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## Recognition of Online Handwritten Characters Using LIPI Toolkit

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**Abstract:** *Handwriting deformation and complex structure have been one of the most challenging problems in handwritten recognition. In this paper, a online handwritten recognition tool has been for recognition. Online handwriting data is collected as strokes, where a stroke is defined as the sequence of data points captured from the event of a pen-down to the subsequent pen-lift. Lipi toolkit engine is used to develop the character recognition system. Lipi toolkit is open source engine. The engine uses backpropagation and nearest neighbour for pattern classification and recognition which employs unsupervised learning algorithms. It has shown that the Lipi engine is feasible for online handwritten English character recognition to a certain degree.*

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**Keywords:** *Online Handwritten Character Recognition, Lipi Toolkit, Artificial Neural Network, Nearest Neighbour, Android.*

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### I. INTRODUCTION

Character Recognition helps in automation. It helps to reduce human effort. However, it becomes complex to recognize handwriting because of overlapping and different variations in writing. There are two types of Character Recognition- Offline and Online. Offline is also called static approach and Online is called as dynamic. In offline the imaged is scanned and then the digital output is obtained whereas in online the machine recognizes the handwriting while the user writes on the surface of a digitizing tablet with fingertip [1]. This paper aims to explore the availability of the Lipi engine for online handwritten character recognition. Lipi toolkit supports various languages and provides default libraries of these languages.

### II. LIPI TOOLKIT

Lipi toolkit is a generic toolkit which helps in the recognition of characters. The toolkit helps in robust implementations of tools, algorithms, scripts and sample code necessary to support the activities of training and evaluation. For researchers toolkit act as a testbed of testing various scripts. The toolkit is designed in such a way that it can help to develop new algorithms according to the requirement of the script. It provides flexibility to tune and replaces any component according to the requirements. Lipi toolkit is majorly used by Handwriting recognition Researchers, Application Developers, Tech Enthusiast and Handwriting recognition vendor. Lipi toolkit is supported by Windows and Linux platform. The components of the toolkit are implemented using C++ & STL, using ANSI functions to address portability issues. Some of the utilities are written in Perl. The toolkit provides an implementation for Pre-processing algorithms, Feature extraction algorithms, Shape recognition algorithms, Word recognition algorithm. The toolkit helps in the recognition of characters as well as a string of characters. Lipi toolkit is used for developing an application on Android devices [5].

### III. FLOW OF PROPOSED SYSTEM

In Android, the screen is a source of input. Pre-processing helps to reduce unwanted noise and distortion. It helps to remove variations and normalized character. Feature extraction helps us to discriminate and extract the exact source. Classification and Recognition helps to match input images with the trained set. It looks for an exact match with the existing pattern and displays the output [1].

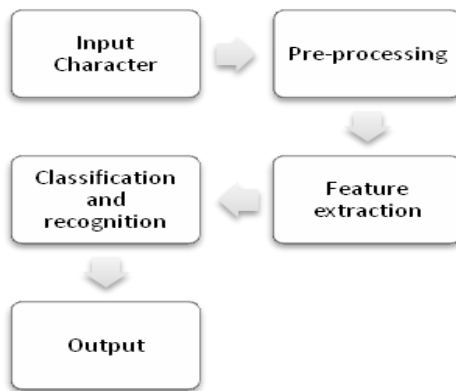


Fig. 1 Flow of System

#### IV.METHODODOLOGY AND ALGORITHMS USED FOR DEVELOPING THE APPLICATION

Lipi engine is the controller that loads all the modules (logger, pre-processor, a feature extractor, recognizer) required for a particular project configuration. The lipi engine sets the log file name and the log level for the current project.

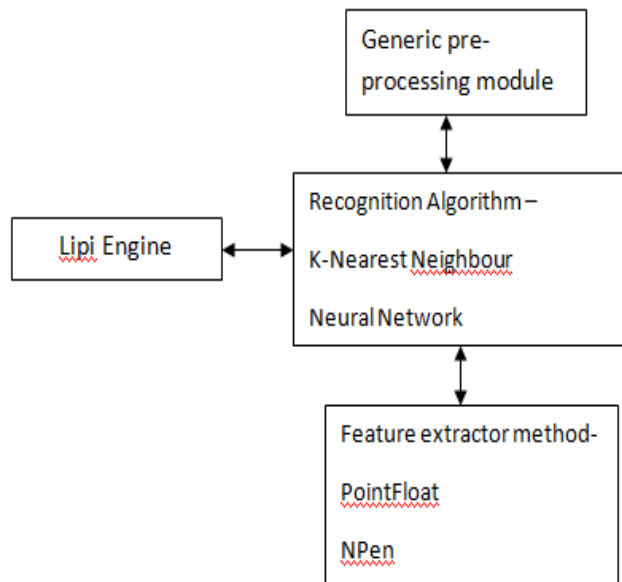


Fig. 2 Architecture of developed application

##### A. Pre-processor

LTK Pre-processor module provides implementation for commonly used character pre-processing operations such as

- 1) *Moving average smoothing*: it helps to filter and remove noise helps to allow important patterns to stand out.
- 2) *Normalization of size*: It is scaling method and useful for the transformation of data.
- 3) *Equidistant resampling*: Helps in resizing an image. Also, helps in reducing or increasing its number of pixels.

##### B. Feature Extraction

###### 1) Point Float Shape Feature Extractor

It extracts the following features from each point along the stroke trajectory:

- X dimension - The X-Coordinate of the point
- Y dimension - The Y-Coordinate of the point
- Sine theta – Sine of the angle between the line segment joining two adjacent points and the X-axis (Note: Though the value of sine theta ranges from [-1 1] the extracted value for this feature has been normalized to the range [0 10])
- Cosine theta – Cosine of the angle between the line segment joining two adjacent points and the X-axis (Note: Though the value of sine theta ranges from [-1 1] the extracted value for this feature has been normalized to the range [0 10])
- Pen up – This is true if the point is the last point in a trace; otherwise set to false.

C. *Recognition Algorithm*

Supervised learning algorithm is used for training the character. It consists of one input layer, more than one output layer and some intermediate layers. The backward propagation is a common method of training artificial neural networks. The algorithm repeats a two-phase cycle, propagation and weight update. When an input vector is given to the network, it is propagated forward, layer by layer, until it reaches the output layer. The output of the network is then compared to the desired output and an error value is calculated for each of the neurons in the output layer. The error values obtained are then propagated backward, starting from the output, until each neuron has an associated error value. The error rate is decreased using back propagation.

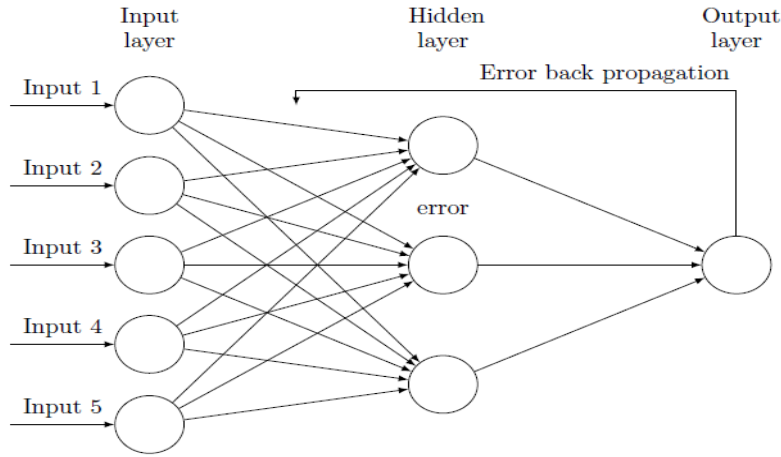


Fig.3 Back propagation neural network

The back propagation learning algorithm [7] can be divided into two phases:

1) *Propagation*[2]

Each propagation involves Forward propagation of a training pattern's input through the neural network in order to generate the propagation's output activations. Backward propagation of the propagation's output activations through the neural network using the training pattern target in order to generate the deltas (the difference between the targeted and actual output values) of all output and hidden neurons.

2) *Weight update*[2]

For each weight-synapse multiply its output delta and input activation to get the gradient of the weight. Subtract a ratio (percentage) from the gradient of the weight.

The K-Nearest Neighbour classifier which is data mining algorithm for shape recognition. It helps in mapping the input character to a trained set of characters. Nearest neighbour search, also known as proximity search, is the optimization problem of finding the point in a given set that is closest (or most similar) to a given point. The nearest Neighbour algorithm is a method of classifying the test sample based on the closest training samples in the feature space. Using the concept of majority voting of neighbours, an object is classified with being assigned to the class most common amongst its k nearest neighbours, where k is a positive integer (typically small). If k = 1, then the object is simply assigned to the class of its nearest neighbour. The best choice of k depends upon the data. Generally, larger values of k reduce the effect of noise on the classification. The commonly used distance metric is Euclidean distance.

V. TESTING AND RECOGNITION

Test of application developed using Lipi toolkit is done on Samsung Galaxy and HTC E9 plus phone.

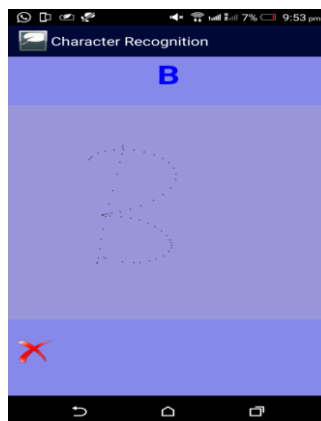


Fig.4 Screenshot of Character Recognized



Fig.5 Screenshot of Character Recognized

### CONCLUSION AND FUTURE WORK

The application developed helps to recognize handwritten English alphabets and convert it to digital format. The experiment shows that the online handwritten character recognition based on the Lipi engine is flexible as we can use the required set of tools and algorithm required by the script. Accuracy obtained using lipi toolkit for recognition of uppercase [A-Z], lowercase [a-z] and numbers [0-9] is 90%. The system is also able to convert recognize character to speech using text to speech engine. Further, this work can be extended for recognition on various scripts. It is also suggested to enhance the accuracy rate.

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