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Automated Electricity Meter Reader for Bill generation and Prediction of Electricity Consumption

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ABSTRACT: Traditional energy meter billing techniques use huge manpower as readers and also long working hours to gather complete data and to prepare the bills. Sometimes the energy meter is placed in a location that is not easily accessible. The manual billing system is sometimes restricted and is slowed down by bad weather condition. In a developing country like India, due to the increasing population and industrialization, automation in the traditional billing system is required. In the Automated Meter Reading concept, the meter readings are obtained by using the Internet of Things (IoT), it includes Raspberry Pi and camera which will be placed near the meter and camera will capture the meter reading from time to time, this reading will be in image format and further will be converted into text format by Seven Segment Optical Character Recognition (OCR) and will be uploaded on the database of power distribution companies. Then the saved data can be used for bill generation. We can also use this data for estimating the amount of electricity consumption an individual will do in future by using past records. This system provides benefits to both, electricity provider and consumer as it saves time, money and manual efforts of power distribution companies and provides efficient service and accurate electricity bills to consumers.

KEYWORDS: Electricity meter Reader, Internet of Things, Seven-segment OCR, Estimation of energy consumption, Statistical Approach, Raspberry Pi.

I.INTRODUCTION

Electricity is a crucial part of everyone's life. Electricity power consumers have increased immensely in every sector. Today there are a number of customers which use the electricity but they are not satisfied with the services provided by power distribution companies. The reason for this is inaccurate bills. Electricity is our daily need and hence it is very important to ensure we keep proper track of energy consumed by an individual to generate an accurate electricity bill. Traditional electricity billing involves manual techniques, here a person manually captures images of the electricity meter by going door to door and then the readings are obtained manually with a monthly timestamp. But this manual system is a restricted process and also have lots of drawbacks. The manual image capturing process can slow down in bad weather conditions and thus affect the accuracy of the bill. Also, in this COVID pandemic electricity billing system was hugely affected, as manual image capturing was not possible in the lockdown period, and power distribution companies used approximate readings by using the past records and thus there was an inaccuracy in bills generated during that period. In a traditional billing system, a huge number of human operators are required to collect the meter readings. Because of this Power distribution companies have to spend more money on the salaries of these human operators. All these drawbacks can be eliminated by automating the electricity meter reading system.

Many automated electricity meters are designed to upgrade the existing system, but up-gradation and changing of all existing electricity meters is a highly impractical and economically expensive solution for some power distribution companies. So instead of replacing the existing meters, we can modify the meter reading technique by fixing a reader module on the meter and obtaining the meter reading by using Optical Character Recognition (OCR). Also, data collected from different locations can be efficiently managed in a centralized database. And hence it will be very convenient to outsource this data for various operations like estimating the amount of energy that will be consumed in

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future by analyzing past records or even suggesting measures to be taken to save the excess consumption of energy. This is a motivation behind designing this system, which automates the meter reading process.

II. RELATED WORK

This section presents similar researches, the steps they followed in their systems, and the techniques they used in each step.

The paper [1] includes the technique of getting meter readings when needed, so meter readers don't need to visit every customer to collect energy usage data and distribute bills. The microcontroller can be used to monitor and record meter readings. In case of a customer default, there is no need to send someone to cut off the connection of the customer. The utility can cut and reconnect the client's connection via Short Message Service (SMS). In addition, customers can check the status of electricity (charge) from anywhere. In this system, the electricity meter reading is transmitted through the use of GSM.

In this paper [2] author introduces an image processing-based system that can efficiently and accurately obtain meter readings. In this system, the rear camera of the mobile phone is used to obtain the image of the electricity meter. The system then applies a series of image processing functions to automatically extract and recognize the digits from the meter reading image. The image goes through three main stages: pre-processing, which results in cropping the digital reading area, using horizontal and vertical scanning of the cropped digital area to segment individual numbers, and comparing each segmented number with a digital template Identifying the reading. The proposed system is implemented using Android Studio software with the OpenCV library and has been tested on 21 electricity meter images taken with a smartphone camera in Saudi Arabia. The results show that the recognition rate reaches 96.49% (per digit) and the meter reading accuracy rate reaches 85.71%. The proposed system will be used in the future to develop mobile applications, which can be used by power company employees to facilitate the reading process.

The author in [3] has designed a smart meter for automated billing and advanced metering systems. The integration of Arduino and the GSM Short Message Service (SMS) provides some predefined automatic functions for the meter reading system. The proposed electricity meter system can be used in combination with an integrated controller and a GSM modem to transmit data, such as energy consumption in kWh, generated bills, security services (line on / off) through the mobile network GSM, and then you can Data is entered and integrated into the management system of existing energy companies or organizations, and services can be provided between clients without the need for labor.
This [4] paper proposes a solution that includes Android applications and web applications. The proposed system will obtain meter readings, update the server with the reading unit, and notify consumers of the billing unit and amount. The Android application is used to automatically obtain meter readings simply by capturing an image of the meter. OCR (Optical Character Recognition) technology is used to extract meter units from an image. The counter unit is sent to the server. On the server-side, calculate the invoice amount.

In paper [5] author presents the framework of an Internet of Things (IoT) device as an automated industrial meter reader, uploading collected digital data to cloud storage for centralized data processing. The implementation of this device is done using Raspberry Pi as the platform. The device follows four steps: use the Raspberry Pi camera module for image acquisition, use feature extraction technology for optical character recognition, use Google Forms for the Internet upload mechanism, and use the spreadsheet from Google for online data processing. Equipment performance and debugging techniques are also discussed.

III. PROPOSED SYSTEM

The proposed system consists of the following stages 1. Image Acquisition, 2. Optical Character Recognition (OCR), 3.Bill Generation and Estimation of Energy Consumption. Given below fig.1 is a system architecture of the proposed system. The system uses IoT as the main technology for a meter reader. The reader is made of Raspberry Pi and a Raspberry Pi Camera Module for image acquisition. Further, OCR will process the captured image and will store the obtained meter reading in the central database. The stored data will be further used for bill generation and estimation of energy consumption.

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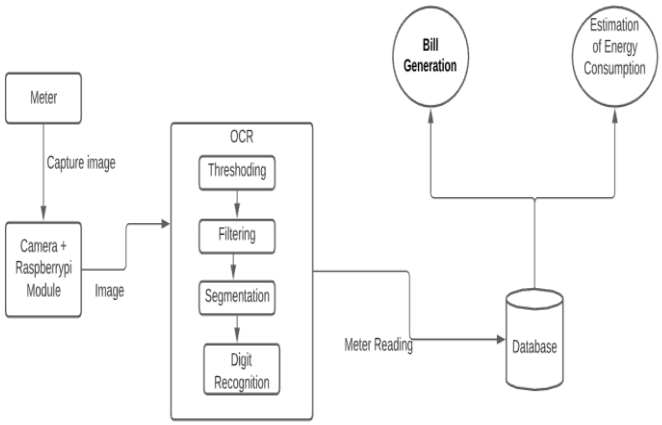

Fig 1: System Architecture

3.1 Image Acquisition

In this stage, Raspberry Pi and Raspberry Pi Camera Module will be placed at the perfect position in front of the electricity meter for image acquisition purpose. The PiCamera will be set at the distance from where our Region of Interest(ROI) i.e., LCD screen will be properly captured. We avoid taking the background area because we again will need to crop our Region of Interest from that, so to eliminate excess image processing and to reduce the computational requirement and processing time of the device we set PiCamera accordingly. The images will be captured after specific time intervals, on daily basis. Here, we keep track of meter reading on daily basis for accuracy and estimation purpose. Then the image captured by PiCamera will be sent to Raspberry Pi for further processing.

3.2 Optical Character Recognition (OCR)

Optical Character Recognition (OCR) is an algorithm that is used to convert the data given in image format to text format. Here we are using the seven-segment display OCR technique because the LCD is in the seven-segment display format. OCR includes various steps, in which the image will be processed and then the digits will be recognized. Given below in Fig.2 are the different processes included in OCR to obtain the meter reading from the image of LCD captured by PiCamera.

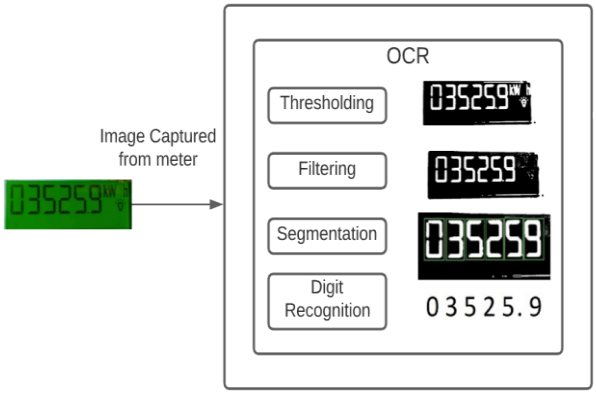

Fig 2: Optical Character Recognition

First, the image is converted to grayscale and then thresholded, Thresholding is a type of image segmentation, where we change the pixels of an image to make the image easier to analyze. Here we convert an image from grayscale into a binary image, i.e., one that is simply black and white. We use this process as a way to select the region of interest of an image. Then the thresholded image is filtered, Filtering is a process that removes the irrelevant data and background noise of the image. Once the image is filtered, we perform segmentation on it. In which the image will be segmented to separate digits and will assign each segment a close bounded box. Further, each segment will go through the

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recognition algorithm, where individual digit will be recognized by extracting some characteristic features. All the recognized digits will be then combined to form a complete meter reading.

3.3 Bill generation and Predicting Electricity Consumption

The data obtained from OCR will be then sent to the central database of the power distribution company through the internet and the stored data will be used to generate a bill. As we are obtaining data on daily basis, this data is used for estimating the amount of power consumption a person will do in future, and this is analyzed on the basis of past records. Here for estimation, we are using the statistical approach which takes the past records as the main input and predicts the approximate consumption of energy a consumer will probably do in future. By this estimation algorithm, one can also see the approximate bill amount that will be received at end of the month. All this will be calculated by using the pass records present on the central database.

IV. CONCLUSIONS

The proposed system is an automated electricity meter reader which is used to eliminate the manual image capturing process. The reader module captures the image using a RaspberryPi camera that is implanted in the constrained environment, which is having a minimum of 5.0 Megapixels of depth. The camera will automatically capture the image after the specified time interval. Further PiCamera sends the captured image to Raspberry Pi where Seven-segment Optical Character Recognition(OCR) translates the image to text format by going through various processes. The data obtained from this algorithm is further stored on the central database of the power distribution company and therefore will be used for electricity bill generation and for estimating the amount of power consumption a consumer will do in future.

V FUTURE SCOPE AND APPLICATIONS

Future prospects aim to develop an android application through which users can interact with it so as to get an update on the usage of electricity anytime when needed, also to set a limit on the usage, even get a reminder if the limit is crossed, payment of the bill and complain & enquire can be made from the application itself. Also, instead of a statistical approach, Machine learning algorithms can be used to predict the consumption of electricity. In case of any null values present in the meter reading database, it can be easily handled using Machine Learning algorithms and will give more accurate results. The present system is used for digital meters, in future, a combined algorithm can be designed, which will work on both digital and analog meters. A robust and comprehensive reader that captures and obtain a meter reading from any electricity meter and stores it in a central database will be very beneficial and will work fine without having to upgrade any existing meters.

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