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Android App for Meter Reading

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Abstract: ***There exist a billing process for meter reading of electricity, gas and water supplier companies, as well as to know the consumption of particular vehicle by reading the meter. Now a days, electricity billing and meter reading are very complex tasks. The current method of billing process uses manual work of reading the meter, updating details of meter and sending bill to the customer. We are developing the technology that comprises android application as well as web application to get reading, updating information into server and informing consumers about electricity consumption units and bill amount. To make meter reading task automatic android application is used to get the readings from the meter by only capturing the image of the meter and then performing the OCR i.e. "optical character recognition" technique on that image in android app. The result of OCR is meter readings extracted from the captured image and then send to the server. With the help of web application customer can receive mail regarding the bill at the instant the image is accepted at the server and then customer can view his bill. New features can also be added that will reduce workload on companies as well as their workers.***

Keywords: Meter, Optical Character Recognition, Android mobile.

1. Introduction

Now a days electricity supplier companies has maximum part of manual process which include calculating the bill and writing meter reading in book. Due to manual procedure incorrectness in bill generation is occurred. This procedure makes a lot of burden on meter reader and is also inconvenient for the customer to lodge any complaints. The solution to the above problem is proposed which makes advanced version of current procedure. In this paper we suggest Android application which is carried by meter reader and a web application for customer to interact with electricity supplier companies. Using the Android application meter reader captures the image and sends to the server. The server does pre-processing on image and OCR extracts Meter reading and Customer number. Using these extracted details Bill is generated, updating the database and PDF of the bill is send via mail to the customer. Thus this automated process reduces workload on the employees and incorrectness in bill generation is avoided. The time consuming process is turned to fast and completely automated.

2. Related Work

In Method for text localization and recognition [2] while recognizing the character the boundary of external region is considered. From the maximal stable external region the 35 x 35 pixel matrix is drawn. This is sub sampled to 5 x 5 matrix pixel which generates 25 feature x 8 directions which give 200 features from which Microsoft OS detects the character. For word detection and recognition [4] given is the list of words that are to be detected and read. Now the performance of the method is based on text detector followed by OCR engine.
In Reading digits from natural image with unsupervised features [3] the detector sends the building number to recognition module then the segmentation process is applied which verifies the digits. The problem with this application to identify hand designed features. In End to end text recognition with convolution neural network [5], the neural network is combined with character recognition module. Accuracy of character is found out with the help of lexicon used along with detection module. But the accuracy is achieved only for cropped characters. For Prototype extraction and adaptive OCR [1] template matching algorithm is used where template is 2D

array from the set of prototypes. The binary bitmap is matched with template. The level building algorithm is used to provide solution to word recognition problem. OCR accuracy is improved through recognition of prototypes.

3. Existing System

The current procedure is that meter reader clicks image of the meter using digital camera and submits that images to the administrator and then performing manual operation to extract text from images and bill generation process is carried out.
The companies that uses manual task for billing purposes thinks that it is an easy task and skills are not important, so these companies don't invest a huge amount of money for a new solution. With the current procedure followed by these companies to calculate bills the customer has to face many problems.
According to customer's perspective of knowing their current consumption units or calculating it manually is not provided. Also the facility to compare the previous month's consumption units with the current month is not provided. Customer has to face many difficulties in contacting with companies for making any complaints about device failure or incorrect bill.
Companies doesn't provide proper communicating channel for broadcasting information about power failure and power consumption to the customers.

Difficulties in Existing System:-

- Time consuming process.
- Totally manual process.
- Adds lots of burden on employees.
- More chances of occurring human errors.

4. Proposed System

We are developing the android application and a web application. Android app is only for meter reader to get the meter reading. This solution is more beneficial for meter readers. At the start of the day meter reader carries android mobile including android app in it to get the meter reading within a day.

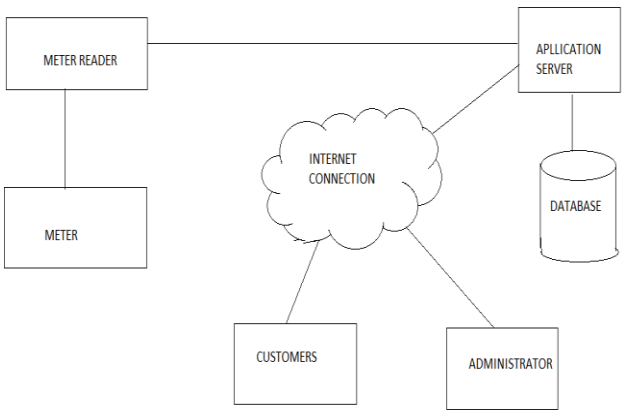

Figure 1: System architecture

The simple process is just to capture the meter image and then sent to the server with the help of android app. At the server side, the operation of extracting the meter reading text from the image will be performed. Further, server does the calculation and proceed bills are sent to the respective consumers via email at the same instance. In the case where an illegal power usage is spotted or a fault device is seen by meter reader that particular meter image can be sent to the server.
With the help of website a customer can view bill consisting all details related to any of the particular month with previous month consumption. Customers can use that website for lodging any complaint of incorrect bill or meter device failure. This web application is applicable for administrative purposes too. An administrator can allocate particular route to the relevant meter readers with the list of customers using this system and new employees or customers in database can be added. The news regarding power failure and any information about the power consumption is broadcasted on the website by administrator.

5. Mathematical Model

1. Let S be the system for meter reading
   S = {...}

2. Identify input as I
   S = {I, ...}
   I1: User or Meter reader Login.
   I2: Captured image.

3. Identify output O
   S = {I, O, ...}
   O1: Generated Bill.
   O2: PDF to customer.

4. Identify the processes as P
   S = {I, O, P, ...}
   P0: Gray scale conversion.
   P1: Binarization.
   P2: Morphological operation.
   P3: OCR Operation
   P4: Bill Generation.
   P5: Send PDF.

5. Identify failure cases as F.
   S = {I, O, P, F ...}
   F = {Failure occurs if incorrect bill generation.}

6. Identify Success cases as s.
   S = {I, O, P, F, s....}
   s = {Success occurs when bill is generated accurately.}

7. Identify Initial condition as Ic.
   S = {I, O, P, F, s, Ic}
   Ic = {Meter image is compulsory.}

6. OCR

Optical character recognition is an electronic analysis of image to identify textual information area and extract text from it. Following are phases of OCR:

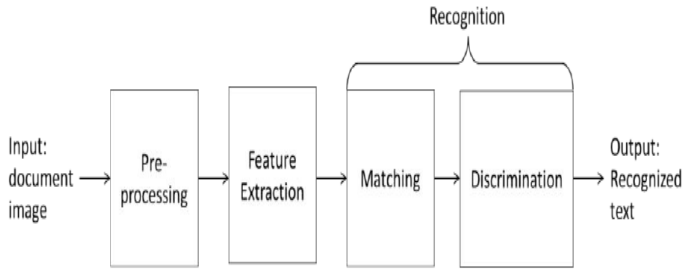

Figure 2: Phases of OCR

6.1 Pre-processing

This phase is used to produce data for OCR system to operate accurately. It improves Recognition rate. It consist of following techniques:

6.1.1 De-skew

The document was not aligned properly then it may need to tilt in order to make text perfectly horizontal or vertical.

6.1.2 Binarization

The process of converting colour or grayscale image into black and white image is called as "Binarization". The Otsu Thresholding method is used in binarization.

This algorithm consists of following steps:

a) Draw the histogram for the gray scaled image.
b) Assume some threshold value and calculate Weight, Mean and Variance for foreground and background.
c) Calculate within class variance.
d) Calculate final value using sum of weighted variance.

6.2 Feature Extraction:

It scans the input image and select the set of features that classifies and identify the character. This phase will maximize the recognition rate.

6.3 Recognition:

This phase is divided into two sub phases: Matching and Discrimination.

6.3.1 Matching

Extracted features are matched with Template character.

6.3.2 Discrimination

The matched features are converted into character code.

7. Algorithm

The system algorithm consists of following steps:

7.1 Load image as a .jpg or .png format.

When meter reader captures the meter image from the android application, the format of image is either .jpg or .png.

7.2 Detecting the most important features

This step involve detecting most important features from image like resolution and inversion. The resizing on image is done before pre-processing is applied to image.

7.3 Grayscale conversion

The process of converting colourful image into gray-scale image is called as gray-scale conversion. The colourful image each pixel consist of three colours i.e. Red, Green, and Blue with pixel range of 0-255 each. In gray-scale pixel range is from 0-255, where 0=black, 255=white and the value in between the range 0-255 denote gray colour.

Formula for gray scale conversion:

Gray=R*0.21+G*0.71+B*0.07

7.4 Binarization

The process of converting gray scale image into binarized image is called as binarization. We are using Otsu thresholding algorithm for binarization.

This algorithm consists of following steps:

7.4.1 Draw the histogram for the gray scaled image.

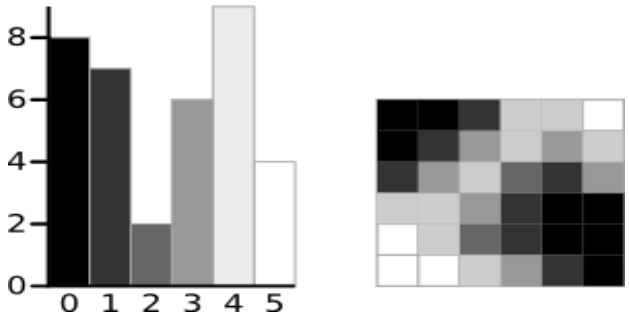

Figure 3: level gray scale image and histogram

7.4.2 Assume some threshold value and calculate Weight, Mean and Variance for foreground and background [6].

For e.g. consider the threshold value as 3.

The calculations for finding the background:

$$\text{Weight } W_f = \frac{\sum(\text{frequency count of each pixel} < \textit{threshold value})}{\text{total number of pixel}}$$

$$\text{Mean } \mu_f = \frac{\sum(\text{pixel no.} \times \text{freq count of pixel})}{\text{total number of pixel in background}}$$

$$\text{Variance } \sigma^2_f = \frac{\sum(\text{pixel no.} - \text{mean of pixel})^2 \times \text{freq count of pixel})}{\text{total number of pixel in background}}$$

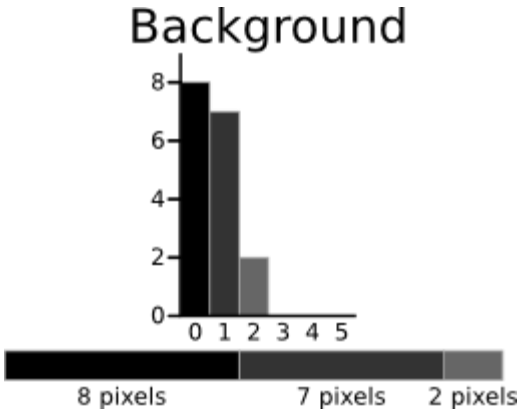

Figure.-4. Background histogram

Now for calculating foreground :

Weight $W_f = \frac{\sum(\text{frequency count of each pixel} > \textit{threshold value})}{\text{total number of pixel}}$

Mean $\mu_f = \frac{\sum(\text{pixel no.} \times \text{freq count of pixel})}{\text{total number of pixel in background}}$

Variance $\sigma^2_f = \frac{\sum(\text{pixel no.} - \text{mean of pixel})^2 \times \text{freq count of pixel})}{\text{total number of pixel in background}}$

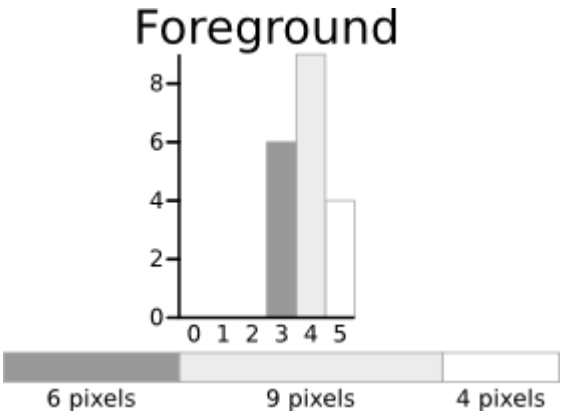

Figure.-5. Foreground histogram

7.4.3 Calculate within class variance.

$$\sigma^2_W = W_b\,\sigma^2_b + W_f\,\sigma^2_f$$

7.4.4 Calculate final value using sum of weighted variance by considering maximum within class variance.

7.5 Morphological operations

It is the process of collecting non linear operation or morphological features. It consists of two operations erosion and dilation.

7.5.1 Erosion

Erosion consists of following steps:

a) Read the current pixel value.
b) Read neighboring 8 pixel value.
c) Find out the minimum value from neighboring 8 pixel values.

7.5.2 Dilation

Dilation consists of following steps:

a) Read the current pixel value.
b) Read neighboring 8 pixel value.
c) Find out the maximum value from neighboring 8 pixel value

7.6 OCR operations are performed

We introduce tess4j library [7] which is a Java JNA wrapper for Tesseract OCR API and is released under the Apache License. It provides optical character recognition (OCR) support for:

- TIFF, JPEG, GIF, PNG, and BMP image formats
- Multi-page TIFF images
- PDF document format

1. Bill is generated from the extracted text and send to the customer via mail.
2. Save the result in database.

8. Technologies

8.1 Android

Android is an mobile operating system based on the Linux kernel .It is designed primarily for touch screen mobile devices such as tablet computers and smart phones with specialized user interfaces. Android is popular OS with technology companies which requires prepared in advance as per need, min-cost and customizable operating system for hi-tech devices. Android's open source has motivated a large community of developers and enthusiasts to use the open-source code as a foundation for community-driven projects. It also adds new features for advanced users.Android is helpful to manage memory to keep power consumption at a minimum compare to desktop operating systems.

8.2 Java

It is general purpose, object -oriented programming language developed by sun micro system of USA in 1991 which was originally called as 'Oka' by James Ghosling. The important feature of language is that it is a platform neutral language. Java is the first programming language which is not tied to any particular hardware or any OS. Programs developed in java can be executed anywhere on any system.

9. Outcomes

The expected result for the system is as follows:

9.1 When meter reader captures the image using android app then OCR extracts the text from the meter-image captured by the meter reader.

9.2 This extracted text contains consumer ID and meter reading.

9.3 After performing extraction the database server will get updated.

9.4 Server does calculation and generates bill according to the reading and send bill to relevant consumer via mail.

10. Conclusion

Android application for meter reading using OCR suggests an easy solution that addresses the problems related to manual electricity, water and gas billing process. The current method of billing process includes the manual process of meter reading, entering meter details at the server and billing to the customers. Our application is only for meter reader that reduces the workload on employees and to make the process of getting the meter reading, updating server and billing to customer via mail is made easy and accurate and also we have provided the facility for the customers that they can complaint about the incorrect bill to our web blog.

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