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A New Approach for Detection by Movement of Lips Base on Image Processing and Fuzzy Decision

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Abstract: Finding movements of lip for distinction of numbers are one of the functions of image processing and for achieving to this purpose. First, the input image was received by camera and it's being developed for it's processing by applying some filters and by using of gray criterion and measure that is on the base of green spectrum and then segmentation of pieces is being carried out on the image bye a compound segmentation algorithm with a set of special filters and in the next stage performs for distinction of lip's movements from each other on the film according to these ways that first, the related frame to primary state and then the related frame to second state is computed and according to these two frames on the basis of criterions of the lip's width, average of top and down angle of lip, linguistic variables and fuzzy sets and fuzzy rules is determined for finding lip's movement. At last, the obtained result is being analyzed by a defuzzified method.

Key words: Image processing . fuzzy rules . decision

INTRODUCTION

One of the images processing function is about human images processing for different purpose. That one of them is, finding the orders by movement of lip by the processing sequential frames that use from human's face for compound understanding by lip's movement on the basis of image processing and speech recognition. This article that is about understanding by movement of lip or finding the orders on the basis of lip movement has done just by processing on the image [1]. Whearas analysis's carried out only on the basis of image processing and isn't dependent on speech processing. It should be considered a set of rules and arrangements about pronouncing of words on the basis of these considerable rules and linguistic variables that could get distinction between words for different people.

Study on doing works about lip's detection: Derivation of lip on the basis of some lip's aspects: an algorithm was explained in it for segmentation pronounced lip and derivation of aspects. The continuation of color-pronounced images that is precived under conditions of natural light and without any special means [2].

Use of one parameter model for segmentation of lips the goal is, applying a exact and useful algorithm for segmentation of lip. First, the place of mouth and several distinctive places with use of "Hybrid edges" that is, a compound of color and light qualifications (marks). And early knowledge about shape of lip is definite [3]. Then, comparing of exist models are resulted to considerable attention.By attention to done acts in this field and preceding obtained results, these algorithms have not suitable usage for finding the orders for different people and also are very dependent an the sound [4]. In this article, we used image segmentation methods in compound method and a new method on the basis of fuzzy decision for developing effect of this structure. The structure of this article gives in the following: The second part is about finding sides (borders) of lip according to our suggestive algorithm. And the third part is about selecting suitable frames from the input film and the forth part is about using fuzzy decision and the fifth part is about testing on eleven cases and analyzing the results and final part is about appreciating and respecting [5].

In this article, for number of processings is large and is done in many stages on the image and also using a natural personal computer, had decided that first, take a photo RGB image on the form of input and after improving image and using of the gray measurement algorithm on the basis of green spectrum, that image is being turned into image in gray measurement. At last, gray measurement image changed to desired binary image and final processing carry out on binary image [6].

In this article, for solving problems of small spots on the face such as beard that yet completely not grow,

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mother's stain,… used from the special filters that could eliminate these small spots. The method of this filter's operation is in this manner that in segmentation image, the pieces which have several pixels, eliminates through some stages of image. It's operation is according to the Fig. 1 in the next.

Finding sides of lip and organizing from of approximate lip: The edge detection on the basis of tests that has performed with the algorithms on the image, we can result that the edge detection algorithms isn't the suitable ones for determining the lip's boundaries in comparision with the face. The main problem of these algorithms is their more sensitiveness to noise in input image that even is known smallest input noises as the edges and deciding would be difficult. So they've decided that uses from segmentation algorithms and filtering without the use of edge detection algorithms.

In this article, from compounding segmentation algorithms, watershed and morphology and some special filters has used for this separating. The stages of said algorithms is located in the following

Watershed segmentation: This segmentation is base on concepts like: improving watershed's contrast and conversion:
The stages of algorithms are:

- Reading image
- The maximum of contrast
  In order to reduce edges which are used by watershed's conversion, should be maximize the contrast between the objects and usual method for improving(developing) contrast is using top hat and bottom hat conversions on the images.
  Top hat conversion is defined as a different between main images and image which is returned by making filters. Bottom hat conversion is defined as a different between main image and image that is closed by making filters.
- Subtraction of making images is been by the second stage of algorithm.
  To hat image is including places of top sharp objects and bottom hat image is showing distance between the objects.
  For maximizing contrast between objects and distance between them should be practice according to (1) formula.

$$Ienhance = imsubtract (imadd (Itop, afm), Ibot) \quad (1)$$

- Conversion of the objects: in order to manifest edges tensing, it should be used from supple mentary image, for better separate of the object in the next stage.

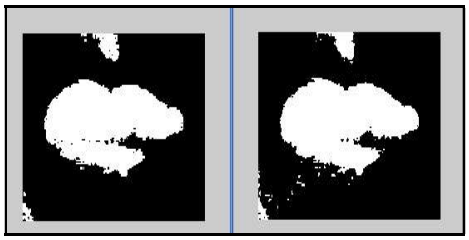

Fig. 1: a) Image after using filter, b) Primary image

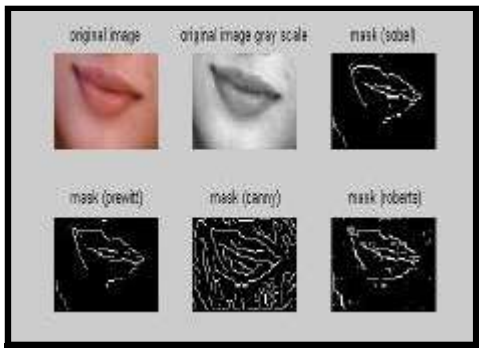

Fig. 2: The comparision of the edge detection algorithms on the special image

- Manifesting of edges tensity. Whole of edges tensity manifest with a special threshold (sill) with imextendedmin function and then with imposemin function has been changed places of main image which have developed and have manifested as edges intensity.
- Watershed segmentation [7].

Morphology segmentation: This segmentation is segmentation on the basis of concepts such as, manifesting edge, provided objects and Erosion.
The algorithm stages are:

- Reading image
- Manifesting image completely

Manifesting object is done completely according to one of the edges detection algorithm. And it is necessary to say that this algorithm uses on the images which haven't noise.

- Manifesting objects is done by edges that obtained by second stage of algorithm.
- Separating edges in images.
- Charging obtained object
- Deleting objects which is located at the side of image [8].

New algorithm of applying segmentation in this article: In this article we used all of the watershed

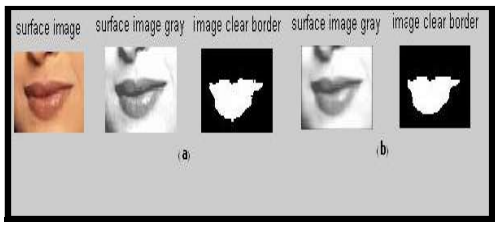

Fig. 3: Filter "motion", 'disk'

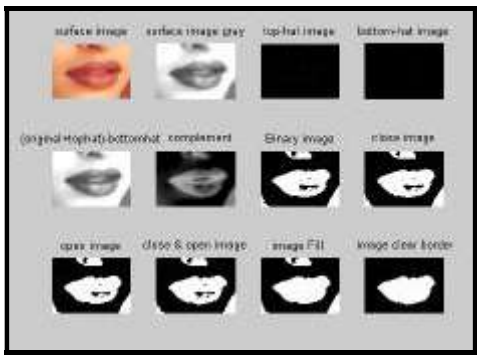

Fig. 4: Segmentation stages on images

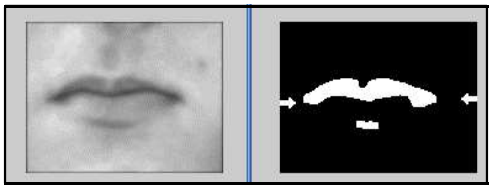

Fig. 5: Method of finding corner of lip

segmentation stages except final stage and so stages of 5, 6 morphology segmentation.

At least, a set of special filters was used.

With observing obtained results understood that limitation of lip were very sharp and were different with main image. For making segmentation inorder to determine of lip be exact, used from old defined special filters, matlab, by names of 'motion', 'disk', with measures that are well set measures of image which you can observed their effect in picture 3. in the following figure, segmentation stages on image in this article is obviousable.

Finding side of lip: In this method, move from two sides of figure toward center of figure and in column analyzing first find a white point and then in the same column by traversing white point should be search black white, if you can not find black white, so there isn't corner of lip in this column. Otherwise, the corner of lip, is located in this column and related line to lip's corner from middle point of white points are obtained. This operation obvious in the following figure.

For finding lip's state for distinction between movement of lip was decided that lip mapping to a hexagon. The operation for acquiring hexagon and have been sides of lip is according to this method that first, with having left and right sides of lip, the width of lip is calculated according to this formula:

$$\text{Width} = \left|\text{left\_lip}(x) - \text{right\_lip}(x)\right| \quad (2)$$

Obtaining approximate hexagon that is equivalent with lip's edges: After acquiring lip's width, for obtaining other sides of hexagon, operate according to the following stages:

1. Obtaining, left part of lip-top: for calculating this place, first the pointer move from left corner of the lip to right side to the extent of 0.2 width of lip. According to the (3-3) formula, the width of starting point at the left side of lip-top calculated and now for calculating the height of starting point at the left side of lip-top operates in the case that first has formed the line equation of the lip corners and has got the point width till calculate the point starting height that is calculated according to the(4-2) formula [8].

$$\text{Tpls}[x] = \text{left\_lip}(x) + (0.2 * \text{Width}) \quad (3)$$

$$\text{Tpls}[y] = \frac{(\text{left\_lip}(y) - \text{right\_lip}(y))}{(\text{left\_lip}(x) - \text{right\_lip}(x))} * \text{Tpls}[x] + \text{left\_lip}(y) \quad (4)$$

For calculating the starting flat of the left lip-top operates in the case that first from the obtained point is disposed to the up side till the lip border is calculated and the obtained height is equal to Tpls[y]. now with continous movements of 0.05, the lip's width is disposed to the right side and proportional border with it is obtained and in every stage with having the point peculiarities of that stage or the previous one, calculate the variety angle and is compare with minimum flat distinction angle of the lip-top, if the new angle is more than the previous stage angle, algorithm would continue to it's own way and otherwise the point before the last obtained point is the final point of left side of the lip-top that is calculated according to the (5-2) formula [9].

$$|\text{Degree\_limit} = \left|\frac{(\text{Tpls}[y] - \text{Tpls}_{i-1}[y])}{0.05 * \text{Width}}\right| \quad (5)$$

2. Obtaining the right side of the lip-top: According to the (6-2) formula, the width starting point of the right side of the lip-top that is calculated; now for obtaining the height starting point of the right side of the lip-top that is calculated according to the (7-2) formula.

$$Tprs[x] = right\_lip(x) - (0.2 * Width) \quad (6)$$

$$Tprs[y] = \frac{(left\_lip(y) - right\_lip(y))}{(left\_lip(x) - right\_lip(x))} * Tprs[x] + right\_lip(y) \quad (7)$$

For obtaining the starting flat of the right side of the lip-top the lip-top that is calculated according to the (8-2) formula.

$$Degree\_limit = \left| \frac{(Tprs[y] - Tprs_{i-1}[y])}{0.05 * Width} \right| \quad (8)$$

3. Obtaining the left side of the lip-top: For obtaining this point, the width starting point of the lip-down is calculated; now for obtaining the height starting point of the left side of the lip-down that is calculated according to the (10-2) formula.

$$Dols[x] = left\_lip(x) + (0.1 * Width) \quad (9)$$

$$\left[Dols[y] = \frac{(left\_lip(y) - right\_lip(y))}{(left\_lip(x) - right\_lip(x))} * Dols[x] + left\_lip(y) \right] \quad (10)$$

For obtaining the flat starting of the left side of the lip-down that is calculated according to the (11-2) formula.

$$|Degree\_limit = \left| \frac{(Dols[y] - Dols_{i-1}[y])}{0.05 * Width} \right| \quad (11)$$

4. Obtaining the right side of the lip-down:

$$Dors[x] = right\_lip(x) - (0.1 * Width) \quad (12)$$

$$Dors[y] = \frac{(left\_lip(y) - right\_lip(y))}{(left\_lip(x) - right\_lip(x))} * Dors[x] + right\_lip(y) \quad (13)$$

$$|Degree\_limit = \left| \frac{(Dors[y] - Dors_{i-1}[y])}{0.05 * Width} \right| \quad (14)$$

For obtaining the hexagon, for analyzing the lip varieties, calculates the criterions in the following and is used in distinction of lip movements in a figure.

The width main diameter of the hexagon that is width in the following figure and it's quantity is calculated according to the (3-3) the average of top left and right angles that is the same average of a 2, a 1 in the above figure and it's quantity is according to the (15-2) formula.

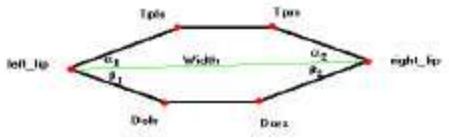

Fig. 6: The sight of approximate hexagon from the lip border

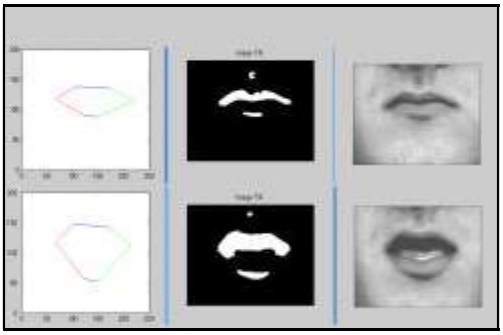

Fig. 7: A sample of primary and final frame in expression of number one

$$\alpha = \frac{(\alpha_1 + \alpha_2)}{2} \quad (15)$$

The average of down left and right angles that is the same average of ß1, ß2. In the above figure and it's quantity is according to the ((16-2) formula.

$$\beta = \frac{(\beta_1 + \beta_2)}{2} \quad (16)$$

FRAME SELECTION

In order to determine the lip movements, first we should be determine the lip's static state from the frame input film and then determine the most lip varieties that infact is the pronunciation of a special number(the following figure) that obtained on the basis of top criterions according to the varieties of these two frames, will be taken the necessary decisions. At the result of these formulas describe like this:

$$D\_width = \frac{Width_f - Width_s}{Width_f} * 100 \quad (17)$$

$$D\_Degreetop = \frac{\alpha_f - \alpha_s}{\alpha_f} * 100 \quad (18)$$

$$D\_DegreeDown = \frac{\beta_f - \beta_s}{\beta_f} * 100 \quad (19)$$

In order that these criterions should be used for different people finally and on the basis of the test that was carried out on different images, resulted that use from the difference relative criterions of two frames

The reasons of using from the fuzzy system in article: For finding distinction of lip movements, it couldn't from Boolean logic for not having a complete similarity of lip movements in various tests in comparision with each other and also for the different pronunciations for various numbers. For cause of this subject, had been decided that use from the fuzzy logic or neuro fuzzy in the final decisions.

The used linguistic variables in article: Now, it uses for studying of lip variables from a set of linguistic variables with a set of fuzzy sets for deciding that these input linguistic variables consist of:

- The relative variables of lip's width
- The averages relative variables of lip-top angles
- The average of relative variables of lip-down angles

In this article on the basis of these linguistic variables was studied fuzzy reasoning algorithms of max-min and max-product and according to the obtained results, the fuzzy reasoning algorithm fo max-product was selected.

Linguistic variable, relative variables of lip's width: According to the explained subjects in the last part, after obtaining the approximate hexagon of lip's border, the relative variables of lip's width is calculated according to the (17-2) formula; after several tests, the distances related to the lip's width had been estimated approximately and for number distinction for this factor was considered two fuzzy sets. These fuzzy sets consist of:

No change: This set is according to the portional membership function from the kind of explained membership function of matlab that is called zmf that observe it's place in the following figure.

Change: this set is according to the portional membership function from the kind of explained membership functions of matlab that is called smf that observe its place in Fig. 8.

Linguistic variable, the averages relative variables of lip-top angles

According to the explained subjects in part 2, after obtaining the relative hexagon of lip's border, the averages relative varieties of lip-top angles is calculated

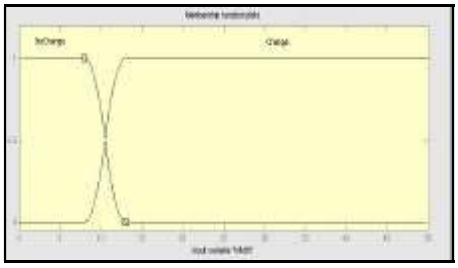

Fig. 8: The fuzzy sets on linguistic variables of relative varieties of lip's width

according to the (18-2) formula. After doing continous tests on the different sample, the distances related to the lip's angle varieties was explained

This set is according to the portional membership function from the kind of smf that difference relative angle less than 70, has membership degree of 0 and the difference relative angle more than 85 degrees, has the membership degree of 1, in this set and the quantities between 70-85 have the membership degree between 0-1 that has shown its place in the above figure.

Linguistic variable, the averages relative varieties of lip-down angles: According to the explained subjects in part 2, after obtaining the relative hexagon of lip's border, the averages relative varieties of lip-top angles is calculated according to the (19-2) formula. After doing continuous tests on the different sample, the distances related to the lip's angle varieties was explained approximately according to the three fuzzy sets and was considered for the linguistic variables of the averages relative variables of lip-down angles till it's useful for the number distinction.

Approximately according to the three fuzzy sets, till it's usefull for the number distinction.

Small: this sets is according to the portional membership function from the kind of zmf that the difference relative angle less than 25 hast the membership function of 1 and the difference relative angle more than 50, has the membership degree of 0/in this sets and the quantities between 25-40, have the membership function between 0-1 that has shown its place in the following figure.

Medium: Figure 9 the fuzzy sets on the linguistic variable of

Relative varieties of lip-top angles large: This sets is according to the portional membership function from the kind of pimf that difference relative angle less than 25 degrees and more than 85 degrees, has the membership degree of 0 in this set and the quantities between 25-40 and 70-85 have the membership degree

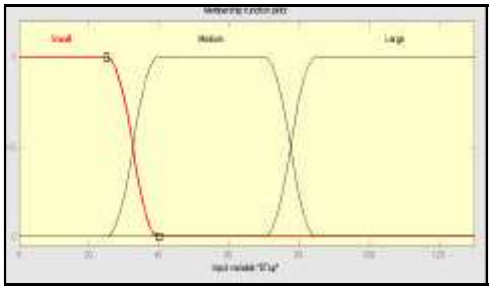

Fig. 9:

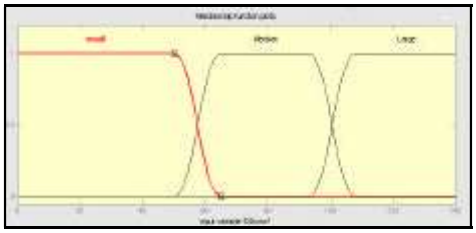

Fig. 10: The fuzzy set on linguistic variable of the relative varieties of lip-down angles

between 0-1 and the difference relative angle between 40-85, has the membership degree of 1, in this set that has shown in it's Fig. 9.

Small: The difference relative angle less than 50, has the membership degree of 1 in this set and the difference relative angle more than 65 degrees has the membership degree of 0 in this set and the quantities between 50-65 have the membership degree of 0 in this collection and the quantities between 50-65 have the membership degree between 0-1 that has shown its place in the Fig. 10.

Medium: The difference relative angle less than 50 and more than 108 degrees, has the membership function of 0 in this set and the quantities between 50-65 and 93-108 have the membership degree between 0-1 and the difference relative angle between 65-93 has the membership degree of 1 in this set and has shown it's place in the Fig. 10.

Large: The difference relative angle less than 93 has the membership degree of 0 and the difference relative angle more than 108 has the membership degree of 1 in this set and the quantities between 93-108 have the membership degree between 0-1 that has shown it's place in Fig. 10.

The output linguistic variables: In this article instead of every one of the numbers between 1-5, was considered and output language variable that for every

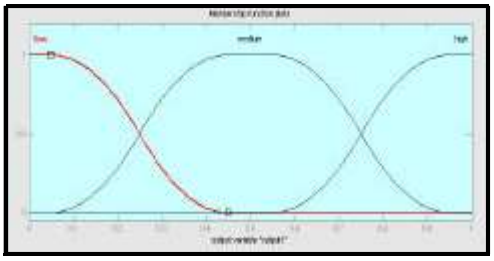

Fig. 11: The fuzzy set on an output linguistic variable

one of them was considered the similarly fuzzy sets according to the portional membership function that consist of:

Low: this set is according to the portional membership function from the kind of explained membership functions of the matlab that called zmf that has shown its place in the Fig. 11.

Medium: This set is based on the portional membership function from the kind of explained membership functions of the matlab that called pimf that has shown its place in the Fig. 11.

This set is based on the portional membership function from the kind of explained membership function of matlab that called smf that has shown its place in the Fig. 11.

The rules of fuzzy reasoning in article: After describing the input and output linguistic variables and also their fuzzy sets, it should be made the relation between input and output fuzzy variables by fuzzy rules, for cause of this subject, it operates respectively that base on the existing samples, find their relation and the rules is explained according to the relations between input and output linguistic variables

1. if (Width is Nochange)and(DTop is Small)and (DDown is Large) then (Outpot1 is mf1)(1)
2. if (Width is Nochange)and(DTop is Medium)and (DDown is Large) then (Outpot1 is mf1)(0.5)
3. if (Width is close)and(DTop is Medium)and (DDown is VeryLarge) then (Outpot2 is mf1)(1)

The samples of used fuzzy rules in article

The defuzzified stage in article: After using the fuzzy rules on linguistic variables, it should be done the defuuzified stage in article and should be tested two algorithms of the gravity center and the average of the center on samples that the algorithm of the gravity center has more appropriate response for this article.

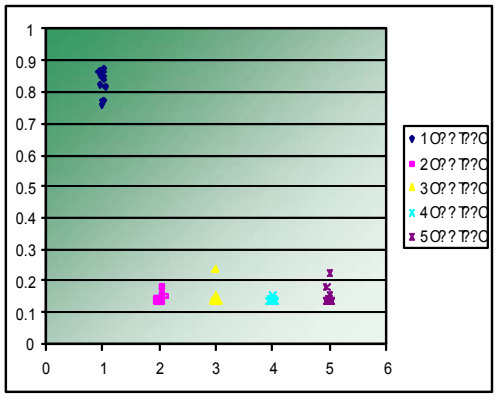

Fig. 12: The diagram of testing number 1 for the 11 samples

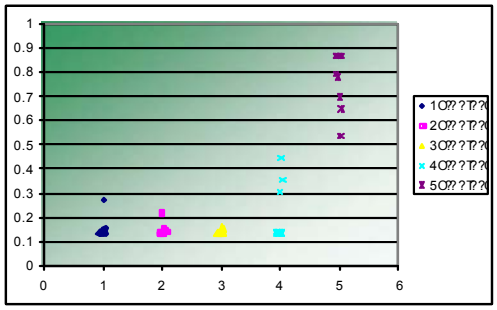

Fig. 13: The diagram of testing number 5 for the 11 samples

RESULTS

This article is tested on three different people with some samples of the number images between 1-5 that its results explained according to the Fig. 12 and 13 that we have only shown the number results of 1 and 5.

As you see in the above figure, has determined averagely for 11 samples up to the 75% of number 1 and has appropriated to the other numbers less than 25%.

As you see in the above figure, has determined averagely for 11 samples up to the 75% of number 1 and has appropriated to the other numbers less than 20%.

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