# Intelligent Metering Device and Instrumentation Software

R.R.khandelwal, S. K. Shrivastawa, J.P.Kalambe and M.A.Hasamnis

*Abstract*-- **The aim of this project is to design an Intelligent Metering Device and Instrumentation software ,for curbing of transmission and distribution losses, power theft etc. This software based method is the most suitable method as compared to other methods because it does not need large scale replacement of existing metering system. It is user friendly too.**

**In this system images of meters are captured using digital camera ,mobile phone camera etc. On these images some Image processing steps are applied to make the image compatible to the ANN module. Neural networks are a powerful techniques to solve real world problems. Various learning mechanisms exist to enable the Neural Network acquire Knowledge. We can represent such information , and any subsequent information ,in a much reduced fashion using Competitive Networks .The same can be used for pattern recognition ,which is mainly used here for energy metering. This process can be done either by supervised method or by unsupervised method. But unsupervised way is more suitable for this system Results have been presented in the paper using MATALAB based ANN module and GUI module .**

*Keywords*-- **ANNModule , GUI, Image processing**

## I. INTRODUCTION

A developing country like India will go for optimization techniques on a large scale which will finally result in achieving excellence in industry. Power industry is also not an exception to this. In India, the losses due to power thefts are to the tune of twenty thousand crores as per the various reports. As per the category of consumers, when these losses are classified, it is evident that accurate metering and further correct acquisition is very important and crucial. For this, various smart instrumentation techniques are used. These methods are based on smart sensors that provide the following advantages: -

1) Such systems are reprogammable and help in assessing their raw data programmes and results with the help of external communication port.

2) Adaptive to environment thereby optimizing their sensor detection performance, power consumption and communication activity.

3) Helps in extracting information from raw data so that it should be self learning process.

4) Such systems are self decisive and can easily predict future pattern and can provide necessary action for them.

The curbing of transmission and distribution losses, annual power theft etc. is necessary. These could not be curbed because of unavailability of efficient method. The aim of this project is to design an Intelligent Energy Metering and Instrumentation software System, which can avoid transmission and distribution losses and power theft. This software technique is most suitable technique as compared to other method for implementing such system. Besides this method does not need large scale replacement of existing metering system .It is user friendly too.

## II. MAIN PARTS OF THE SYSTEM

The entire system is divided into following parts **:-**

1) An image capturing set up
2) Image preprocessing module
3) MATLAB based ANN module
4) Bar code decoding and GUI module
5) Customer database handling

### *A. AN IMAGE CAPTURING SET UP*

Image capturing set up has a mechanical arrangement on which the image capturing device and meter is set. Here the image capturing device is a digital camera. The adjustment of camera height and distance from the meter is possible on the mechanical bench as shown in fig. 1

Phantom loading is constantly provided to the meter. Camera is connected to PC through an USB interface. To capture the image of the meter in consistent environment the camera is switched at regular intervals. By using this set up consistent environment can be maintained in which image is

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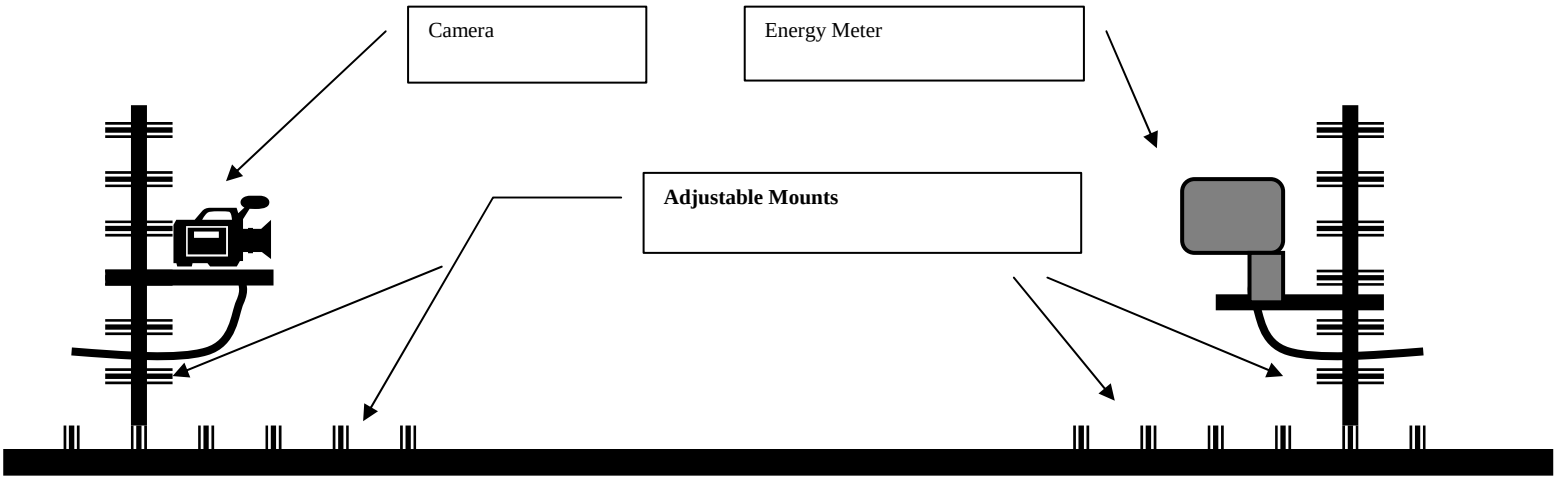


Fig.1 Image capturing set up

captured Figure 2.1. These captured images are sent to PC for recognition[3] .

It is to be noted that the main parameters are to be maintained consistently and whenever the image is captured their values should not be changed, otherwise the quality of image captured may affect the result.

Any residual variation in such parameters would bring wrong result as ANN would fail to classify the distorted input sample pattern. In such cases a super tuning is required for correct classification. This makes the ANN capable of identifying such patterns also[11]. These parameters are as follows -

1) The characteristics of the camera like resolution etc.
2) The angle at which the photograph is taken.
3) The distance at which the image is captured.
4) Type of meter and its window surface and other parameters like colour, material etc.
5) The illumination available.

*B. IMAGE PREPROCESSING MODULE*

The idea behind image preprocessing is to bring out detail that is obscure, or simply to highlight certain features of interest in an image[1]. Before actual recognition the image must be made first compatible to the ANN module by bringing it to desired levels of various parameters like resolution, colour, size, etc[10]. This is because even after maintaining the consistency in the environment a slight change in any of the parameters changes the nature of image in a way, which finally may result in misclassification. Hence it is necessary to make the image compatible to the input of ANN module so that the digits are correctly identified. This also avoids further need of retraining of ANN. This preprocessing is divided into following sub processes :-

a) Separate the reading and barcode strip

b) Converting the acquired RGB image into gray format Figure 2.2

c) Cropping the image to acquire only the reading strip and image of bar code from the entire image of the meter Figure 2.3

d) Resizing each individual image matrix into predesired matrix size so that all images will be of same size and shape

e) Use suitable filtering techniques to minimize distortions Figure 2.4

f) Using thresholding, finally each individual image of the separated digit is converted into binary image [7] Figure 2.5

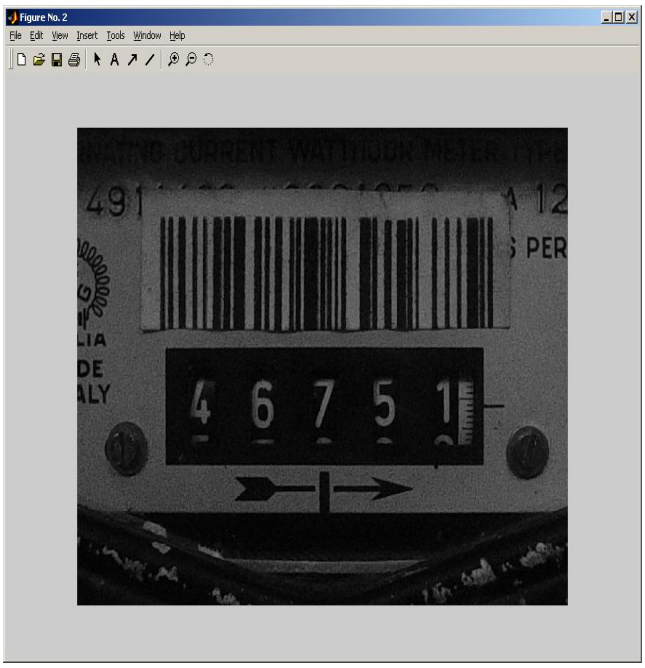


Fig. 2.1 Original colored Image of the meter


Fig. 2.2 The output of RGB2GRAY

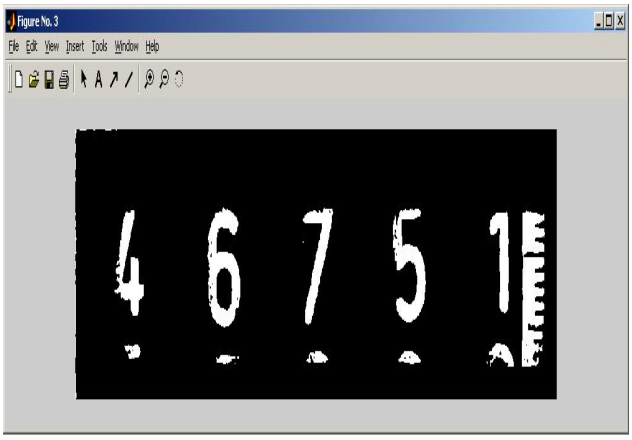


Fig.2. 3 First phase cropping to acquire only reading strip


Fig. 2.4 Filtered image

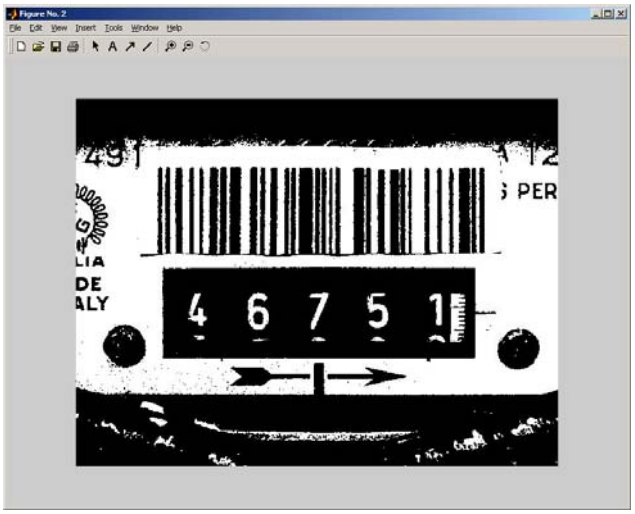


Fig. 2.5 The binary converted image

### *C. MATLAB BASED ANN MODULE*

Neural Networks ,which are simplified models of the biological neuron system ,is a massively parallel distributed processing system made up of highly interconnected neural computing elements that have the ability to learn and thereby acquire knowledge and make it available for use[4]. In addition to that they are able to deal with incomplete information or noisy data and can be very effective especially in situations where it is not possible to define the rules or steps that lead to the solution of a problem. Neural networks are a powerful technique to solve many real world problems[8].

Various learning mechanisms exist to enable the Neural Network acquire Knowledge. We can represent such information, and any subsequent information, in a much-reduced fashion using Competitive Networks or Self Organized Maps. The same can be used for task of pattern recognition, which is mainly used here for energy metering. This process can be done in two ways, either by supervised method or by unsupervised method. Supervised ways need complex algorithm of feature extraction for each sample image of each digit and is suitable only when classification is to be done between multiple alphanumeric characters, that too of various styles[6]. As here the input is only of numeric type and will be captured for same type of meters, repeatedly with same illumination, distance and surroundings, there will be large consistency in the images produced by the image capturing set up. Hence unsupervised way of training is finally chosen.

The entire module is designed using MATLAB. The module is divided in two main part

1) *Training module***:** This is mainly responsible for training the unsupervised ANN for correct classification of digits. It works mainly on Winner's take all algorithm. K-means algorithm is used for making clusters of the digits[5].

2) *Calibration module:* This module maps the winning nodes to the respective classes which finally helps in identifying the given test sample pattern (digit).

D. BARCODE DECODING AND GUI MODULE

In this module the bar code strip is separated from the meter image and same steps of preprocessing are applied on barcode which are applied on reading strip. After preprocessing steps binary image of barcode is achieved from which decoding is done. Bars in barcode give information about various parameters like city, area code and customer id. etc figure 3. This barcode module creates output in the form of an array containing values of widths in pixels for all bars of the barcode figure 4. Finally the output array of decoded numbers of this module send this information to database module which updates the customer consumption record, which is further, used for billing[2].

GUI is a pictorial interface to a program. A good GUI can make programs easier to use by providing them with a consistent appearance and with intuitive controls like push buttons, list boxes, sliders, menus and so on. The GUI should behave in an understandable and predictable manner, so that user knows what to expect when an action is performed figure 5.

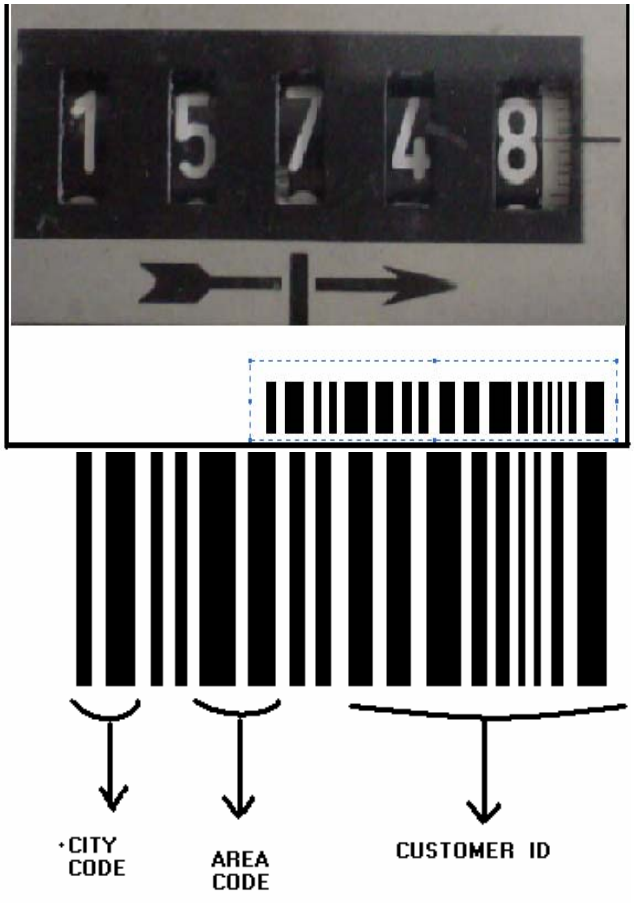


Fig.3 Barcode Specification

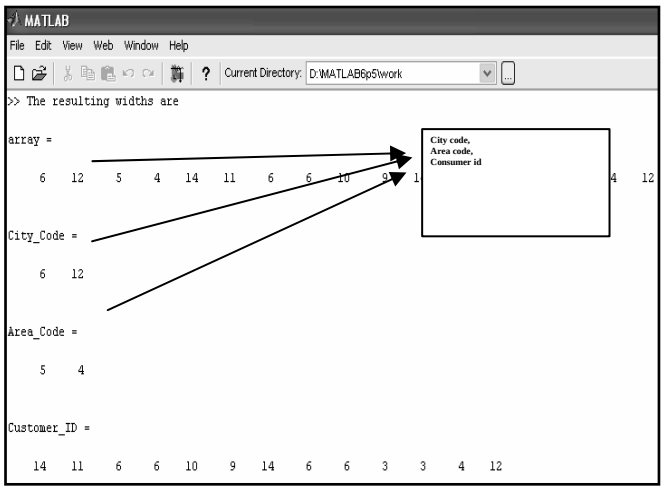


Fig.4 Result of barcode analysis

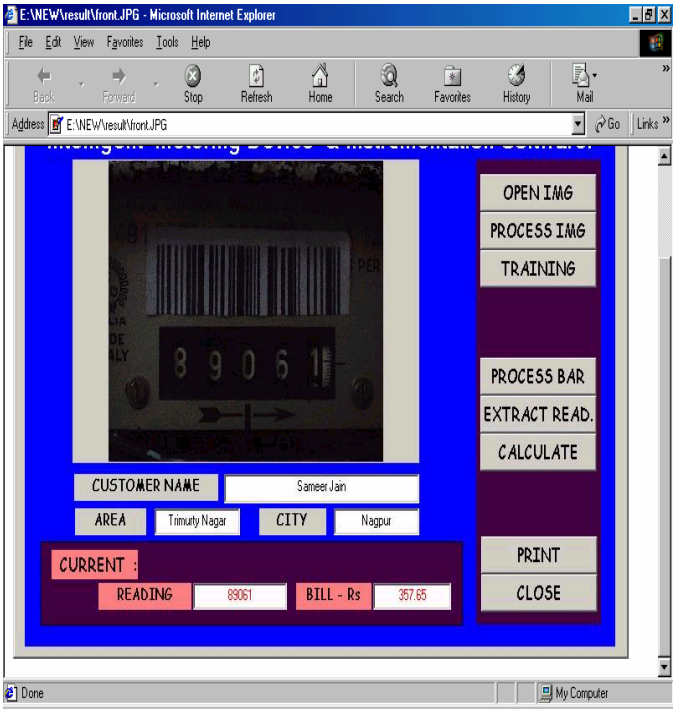


Fig. 5 GUI window shows the current reading and Bill in Rs.

*E.CUSTOMER DATABASE MANAGEMENT MODULE*

This module of database management system is connected to MATLAB module to process and store reading acquired[9]. This is for customer database handling. Finally printed bill will be received figure 6.

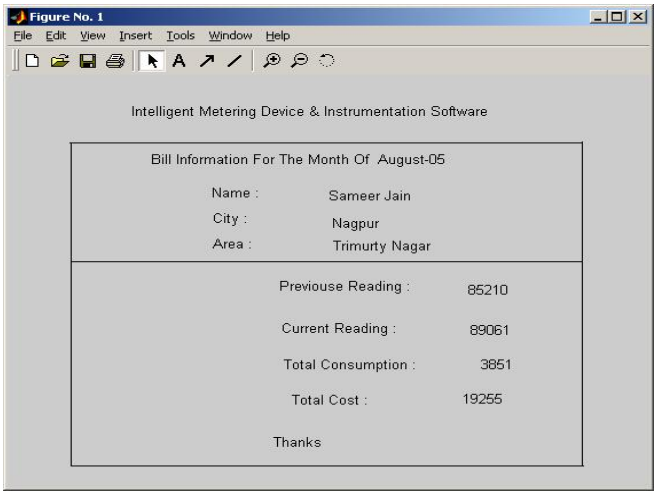


Fig. 6 printed Bill of the customer

## III. CONCLUSION

This software helps Electricity Board to reduce the transmission and distribution losses and increases the accuracy in meter reading.Therefore in the past few years it is seen that the Electricity Board in India are slowly and gradually increasing their familiarity with electronics.This Intelligent Metering Device and Instrumentation Software is beneficial because of the following reasons-

It is accurate .

It is technology wise backward compatibe i.e.no large scale need of replacement of existing meters.

It is user friendly.

## IV. REFERENCES


*[1] Earl Gose, R. Johnsonbaugh and S.Jost, "Pattern recognition and image analysis", PHI, New Jersey, 1997,pp.*

[2] Richard O.Duda,Peter E.Hart, David G.Stork,"Pattern Classification", A Wiley –Interscience Publication

[3] A.K.Jain, "Fundamentals of digital image processing", PHI, New Jersey

[4] Jacek M. Zurada, "Introduction to artificial neural systems", Jaico publishing house, Mumbai,1994,pp.

[5] Jacek M.Zurada,"Introduction to Artificial Neural Systems"

[6] B.Yegnanarayan,"Artificial Neural Networks"

[7] Rafael C. Gonzalez, Richard E. Woods, " Digital Image Processing", Prentice Hall Publications

[8] Gonzalez, Richard E. Woods," Digital Image Processing Using MATLAB", Prentice Hall Publications

[9] Stephen J.Chapman,"MATLAB programming for Engineers", Thomson publications

[10] Arthur R. Weeks,Jr ,"Fundamentals of Electronic Image Processing", Prentice Hall Publications

[11] Kishan Mehrotra, Chilukuri K. Mohan, Sanjay Ranka, ''Elements of artificial neural networks''.


## V. BIOGRAPHIES

**Ms. Richa Khandelwal**, born in Gwalior in India on June 05, 1976. She graduated from Madhav Institute of Technology and Science, Gwalior (Madhya Pradesh) and studied her post graduation in Electronics Engineering from Yeshwantrao Chavan College of Engineering, Nagpur , (Maharashtra State).

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His employment experience includes 21 years . He is having to his credit 29 research paper at International and National levels. He is Technical Advisor to many colleges in India for planning & development related work,.Consultant to number of Education Groups**Nikola Tesla** (M'1888, F'17) was born in Smiljan in the Austro-Hungarian Empire, on July 9, 1856. He graduated from the Austrian Polytechnic School, Graz, and studied at the University of Prague.

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