*International Journal of Applied Information Systems (IJAIS) – ISSN : 2249-0868*
*Foundation of Computer Science FCS, New York, USA*
*2nd National Conference on Innovative Paradigms in Engineering & Technology (NCIPET 2013) – www.ijais.org*

# Mechanical Nut-Bolt Sorting using Principle Component Analysis and Artificial Neural Network

Amol Dhenge
Y.C.C.E, Nagpur

A.S.Khobragade
Y.C.C.E, Nagpur

Ambarish Salodkar
A.R.M.I.E.T, MUMBAI.

## ABSTRACT
The main aim of this paper is to build a method for recognition of bolt and nut which can be useful in mechanical industries. The objective of this study is to develop the image processing algorithm using principle component analysis to get the normalized resize images which would be suitable inputs for processing and detection. The Matlab software version 2011a is used to integrate all algorithms. This implementation also justify a prototype that emulates the sorting of nuts and bolts. The input is image through the high performance camera which is pre-processed at the suitable level. The image is then applied the principle component analysis (PCA) for the feature extraction. The resultant is given to the artificial neural network (ANN) system can detect object accurately and them accordingly as required for the application.

## General Terms
Pattern Recognition.

## Keywords
Pattern recognition, bolt and nut, principle component analysis (PCA), artificial neural network.

## 1. INTRODUCTION
There are things at which humans are still way ahead of the machines in terms of efficiency one of such thing is the recognition especially pattern recognition. There are several methods which are tested for giving the machines the intelligence in a efficient way for pattern recognition purpose. The artificial neural network is one of the most optimization techniques used for training the networks for efficient recognition.

Computer vision is the science and technology of machines that can see. The machine is made by integration of many parts to extract information from an image in order to solve some task. As a scientific discipline, computer vision is concerned with the theory behind artificial systems that extract information from images. Each of the application areas described above employ a range of computer vision tasks; with more or less well defined measurement or processing problems, which can be solved using a variety of methods. Some examples of typical computer vision tasks are presented below. Recognition is the classical problem in computer vision, image processing, and machine vision. It is related to the determination of whether or not the image data contains some specific object, feature, or activity. This task can normally be solved robustly and without effort by a human, but is still not satisfactorily solved in computer vision for the general case, involving arbitrary objects in arbitrary situations. The existing methods for dealing with this problem can at best solve it only for specific objects, such as simple geometric objects, human faces, printed or handwritten characters, or vehicles, and in specific situations, typically described in terms of well-defined illumination, background, and pose of the object relative to the camera ([1]–[6], [8], [11],[17]).

The bolt and nut is a sample of a automobile fixer that mechanically joins or affixes two or more objects together. Fixers can also be used to close a container such as a box, or a tyre etc. Principle component analysis is a technique that will be suitably used for the application purpose for sorting of nuts and bolts. MATLAB is the abbreviation of matrix laboratory, which has several hundred built-in functions packages and thirty kinds of tool kits.

In this paper, we use the MATLAB and implement the principle component analysis and artificial neural network for image processing and detection. The optimization algorithm has less iteration than implementation with Artificial Neural Network process for the same task and other improved algorithms while the convergence rate is faster and the precision is higher [7,17].

Curve figures in terms of perimeter radius are used as feature extraction ([6], [10], [12]) for recognizing objects.

This method is efficient and more suitable for real time recognition systems compared with previous research [5, 7, and 17], because we can get better iteration time, speed of belt conveyor and accuracy. This paper is organized as follows; software implementation is proposed in the section 2. Methodology and hardware details are presented in section 3. The result and discussion are presented in section 4. Finally, section 5 presents the conclusion on the findings.

## 2. METHODOLOGY
A software framework is designed using the MATLAB which is more suited for the image processing application due to its basic matrices. The process start with image acquisition where image will be capture using the high resolution camera, follow by pre-processing of the images captured to reduce the image for its unified size. Images are then converted to gray scale and double precision image for the analyzing process. After the images have been pre-processed, the principle component analysis is determined. Lastly according to the parameter of PCA, the status of a TRAINING process can be determined

by using neural network and action can be taken to follow up this result [15].

### 2.1 Configuration database

This configuration is used for configuring the information such as image size and image resolution. In this case, image size is fixed i.e. 100 x 100 pixels, and the image input format is in gray scale.

### 2.2. Image processing feature extraction

Image processing feature extraction consists of principle component analysis methodology for getting the unique feature vector.

### 2.3. Artificial neural network

Artificial neural network is the soft computing optimisation technique which is used to give the train result in a efficient way depending on the training set of data.So, it is essential to give artificial neural network proper training input vectors which is nothing but the principal component analysis highest eigen values. These values are different and unique for the input datasets.

.

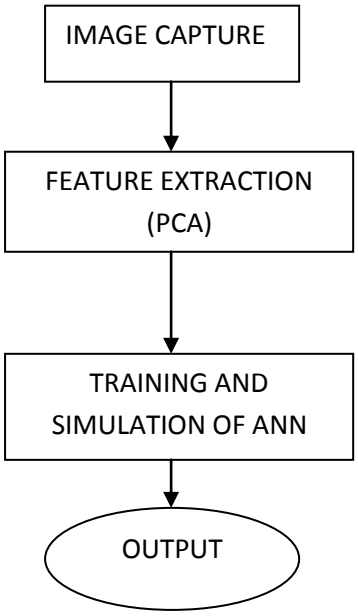


Fig1. Main stages of program

## 3. HARDWARE PROTOTYPE

The framework starts when mental sensor detects the presence of a moving object on the belt conveyor. This signal is provided to the microcontroller unit that tells Matlab program that a nut or bolt is present in front of the webcam. With a response time of less than 250 ms, the sensor via the controller system initiates the web camera to capture the object. The captured image then will be processed by computer using image processing and PCA transform, finally sending the output signal to the microcontroller ATMega32. As an actuator, the

microcontroller which is connected to a personal computer via serial port RS232, orders the Smart Peripheral Controller (SPC) motor to differentiate the bolt and nut as fig.1.[17].

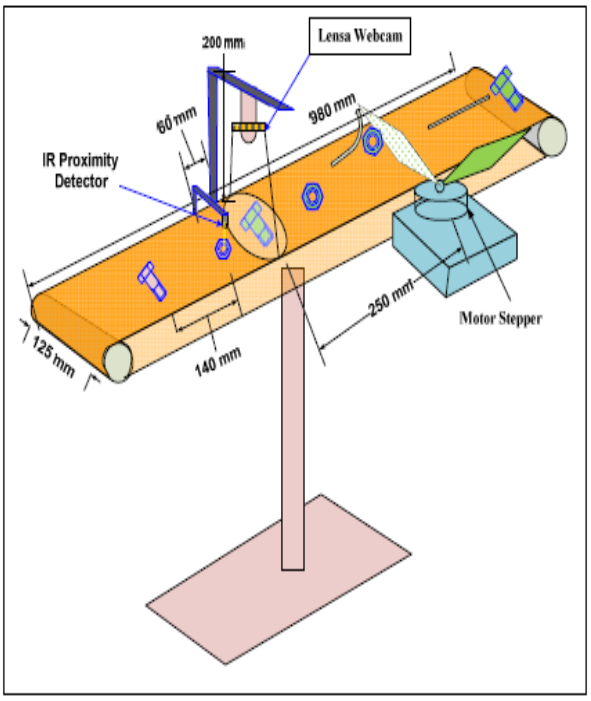


Fig.2 Layout of the prototype

The hardware system provides a communication between the prototype setup and the Matlab code. The microcontroller is programmed using C language and controls the input and output of the system. The microcontroller can also control the speed of the conveyor in case the Matlab code goes slow due to heavy processes running on the machine..

## 4. RESULTS

After the neural network simulation, we have a final result for each bolt and nut as shown in Fig. 3 and Fig. 4.

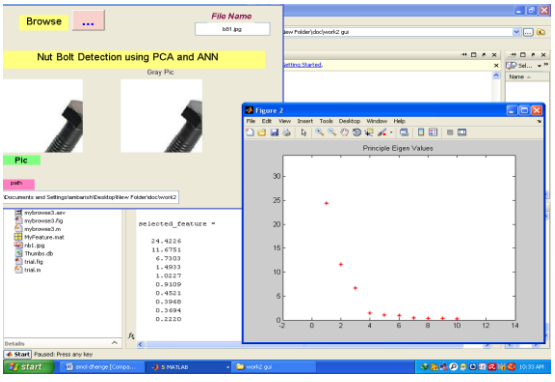


Fig.3 PCA graph for Bolt

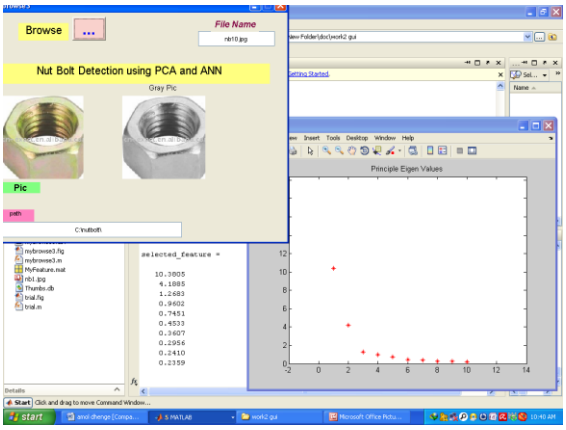


Fig.4 PCA graph for nut

The results of principle component analysis of testing can be seen in the Fig. 2 and Fig. 3. By using the heuristic method for three types of bolt and nut, we can decide that for an output value of less than 0 to almost zero is defined as a nut, whereas the output value of greater or equal to 1 to almost one is defined as a bolt.

## 5. CONCLUSION

The result achieved on the database 23 set of different nut and bolt shows good result with very high accuracy for any directivity of nut or bolt. So further hardware implementation can give good success rate which should depend on speed of belt conveyor, and types of bolt and nut.

## 6. ACKNOWLEDGMENTS

Our thanks to the experts who have contributed towards development of the paper.

## 7. REFERENCES

[1] Akbar H. and Prabuwono A. S., "The design and development of automated visual inspection system for press part sorting," in *Proc. International Conference on Computer Science and Information Technology (ICCSIT'08)*, 2008, pp. 683-686.

[2] Akbar H. and Prabuwono A. S., "Webcam based system for press part industrial inspection," *International Journal of Computer Science and Network Security*, vol. 8, pp. 170-177, Oct. 2008.

[3] Akbar H., Prabuwono A. S., Izzah Z., and Tahir Z., "Image processing algorithm in machine vision approach for industrial inspection," in *Proc. the 1st Makassar International Conference on Electrical Engineering and Informatics (MICEEI'08)*, 2008, pp. 58-62.

[4] Akbar H. and Prabuwono A. S., "Automated visual inspection (AVI) research for quality control in metal stamping manufacturing," in *Proc. the 4th International Conference on Information Technology and Multimedia (ICIMU'08)*, 2008, pp. 626-630.

[5] Dewanto S., Suwandi, T. and Yanto, E., "Sistem sortir mur dan baut menggunakan jaringan syaraf tiruan," *Jurnal Teknik Komputer*, vol. 13, no. 1, pp. 1-13, 2005.

[6] Kyaw M.M., Ahmed S. K., and Md Sharrif Z. A., "Shape-based sorting of agricultural product using support vector machines in a MATLAB/SIMULINK environment," in *Proc. 5th International Colloquium on Signal Processing & Its Applictions (CSPA'09)*, 2009, pp. 135-139.

[7] Zhao Z., Xin H., Ren Y., and Guo X., "Application and comparison of BP neural network algorithm in MATLAB," in *Proc. International Conference on Measuring Technology and Mechantronic Automation*, 2010, pp. 590-593.

[8] Lahajnar F., Bernard R., Pernus F., and Kovacic S., "Machine vision system for inspecting electric plates," *Computers in Industry*, vol. 47, no. 1, pp. 113-122, Jan. 2001.

[9] Liu L., Chen J., and Xu. L., Realization and Application Research of BP neural network based on MATLAB, 2008.

[10] Nooritawati M. T., Aini H., Salina A. S., and Hafizah H., "Pengecaman insan berasaskan kaedah profil sentroid dan pengelas rangkaian neural buatan," *Jurnal Teknologi Universiti Teknologi Malaysia*, pp. 69-79, Sep. 2010.

[11] Prabuwono A. S. and Akbar H., "PC based weight scale system with load cell for product inspection," in *Proc. International Conference on Computer Engineering and Technology (ICCET'09)*, 2009, pp. 343-346.

[12] Prabuwono A. S., Sulaiman R., Hamdan A. R., and Hasniaty A., "Development of intelligent visual inspection system (IVIS) for bottling machine," in *Proc. IEEE Region 10 Conference of TENCON*, 2006, pp. 1-4.

[13] Saad H. and Hussain A., "Classification for the ripeness of papayas using artificial neural network (ANN) and threshold rule," in *Proc. 4th Student Conference Research and Development*, 2006, pp. 132-136.

[14] Siang J. J., *Jaringan Syaraf Tiruan & Pemogramannya Menggunakan Matlab*, Penerbit ANDI, Jogjakarta, 2005.

[15] A.S. Prabuwono, Y. Away, and A.R. Hamdan, Design and Development of Intelligent Vision System for Quality Control in Bottling Production Line, Proceeding of FTSM UKM Postgraduate Seminar, 2004, pp. 138-141.

[16] L.N. Wayne, The Automated Inspection of Moving Webs using Machine Vision, IEE Colloquium in Application of Machine Vision, 1995, pp. 3/1-3/8.

[17]" Recognition of Bolt and Nut using Stationary Wavelet Transform*"Ambarish Salodkar, M.M.Khanapurkar. International Conference on Emerging Frontiers in Technology for Rural Area (EFITRA) 2012 Proceedings published in International Journal of Computer Applications® (IJCA)*