIRT(ROUND COLLAR)</th>
<th>BUSINESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-SHIRT</td>
<td>96.2%</td>
<td>94.3%</td>
<td>3.9%</td>
<td></td>
</tr>
<tr>
<td>BUSINESS</td>
<td>5%</td>
<td>3.2%</td>
<td>95%</td>
<td></td>
</tr>
</tbody>
</table>

**overall accuracy:** 94.8%

<table>
<thead>
<tr>
<th>TABLE 2:</th>
<th>CLASSIFIED AS</th>
<th>SHIRTS(T-SHIRTS AND B-SHIRTS)</th>
<th>CASUAL</th>
<th>BUSINESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-SHIRT</td>
<td>75.8%</td>
<td>15.5%</td>
<td>0.1%</td>
<td></td>
</tr>
<tr>
<td>B-SHIRT</td>
<td>19.2%</td>
<td>10.5%</td>
<td>33.3%</td>
<td></td>
</tr>
</tbody>
</table>

**overall accuracy:** 74.8%

In table 2 we classified as four classes of patterns T-shirt, B-shirt. To find the pattern recognition task we have implemented Bayes classifiers divided into four classes such as in discriminant analysis.

<table>
<thead>
<tr>
<th>TABLE 3:</th>
<th>CLASSIFIED AS</th>
<th>PANTS(SHORT AND LONG PANTS)</th>
<th>CASUAL</th>
<th>JEANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-PANT</td>
<td>14.2%</td>
<td>17.2%</td>
<td>27.4%</td>
<td></td>
</tr>
<tr>
<td>S-PANT</td>
<td>15.4%</td>
<td>22.3%</td>
<td>29.2%</td>
<td></td>
</tr>
</tbody>
</table>

**overall accuracy:** 81.7%

In table 3 is classified as two classes of patterns long pant, short pant. To find the pattern recognition task we have implemented Bayes classifiers technique divided into two classes such as in discriminant analysis.

6. CONCLUSION:

It is very challenging task for interactive mirror to recognizing the image and match the samples patterns then display on mirror precisely. Although the existing system recognizes the images using interactive mirror not that much accurate and fast searches. Our research does focuses on proposed efficient interactive mirror recognition system in shopping malls based pattern recognition and Back propagation neural networks to recognize the images with interactive mirror and reflect same image on
mirror without any error. Then after recognizing search the body dimensions samples (sunglasses, clothes, jewelry…) in the database in fastest way. This will improves the quality of service given by system. For checking the error and correcting it will use back propagation technique and for matching the patterns of the samples pattern recognition is used. For searching in the database hash function is used for fast searching and finding the location in the database. But it is difficult task to implement because in all countries we are not using interactive mirrors in shopping malls and it is costliest method to implement in the business. A lot of maintenance is required. Every time update the database with new sample patterns.

7. REFERENCES:
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