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Electricity Billing Automation Using Image Processing

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Abstract*: Automation is the concept in which the entire process reduces the time and cost of man work to an immense limit. Through the introduction of technologies into man force, the results turn up to be in efficient accuracy with greater speed. The idea of implementing automation in electricity billing process is to show the key features on efficiency in its results. The proposed system shows that rather than manual procedure of taking electricity meter reading, we can implement a process in which the meter reading is captured with the help of a image capturing device. By applying the Edge Detection technology on captured image, we can extract the reading from the image and it is sent to the electricity board with the help of a network connection. The user can also track their daily electricity usage with help of an application that can be installed and used. This idea reduces the difficulty of the employee and increases the efficiency. Thus while implementing it would be at low cost with the desired results as the consumer wishes.

Keywords: Automation, Edge detection

I. INTRODUCTION

In this era of digital world, we have succeed in automating almost every task, hence reduce the human effort. Here we would like to introduce Automated Electricity Billing System, used for generating electricity bill automatically. At present electricity bill is generated manually. An officer from electricity board visit every houses in a locality and generate the bill by using the meter reading.

This method is not accurate enough. We introduced a new method to generate the bill automatically using pattern extraction algorithm. Here we use 3 algorithms Canny, Sobel and Prewitt for comparison.

The pattern in the meter is extracted using camera and that image is processed. This image is send to the Electricity board server using Wi-Fi module. The digit in the image is used to calculate the bill of the customer.

At present bill generated during every month is not accurate enough. Customers are not able to manage the usage of electricity. If the unit reading of every month is known to the customer, he can reduce the usage up to a certain limit. Through this project we can know the current status of the unit and previous 10 months bill.

The existing system is manual. An employee from electricity office visits every house periodically takes the meter reading and submits this reading at main office. In some houses meter board is inside the house, so meter readers cannot take reading when no one is in the house. For customers to check the units consumed they have to look to meter board and it will not be understood by everyone. Calculation may be inappropriate. Some Customers are not satisfied with existing system. The rest of the paper is organized as follows: Section II contains proposed system, section III contains module description section IV contains system design and the last sections include the concluding part of this paper.

II. PROPOSED SYSTEM

Proposed system is based on image processing to obtain efficient and accurate reading of the meters. No human interaction is needed in entire billing process. An app is generated for customers and by log in they can check current unit consumed and the bill for it.By checking this they can reduce the usage of electricity thereby reducing the bill generated.

A. Description About The Work

We proposed pattern extraction algorithm for automating the billing system. Pattern extraction algorithm consist of three main stages of image processing: Preprocessing: It includes Convert RGB to gray scale, Image binarization, Noise reduction, Crop reading area. The next step is Digit segmentation, then the last step is Digit recognition, it includes Feature extraction, Template matching.ESP 8266 is the Wi-fi module which we are using. Wi-fi serial transceiver module. It helps in transmission of the data.ATMEGA328 controller is used. It is 8 bit processor and is 32 kb.

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Using Embedded C language Wi-fi interfacing program is done. At server side calculation of bill is done in PHP. An app is created for customers. Customer can log in to account using id.

B. Design Description

Image of meter reading is captured from the energy meter. Then we process the obtained reading using 3 pattern extraction algorithm Sobel, Canny and Prewitt. The extracted digit is send to the electricity board server using ATMEGA328 micro controller and ESP8266 Wi-fi module

C. Testing and Evaluation

Testing is the process of evaluating a system or its component(s) with the intent to find that whether it satisfies the specified requirements or not. This activity results in the actual, expected and difference between their results . In general, given properties are taken under testing phase: Meets the requirements that guided its design and development, Responds correctly to all kinds of inputs, Performs its functions within an acceptable time, Is sufficiently usable.

In our project testing is done using sample inputs. The system is already trained with 7 digit segments. But this is not sufficient for obtaining accurate results. For this we try the system accuracy with the sample inputs. If the digit is not correct then that particular digit is trained. The error is due to the greater probability while matching with the data set, hence the wrong character will be taken. This can be reduced by training the data set properly. This process is repeated till the accuracy improves. By this we can reduce the errors that occur due to segmentation

D. Result and Analysis

We mainly have two sets. Training Set: The System is trained using around 100 samples consisting of digits from 0 to 9.Training is performed by using OCR Application in MATLAB. Refer fig.1. Each character is trained with around 4 to 5 samples entered by the user. Further, during testing phase if a digit is not recognized by the system then it can be trained using OCR application. Testing Set: After the system is trained with the digits, each digit is tested and if a particular digit is unrecognized then it is added to the training set.

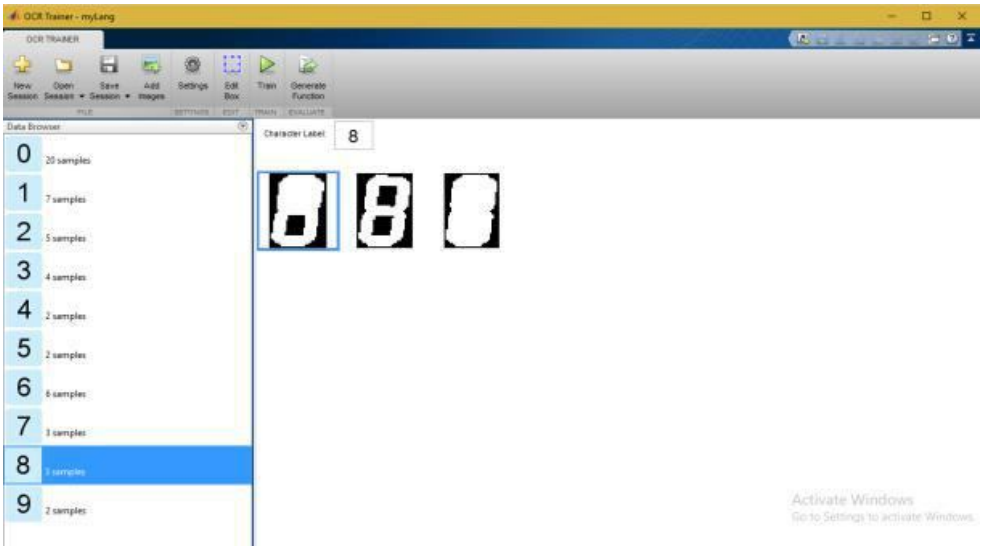

Fig. 1. Training set

III. MODULE DESCRIPTION

A. Image Processing Module

We proposed pattern extraction algorithm for automating the billing system. Optical Character Recognition is used in this project for performing the training of system with digits and for recognizing the digits in the energy meter. The input entered by user is taken as an image which is given to the OCR for recognizing the digit entered. In an OCR each character is located and segmented. By preprocessing techniques unique features of character are extracted to generate training set.

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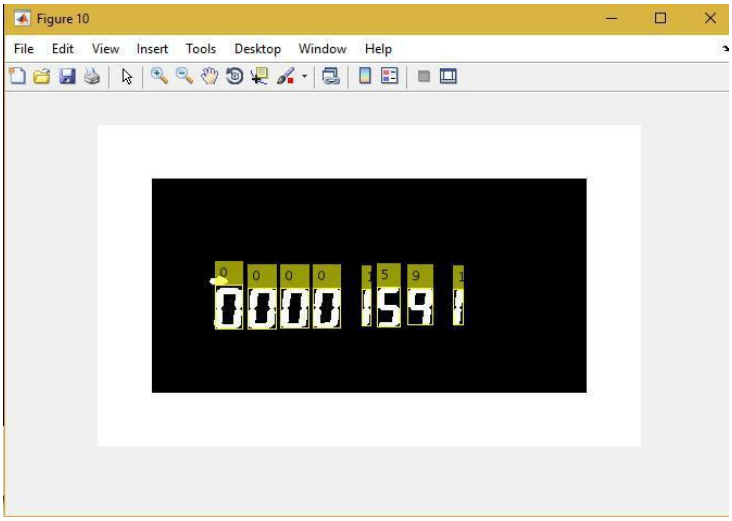

Fig. 2. Output after Image Processing and Digit Recognition

Pattern extraction algorithm consist of three main stages of image processing. This project is done mainly based on Canny Algorithm. A comparison between the image edge detection methods such as Sobel, Canny and Prewitt is also been done here by looking the difference in the output we obtain. In our final software we have options to select the Sobel, Canny and Prewitt methods. We do the project mainly based on Canny algorithm as it is assumed to be more accurate in edge detection. The common image processing steps can be briefed as follows: First step is Preprocessing: In the preprocessing step after the image is being captured, it is then re-sized to the required ratio. We have normally mainly four sub steps in image processing for extracting the digits which include Converting RGB to gray scale, Noise reduction ,Image Binarization and Crop reading area. econd step is Digit segmentation: The proposed idea behind digit segmentation is to scan the cropped numeric area vertically and horizontally from left to right. This is done by the OCR trainer. The OCR is trained with some inputs of our previously collected images. Refer fig.2 for output. Third step is Digit recognition: This step have two main processes which is connected with the digit segmentation process: Refer fig.3. The steps are feature extraction and template matching.

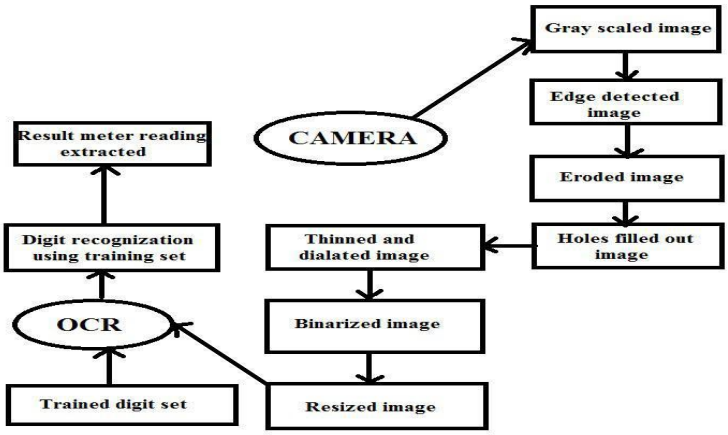

Fig. 3. Image processing module

B. Arduino Module

After the digit extraction ,the output of the digit recognition program is fed into the Arduino. The process of sending the extracted digit to arduino is done by using serial communication. The process takes place only if there is any value being alressady recognized by the OCR. Initial settings such as the baud rate which refers to the speed at which serial communication is done is all been set by default. Our number that is obtained is converted to string first. It is then sent by opening the port, After sending the data there is a pause of some time and then the port is closed. Refer fig.4. Arduino is a micro controller which has arduino program in it. Here we use Arduino 1.8+.Arduino micro controller is used for sending the extracted digit to the electricity board server

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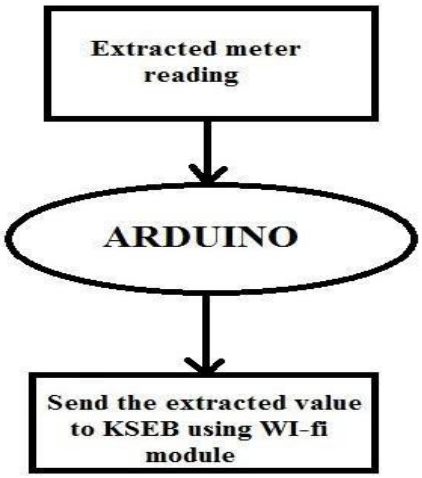

Fig. 4. Arduino module

C. Website Module

The K.S.E.B office server is now provided with accurate meter reading and it is updated in the database with the consumer details. The billing is done by converting the power consumption values in Kilo watt hour into monetary value based on currency exchange rate. Refer fig.5. The billing procedure is followed up by adding tax,tariff etc to the amount calculated.

intruders can't get the data.This allows the consumer to control his electricity consumption. Refer fig.7. The proposed system uses Android Studio,for implementing the application.

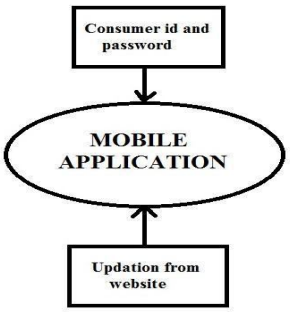

Fig. 5. Website module

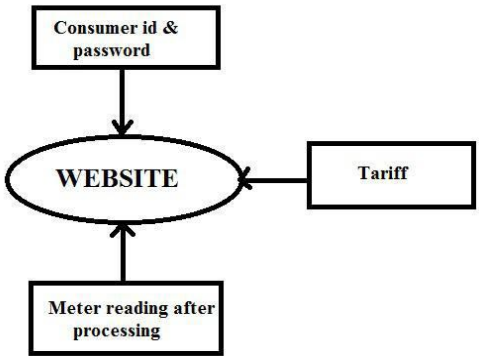

Fig. 6. Mobile Application module

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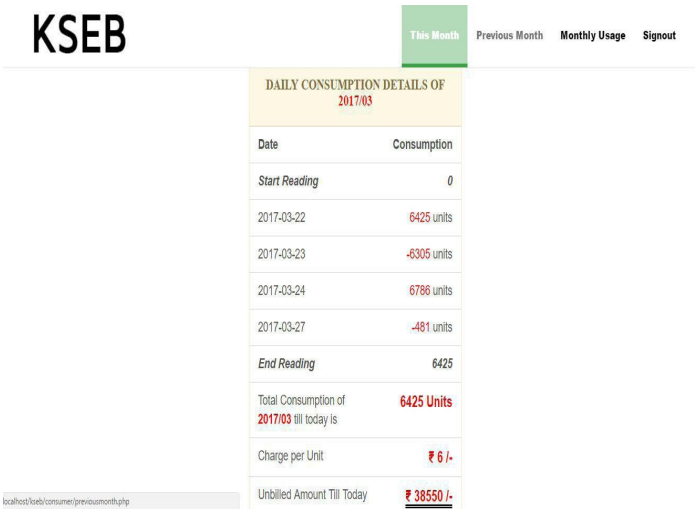

Fig.7. Output that is viewed by consumer.

IV. SYSTEM DESIGN

System design is the process of defining how the information system should be built, ensuring that the information system is operational and used. It also ensures that the system meets quality standards. At present bill generated during every month is not accurate enough. Refer fig.8. Customers are not able to manage the usage of electricity. If the unit reading of every month is known to the customer, he can reduce the usage upto a certain limit. Through this project we can know the current status of the unit and previous month's bill.

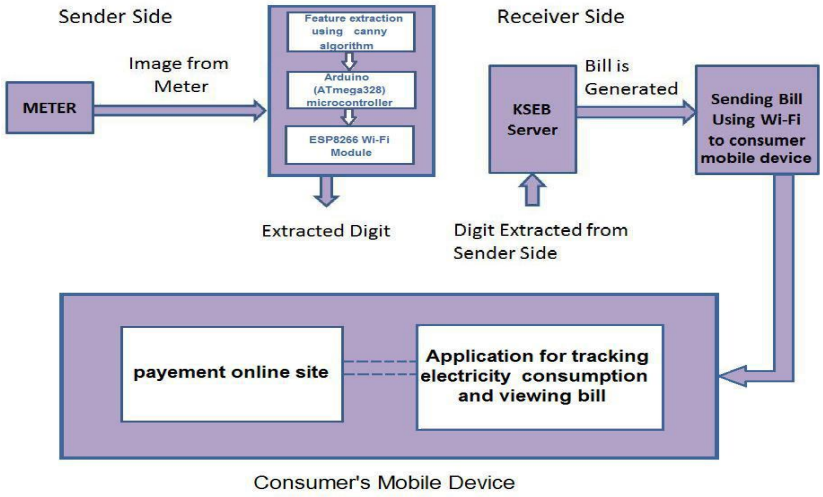

Fig. 8. System design of proposed system

D. Mobile Application Module

In our proposed system we make use of mobile application for consumers. In the mobile app the consumer know the details of the daily consumption of electricity. The consumer can also get the electricity bill and can pay it online. Refer fig.6. The mobile application also has log in id and password so other

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V. CONCLUSION

This paper presented automatic electricity meter reading system based on image processing. Comparison between various edge detection methods where also presented here. The proposed system shows that rather than manual procedure of taking electricity meter reading, we can implement a process in which the meter reading is captured with the help of a image capturing device. By applying the Edge Detection technology on captured image, we can extract the reading from the image and it is sent to the electricity board with the help of a network connection. The user can also track their daily electricity usage with help of an application that can be installed and used. This idea reduces the difficulty of the employee and increases the efficiency. Thus while implementing it would be at low cost with the desired results as the consumer wishes. In future we can implement this project without using camera. So we can reduce the implementation cost. The digit in the meter can be send to the server directly without fixing a camera in front of the energy meter.

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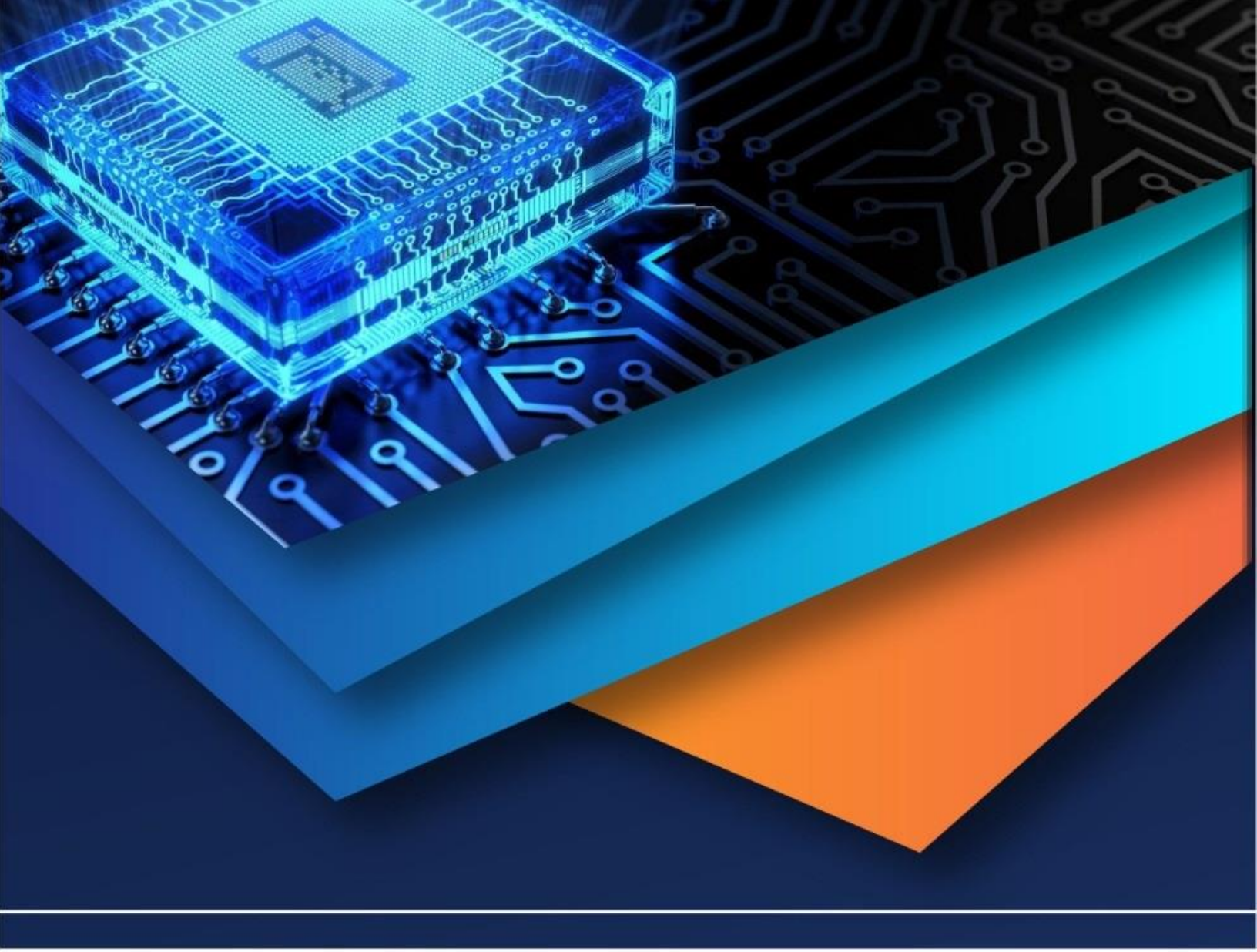

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