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Reading Sentence for Robotic Application

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Abstract- Reading sentence for robotic application is a simple and effective technique for analysing a textual characters present in an image. This paper proposes a method to capture a textual message affixed on an obstacle. The image is captured with sufficient resolution for identification scanning from left to right and from top to bottom of an image. Image enhancement methods are used to increase the visibility of acquired image. Analysing an image requires segmentation, which is an important phase of any Optical Character Recognition [OCR] system. The proposed segmentation algorithm is based on projection profile method. This method is used to segment the textual region present in an image and dividing a text region into number of words into characters. Different pre-processing methods, feature extraction methods are implemented for each and every character present in a sentence. String matching algorithm is used to recognise the identified sentence present in a dictionary and produce an audio output.

Keywords- Image enhancement methods, pre-processing, projection profile segmentation method, Feature Extraction, string matching.

I. INTRODUCTION

We use maps to give us a general idea of the directions to take to go somewhere, but we still rely on signs to confirm our location in the world. This is especially true in dynamic and large open areas, or in environments that cannot be mapped a priori. With all the research that has been going on in the area of optical character recognition, it is surely possible to make a mobile robot read symbols and signs. But contrarily to conventional character recognition system, a mobile robot has to find a textual message to capture, try to compensate for its viewpoint of the message, and use limited processing capabilities to decode the message [1].

Optical Character Recognition (OCR) is a field of research in pattern recognition, artificial intelligence and machine vision. OCR is a mechanism to convert machine printed or handwritten document file into editable text format. This field is broadly divided into two Online and offline character recognition. Off-line Character recognition further divided into two machine printed and handwritten character recognition. The beginning of identification of characters began from machine printed alphabets and then it was enhanced recognise printed characters and sentences. Slowly it developed to implement on character, word and recognition were involved in this area. Textual message present in an image has to be captured. Therefore, the text information has to be extracted efficiently, by performing pre-processing on the input sentence image.

II. PROPOSED METHODOLOGY

In this paper, we have proposed a methodology which is used to segment and recognition of characters present in a textual image, recognised sentence is produced as audio output. It is done by capturing a sentence image present on an obstacle then extracting textual part of an image, segmenting the text into words, words into characters. Each and every character present in an image can be identified based on the feature values obtained. Obtained character is compared with that of the dictionary consisting of set of words which is previously listed.

Once all the words present in an image is recognised then the recognised sentence is produced as audio output. The proposed methodology consists of two phases:

i. Learning Phase.
ii. Recognition Phase.

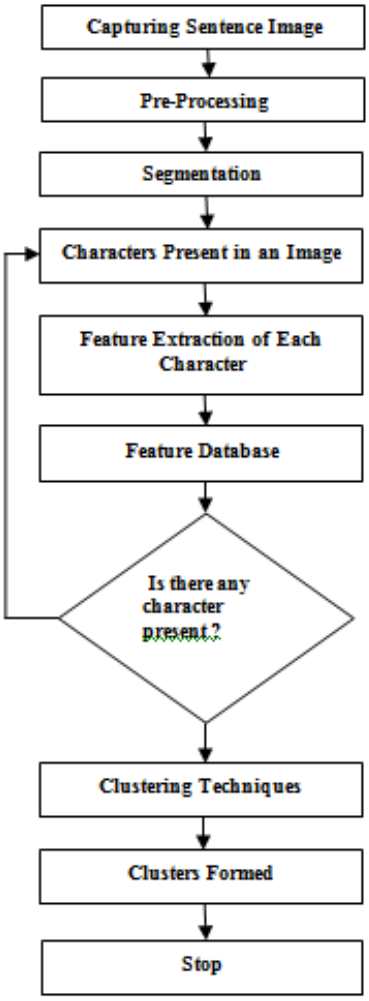

Fig 1: Flow Chart of Learning Phase

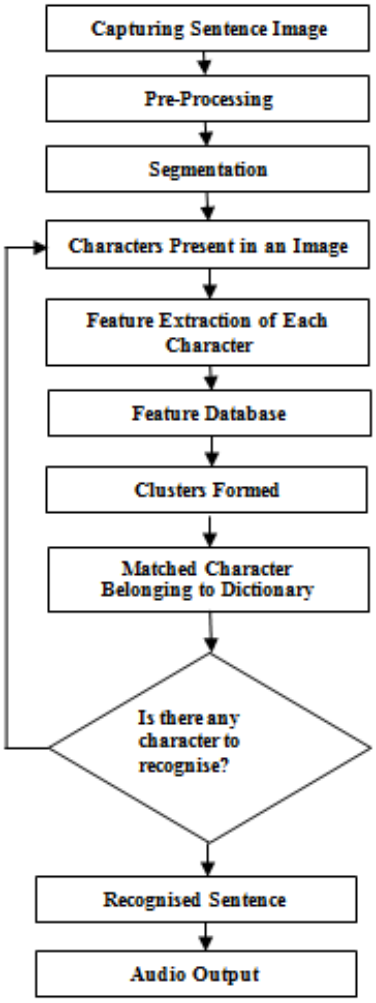

Fig 2: Flow Chart of Recognition Phase

Fig 1 shows the flow chart of learning phase in Sentence Recognition. In learning phase using an external camera the textual image has to be captured, pre-processing techniques are applied, textual part is extracted using segmentation method. Extracting features of each characters and clusters are formed based on the feature values. Fig 2 shows the flow chart of recognition phase. In Recognition phase each and every character is matched in the dictionary whether the character is present or not. Once all the characters of an image is identified then it is produced as a audio output.

Learning Phase of sentence recognition involves following 5 steps:

i. Input sentence image
ii. Image enhancement
iii. Pre-Processing
iv. Character Feature extraction
v. Classification or Clustering

A. Learning Phase

1. *Capturing Sentence Image:* A textual image consisting of two words is affixed on an obstacle. This text is captured using an external camera which has a white plain background. The captured image may be in any format but it will be converted to RAW format. The end user can given that captured image as input to the system.
2. *Image Enhancement:* It is the procedure of increasing the quality of input image. i.e., In order to increase or decrease the brightness or contrast of a input image. Following are the two methods implemented in my project.
   They are:
   a. Linear Stretching
   b. Gamma Correction

a. Linear Stretching

Linear stretching technique is applicable to images where there is lack of contrast or brightness can result in improper identification of objects, its extent relationship and importance. It is also referred as contrast stretching, linearly expands the original digital values of the remotely sensed data into a new distribution. By expanding the original input values of the images, the total range of sensitivity of the display device can be utilised.

l= T(m)= (Lmax-Lmin)/(Mmax-Mmin) * (m-Mmin)+Lmin

Where m is the input gray level, (Lmax-Lmin) is available gray levels, (Mmax-Mmin) is gray level range of input image.

This method is used to enhance the input image in my project because better results can be achieved on an input image over a narrow range of gray level values from the original image.

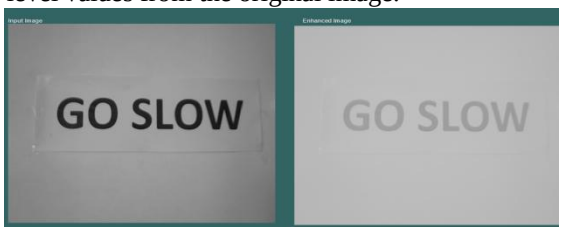

Fig 3: Image enhancement using Linear Stretching method.

b. Gamma Correction

Gamma correction is a non-linear operation used to code and decode luminance value in video or still images.

$$S = Cr^{\gamma}$$

Where r is input gray level, C is gain.

Fig 4: Image enhancement using Gamma Correction method.

3. Image Pre-Processing

The RAW data obtained after capturing the image, it is provided to a lot of early processing steps to make it available for further stages of sentence recognition. The acquired sentence image which is in RGB format is converted into a greyscale image using the Equation:

$$Gray = 0.2989 * R + 0.5870 * G + 0.1140 * B$$

Where R, G, B correspond to the Red, Green and Blue color of the pixel, respectively.

Pre-Processing methods mainly concentrates to obtain the data which is easier for sentence recognition algorithm to produce the accurate result.

Pre-Processing steps involved in this paper are:

a. Image Binarization

Thresholding is a method which creates binary images from gray input by converting the pixels less than threshold value to 0 and pixels greater than threshold value to 255. The primary element in the threshold process is to select threshold value. Various methods are available to select a binarised value. End users can randomly choose a binarised number in order to separate foreground and background is known as manual thresholding, or to obtain the threshold automatically using some of the available thresholding algorithms is known as automatic thresholding. It is a simplest task that will be used by selecting median or else mean value, fundamental reason for it is if pixels of an object are brighter than background then it should also be brighter than the average.

b. Image Thinning.

Thinning is a process in which single pixel of an object is obtained by saving the connectivity of the object in an image along with its end points. We can say this process as deleting the boundary pixels by applying some conditions [8].

P9	P2	P3
P8	P1	P4
P7	P6	P5

Fig 5: Given 3×3 window showing the 8-neighborhood of pixel P1

Algorithm : Thinning

Step1: First iteration: As shown in the fig for every pixel in the image calculate count of 8-neighborhood pixels as N(P1).

Step2: If N(P1) is not equal to 8 and N(P1)>=2 and N(P1)<=6 go to step3.

Step3: Compute number of transitions (i.e. 0 to 1 or vice versa) as S(P1)

Step4: If S(P1)==1

Check for condition,

$$P2 \,||\, P4 \,||\, P6=255$$

P4 || P6 || P8=255

Step5: If all the above conditions are satisfied mark pixel as delete able.

Step6: Second iteration: Repeat the above steps but check for conditions as

P2 || P4|| P8=255

P2 || P6|| P8=255

4. Projection Profile Based Segmentation

Once the input image is binarised, black areas are extracted using segmentation method. This process can be done by looking pixel by pixel of an image. The segmentation regions are identified from the peaks of the vertical projection profile. Vertical projection of a binary image looks like a set of black hills on a white surface. By using the peaks of horizontal projection profile the textual region. After extracting the textual regions, words and characters are segmented.

Fig 6: Horizontal Projection

Fig 7: Vertical Projection

4.1 Algorithm: Horizontal Projection Profile

```
begin input image
/* This loop is to scan till image height*/
for i =0 to height-1
/*Initialise the value to zero*/
count=0 /
/* This loop is to scan till image width*/
for j=0 to width-1
/* Check whether the image pixel is black or not*/
if pixel(i)(j)= black
/* Increment the count of a black pixel*/
count= count+1
end
end
/* Assign count value to an array*/
array=count
end
```

4.2 Algorithm: Vertical Projection

```
begin input image
/* This loop is to scan till image width*/
for i =0 to width-1
/*Initialise the value to zero*/
count=0 /
/* This loop is to scan till image height*/
for j=0 to height-1
/* Check whether the image pixel is black or not*/
if pixel(i)(j)= black
/* Increment the count of a black pixel*/
count= count+1
end
end
/* Assign count value to an array*/
array=count
end
```

The vertical projection profile method is used to segment a sentence into words. The same method is used for segmentation of characters present in a word.

5. Character Feature Extraction

Here, it is used to extract the essential characteristics of an alphabet which is generally accepted that it is one of the biggest problem in recognition of patterns. Features must be invariant to the expected distortions and variations that character may have specific application.

Following are the features that are used to represent a character:

- *Directional Feature.*

The direction of a two variable function, here the image intensity function is at each image point, a 2D vector with the components given by the derivatives in the horizontal and vertical directions. At each image point, the gradient vector points in the direction of largest possible intensity increase and corresponds to the rate of change in that direction. In order to extract the features we have computed 8 directional feature extractions.

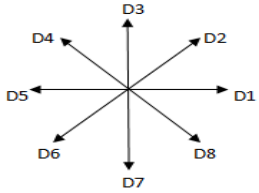

Fig 8: 8- Directions used to compute directional feature

- *Zone Based Feature Extraction.*

For extracting the feature, the zone based hybrid approach is proposed. The major advantage of this approach stems from its robustness to small variation, ease of implementation and provides good recognition rate. Zone based feature extraction method provides good result even when certain pre-processing steps like filtering, smoothing and slant removing are not considered[11].

- *Thinning Features.*

Thinning provides a tremendous reduction in data size, thinning extracts the shape information of the characters. It can be considered as conversion of off-line handwriting to almost on-line data. Thus the reduced pattern is known as the skeleton and is close to the medial axes, which preserves the topology of the image.

Intersections: A intersection is based on number of true neighbors for a particular pixel[8]. Scan the image from top to bottom using 3x3 masks. The image pixel having three or four neighboring pixel is the intersection point.

Open ends: The image pixel having only one neighboring pixel is the open end [8].

Fig 9: Intersection Points

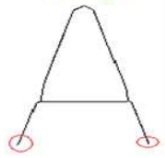

Fig 10: Open ends

- *Shape Features.*

Some of the features used to obtain the shape of the character are:

Sl No.	Feature Name	Feature Calculation
1.	Area	Number of pixels present in an image.
2.	Perimeter	Number of pixels present on the character boundary.
3.	Black Occupancy	Number of boxes that are occupied by the character pixels.
4.	Aspect Ratio	$Aspect\ Ratio = \frac{Length(L)}{Width(W)}$
5.	Waddels Ratio	Wadells ratio = $\frac{2\sqrt{(\pi * area)}}{(perimeter)^2}$
6.	Roundness	Roundness= $4*\pi *$Area/Perimeter^2
7.	Drainage Ratio	Drainage basin ratio= $\frac{\pi * area}{(perimeter)^2}$
8.	Eccentricity	$E=\lambda_2/\lambda_1$
9.	Dispersion	Dispersion= max factor value / min factor value

6. K-means Clustering

The objective of a classification or clustering system is to assign a pattern presented it to a class using the feature vector. The difficulty of the classification problem is dependent on the variability of the feature values for patterns in the same class has some difference in values of feature, for patterns in different classes.

In this algorithm it takes input parameter K and it is partitioned into a set of objects into clusters so that the resulting intra cluster similarity is high but the inter cluster similarity is low. The cluster similarity is measured in regard to the mean value of the objects in a cluster which can be viewed as the cluster centroid or centre of gravity.

B. Recognition Phase

In this phase it is used to recognise the identified character with that of the characters present in the dictionary. This can be done using string matching algorithm. Once all the characters present in an image is recognised by comparing to a dictionary created then the sentence is produced as a audio output.

Algorithm: String Matching

1. Consider the text and pattern.
2. Find the length of text and pattern.
3. If the pattern length is greater than the text length then return nothing.
4. If Pattern length is less than or equal to the text length then compare each and every characters between text and pattern.
5. If all the characters match then successful recognition of a sentence.
6. If any one of the character doesn't match then unsuccessful recognition.

III. EXPERIMENTAL RESULTS

Fig 11: Binarisation is applied to applied to enhanced image.

Fig 12: Text extraction from sentence image

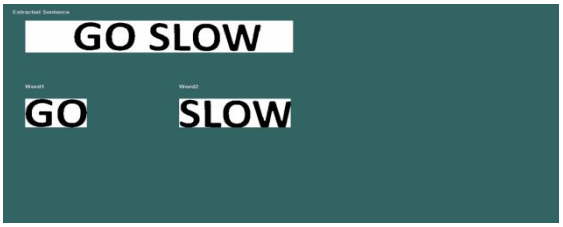

Fig 13: Word Segmentation

Fig 14: Segmented character is classified and identified.

Fig 15: Segmented character is classified and identified.

Fig 16: Segmented character is classified and identified.

Fig 17: Segmented character is classified and identified.

Fig 18: Segmented character is classified and identified.

Fig 19: Character Segmentation and the matched sentence is produced as audio output.

IV. CONCLUSIONS

The experimental result above shows that the proposed algorithm successfully recognises the sentence present in a real image. It identifies successfully by implementing multiple features and clustering method, and when it recognises successfully it produces audio output. The Algorithm works fine only when the sentence image is straight and no

orientation is allowed. It works properly when the image contains only two words. Hence we can say that it is translation and scale invariant but not rotation invariant.

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