

# **TEXT DETECTION AND CHARACTER RECOGNITION USING MORPHOLOGICAL OPERATION**

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**BACHELOR OF TECHNOLOGY IN  
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**MAY, 2019**

## DECLARATION BY CANDIDATES

I hereby declare that the work reported in the B. Tech thesis entitled “**Text Detection and Character Recognition Using Morphological Operation**” submitted at “**Jaypee University of Information Technology, Wagnaghat India**”, is an authentic record of my work carried out under the supervision of “**Dr. Nafis U. Khan**”. I have not submitted this work elsewhere for any other degree or diploma.

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Date – 20 May 2019

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**Kanchan**

**Pallvi**

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## **ABSTRACT**

Character recognition from scanned images has been one of the dynamic and testing research zones in the field of picture preparing and design acknowledgment. It has various applications which incorporate, perusing help for visually impaired, bank checks and transformation of any written by hand report into basic content structure. In this venture an endeavor is made to perceive characters from English letter sets, and numbers by first segmenting them using bounding box and then recognizing each character individually. Each character data set contains 26 alphabets. For connected characters we have utilized morphological operation that method pictures subject to shapes. Morphological operations apply an arranging segment to an info picture, making an image of a comparative size. For the segmentation of cursive characters watershed algorithm can be used. For the purpose of character recognition template matching technique is used. The outcomes demonstrate that the proposed framework yields great acknowledgment rates which are practically identical to other comparable plans for character division and acknowledgment.

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# CHAPTER-1

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## INTRODUCTION

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### 1 Introduction

Character Recognition manages the issue of perceiving optically handled Characters. It is basically aimed to enable computers to recognize optical characters without human intervention. Both manually written furthermore, printed characters may be seen, yet the introduction is direct dependent upon the idea of the data reports. Reports have been the customary mode for printed archives. Be that as it may, with the progression of advanced innovation, it is seen that paper records were progressively increased by electronic documents.

#### 1.1 Description of Project

This venture work actualizes a productive content division and acknowledgment calculation for the extraction of content information from printed records. It involves a intended to decipher pictures of typewritten content (more often than not caught by the scanner of the computer) into the machine editable content. It is a procedure of grouping optical examples regarding alphanumeric or different characters.

#### 1.2 Objective of Study

The primary goal of this project is to build up an effective content extraction framework by first de-noising the image and then segmenting each character individually and recognizing it. The project also focuses on extraction of connected and overlapped characters from an image.

Input: scanned picture of text.

Output: PC readable version of input

Character recognition process of the including of the segmentation and recognition. It forms the computerized picture into little segments for examination of discovering content or word or character squares and again the character squares are additionally broken into parts and are contrasted and lexicon of characters.

### **1.3 Current Status of Character Recognition.**

Acknowledgment of Latin-script, typewritten content is as yet not 100% exact even where the reimagining is clear accessible. One examination dependent on acknowledgment of 19th and mid-20th century paper pages reasoned that character-by-character OCR exactness for business OCR programming differed from 81% to 99%. Electronic OCR frameworks for perceiving hand-printed message on the fly have turned out to be outstanding as business items as of late. Precision rates of 80% to 90% on slick, clean hand-printed characters can be accomplished by pen processing programming, yet that exactness rate still means many blunders per page, making the innovation valuable just in restricted applications.

### **1.4 Problem Formulation**

#### **1.4.1 Problem associated -**

Printed scanned documents are often blur and contain noise and the characters are generally connected or overlapped or unintentional spaces between two parts of character like 'd' which could be mistaken for a 'c' followed by 'l'.

#### **1.4.2 Problem Resolution -**

- De-noising of scanned documents
- Character segmentation using a bounding box
- Character recognition

### **1.5 Goals**

1. To convert optically scanned documents into computer written document.
2. To increase the accuracy rate in recognition of handwritten and cursive text.
3. To develop character recognition system that saves costs and is efficient by not having the paper documents.

### **1.6 Organization of Project Report**

Chapter 1: Introduction, description of Project, objective of Study, current Status of character recognition, problem formulation, goals

Chapter 2: Literature Survey, system design, components of system, description of process, generation of known database, identification process

Chapter 3: The detail study of the approach undertaken for the proposed project, techniques adopted, block diagrams and flowcharts of various stages in process

Chapter 4: Implementation, software used, simulation of model, overview of the coding style, comparison with existing project, usages and advantages.

Chapter 5: Conclusion, comparison of results with existing project and future work.

References

Appendix

## CHAPTER-2

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### RELATED WORK

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## 2 Introduction

There are two kinds of center OCR calculation -

- 1.Matrix matching
- 2.Feature extraction

Matrix matching includes contrasting a picture with a put away glyph on a pixel-by-pixel premise; it is otherwise called "pattern matching" or "pattern recognition".

Feature extraction breaks down glyphs into " features " like lines, shut circles, line bearing, and line crossing points.

## 2.1 Literature Survey

### 2.1.1 Segmentation Methods for Character Recognition: From Segmentation to Document Structure Analysis [FUJISAWA, 7 July] [1992]

This paper discusses character segmentation method in which associated design parts are separated rather than pixel picture, and spatial interrelations between segments are estimated to aggregate them into important character designs. Stroke shapes are examined on account of contacting characters. Ambiguities are dealt with by different theories and check by acknowledgment. An all-encompassing type of example arranged division, unthinkable structure acknowledgment, is considered. Pictures of unthinkable structures are dissected, and outlines in the forbidden structure are separated. By distinguishing semantic connections between name edges and information outlines, data on the structure can be appropriately perceived.

### **2.1.2 A Robust Character Segmentation Approach for License Plate [Feng Yang, Zheng Ma a, Mei Xie, ICCAS-2007]**

The character region in number plate image is enhanced and binaries in the preprocessing stage, and the whole image is performed by the quick region marking method and the useful regions of number plate is located in the following. Then the final character regions are determined based on the large-interval-based character locating algorithm. The proposed method in character division is quick and exact, and is tolerant to tag with disfigurements, revolutions.

### **2.1.3 A New Methodology for Gray-Scale Character Segmentation and Recognition [Seong-Whan Lee, October 1996]**

In gray-scale pictures explicit topographic highlights and the variety of forces can be seen in the character limits. In this paper the proposed technique for character division and acknowledgment utilizes the attributes of dim scale pictures. The character division locales are controlled by using projection profiles and topographic features removed from the diminish scale pictures. By then a nonlinear character division path in each character division territory is found by using multi-mastermind chart look count. In order to affirm the nonlinear character division ways and acknowledgment results, an acknowledgment based division strategy is received.

### **2.1.4 Segmentation of Handwritten Text in Gurmukhi Script [Rajiv K. Sharma & Dr. Amar deep Singh 01/2008]**

The nearness of contacting characters in printed also written by hand reports further reductions right division just as acknowledgment rate radically in light of the fact that one can't control the size and state of characters in manually written records so the division procedure for the transcribed archive is excessively troublesome. A line of Gurmukhi script can be parceled into three flat zones to be specific, upper zone, center zone and lower zone. Consonants are commonly present in the center zone. In Gurmukhi Script, the greater part of the characters contains a flat line at the upper of the center zone. This line is known as the feature. Firstly, we are to find out the lines present in the document then to find words present in each line detected at the first step. Therefore, using line detection algorithm (the first approach) lines were detected. The correctly detected lines were further put to word detection algorithm. Here the locations of the detected words were used to segment the characters.

### **2.1.5 Word & Character Segmentation for Bangla Handwriting Analysis & Recognition [Halder, C. and Roy, K. Dec 2011]**

Segmentation of unconstrained manually written word into various zones (upper center and lower) and characters is more troublesome than that of printed reports. This is for the most part a direct result of fluctuation in between character separate, skew, inclination, estimate and bended like penmanship. At times parts of two sequential characters might be contacted or covered and this circumstance confounds the division task significantly. In Indian dialects such contacting or covering happens much of the time as a result of adjusted characters of upper-zone and lower-zone. The best possible extraction of the characters is fundamental from the manually written archives. Here occupied zone calculation system is utilized. Occupied zone of a word is the district of the word where a most extreme segment of its characters lie.

### **2.1.6 Automatic vehicle number plate Recognition**

**(Swati Bhandari & Sayali Bhatkar,2017)**

Traffic control and vehicle proprietor recognizable proof has turned out to be serious issue in each nation. Now and again it winds up hard to distinguish vehicle proprietor who abuses traffic standards and drives excessively quick. Hence, it is beyond the realm of imagination to expect to get and rebuff those sorts of individuals in light of the fact that the traffic individual probably won't almost certainly recover vehicle number from the moving vehicle due to the speed of the vehicle. Consequently, there is a need to create Automatic Number Plate Recognition (ANPR) framework as a one of the answers for this issue.

## **2.2 System Design**

### **2.2.1 Components of system**

A typical character recognition system consists few parts. The initial phase in the process is to digitize the simple archive for example covert Analog content based assets to advanced content assets and these changed over assets can be utilized in a few different ways like accessible content in records in order to distinguish reports or pictures.

Exactly when the districts containing content are discovered, each picture is removed through a division system. The isolated pictures may then be pre-taken care of, discarding uproar, to empower the extraction of features in the accompanying stage. The character of each picture is found by differentiating the isolated features and depictions of the picture classes gained through a past learning stage. Finally, applicable information is used to change the words and amounts of the primary substance.



### 2.2.2 Process

From the computational perspective, there are three noteworthy errands engaged with a way to deal with performing character acknowledgment

- Pre-processing
- Segmentation
- Recognition

### 2.2.3 Description of process

The fundamental guideline in programmed acknowledgment of examples, is first to show the machine which classes of examples that may happen and what they resemble. In character acknowledgment the examples are letters, numbers and some exceptional images like commas, question marks and so forth., while the various classes compare to the various characters. The educating of the machine is performed by demonstrating the machine instances of characters of all the various classes. In light of these models the machine fabricates a model or a depiction of each class of characters.

### 2.2.4 Block diagram

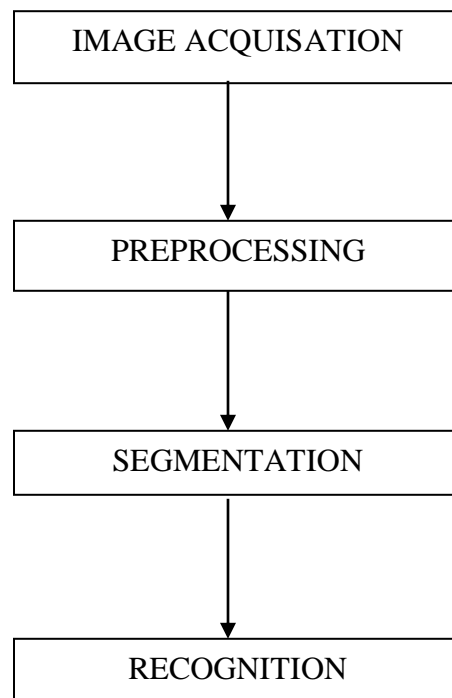


Fig 1: Various stages involved in process

### **2.2.5 Generation of known database**

At that point, amid acknowledgment, the obscure characters are contrasted with the recently gotten portrayals, and appointed the class that gives the best match. In most business frameworks for character acknowledgment, the preparation procedure has been performed ahead of time. In the following areas these means and the strategy included are portrayed in more detail.

### **2.2.6 Identification process**

During recognition, the obscure characters are contrasted with the recently acquired portrayals, and doled out the class that gives the best match. In most business frameworks for character acknowledgment, the preparation procedure has been performed ahead of time. In the following areas these means and the techniques included are portrayed in more detail.

## CHAPTER-3

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### METHODOLOGY AND APPROACH USED

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#### 3 Introduction

Three major tasks involved in performing character recognition are-

- Pre-processing
- Segmentation
- Recognition

#### 3.1 Image acquisition

Through the checking method an electronic image of the principal record is gotten. In character affirmation optical scanners are used, which generally involve a vehicle part notwithstanding a recognizing contraption that changes over light power into dim measurements. Printed records when in doubt include dim print on a white establishment. Therefore, when performing character affirmation, more often than not practice to change over the amazed picture into a bi-level picture of high difference.

The thresholding procedure is noteworthy as the outcomes of the going with affirmation is totally poor of the idea of the bi-level picture. Everything considered, the thresholding performed on the scanner is normally astoundingly clear. A fixed point of confinement is used, where diminish measurements underneath this edge is said to be dull and levels above are said to be white. For a high-offset record with uniform establishment, a pre-picked fixed point of confinement can be sufficient.

### 3.2 Pre-processing

The image coming about as a result of the looking at strategy may contain a particular proportion of bustle. Dependent upon the objectives of the scanner and the achievement of the associated system for thresholding, the characters may be spread or broken. A part of these disfigurements, which may later reason poor affirmation rates, can be cleared out by using a preprocessor to smooth the digitized characters. The smoothing gathers both filling and reducing. Filling discards little breaks, gaps and openings in the digitized characters, while reducing diminishes the width of the line. Despite smoothing, preprocessing generally furthermore joins banalization (i.e. conversion of any gray level or RGB image into black and white image) and complementing the image (i.e. conversion of black pixel to white and vice-versa).

The basic steps involved in preprocessing can be represented using the following flowchart:

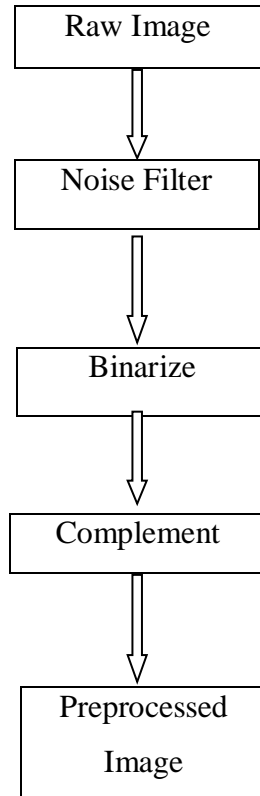


Fig 2: Steps involved in preprocessing

### 3.3 Segmentation

Segmentation is a procedure that decides the constituents of a picture. It is important to find the districts of the archive where information have been printed and recognize them from figures and designs. Associated with substance, division is the partition of characters or words. The greater part of character affirmation counts parcels the words into separated characters which are seen autonomously. Ordinarily this division is performed by disengaging each related part that is each related a dim area. This technique is definitely not hard to execute, anyway issues occur if characters contact or if characters are partitioned and include a couple of areas. The central issues in division may be isolated into four gatherings:

- **Extraction of touching and fragmented characters.**

Such curves may incite a couple of joint characters being interpreted as one single character, or that somewhat of a character is acknowledged to be an entire picture. Joints will occur if the record is a diminish photocopy or in case it is sifted at a low breaking point. In like manner joints are typical if the printed styles are serried. The characters may be part of the document originates from a light photocopy or is sifted at a high point of confinement.

- **Distinguishing noise from text.**

Dots and accents might be confused with noise, and the other way around.

- **Mistaking graphics or geometry for text.**

This prompts non text being sent to acknowledgment.

- **Mistaking text for graphics or geometry.**

For this situation the content won't be passed to the acknowledgment organize. This regularly occurs if characters are associated with illustrations.

#### 3.3.1 Bounding Box

Bounding Box is a logical box that limits the consideration of the division procedure to the inside of the bounding box. One can just dole out every outside pixel to the background class and the interior pixels to the foreground class or the region of interest. Our technique registers the division that fits the jumping encloses an adequately tight way, getting a superior outcome. The formation of a bounding box is based on the distribution of pixels forming an alphabet. In case of connected characters the bounding box often interprets the connected set as a single symbol. This problem is further solved using morphological operations.

The division utilizing bouncing box might be assessed by its affectability to clamor and disfigurement and the simplicity of execution and use. The criteria utilized in the correlation and assessment are the accompanying:

1) Noise.

Sensitivity to a disconnected line segments, bumps, gaps, filled loops and so on.

2) Distortions.

Sensitivity to a local variation like rounded corners and improper protrusions and dilations and shrinkage.

3) Style variation.

Sensitivity to a variation in the style like use of different shapes to representation of the same character and the use of serifs, slants and so on.

4) Rotation.

Sensitivity to a changing in the orientation of the characters.

### **3.3.2 Method Adopted for segmentation of connected characters**

In our project we have used morphological operation in which first image gets dilated and then the dilated image is eroded using the same structuring element for both operations.

Morphology is a wide arrangement of picture preparing tasks that procedure pictures dependent on shapes. Morphological activities apply an organizing component to an info picture, making a yield picture of a similar size. In a morphological operation, the estimation of every pixel in the yield picture depends on an examination of the relating pixel in the info picture with its neighbors. By picking the size and state of the area, you can build a morphological activity that is touchy to explicit shapes in the info picture.

The most essential morphological operation is widening and disintegration. Enlargement adds pixels to the limits of articles in a picture, while disintegration expels pixels on item limits. The quantity of pixels included or expelled from the items in a picture relies upon the size and state of the organizing component used to process the picture. In the morphological widening and disintegration activities, the condition of some random pixel in the yield picture is dictated by applying a standard to the relating pixel and its neighbors in the info picture.

In widening pixels past the picture fringe are doled out the base esteem managed by the information type. For twofold pictures, these pixels are thought to be set to 0. For grayscale pictures, the base an incentive for uint8 pictures is 0. And in disintegration pixels past the picture outskirt are allocated the most extreme esteem managed by the information type. For twofold pictures, these pixels are thought to be set to 1. For grayscale pictures, the most extreme incentive for uint8 pictures is 255.

### **Open and Closed Morphological Operations**

Opening and shutting are two significant administrators from scientific morphology. They are both gotten from the essential activities of disintegration and widening (refer Fig 3). Like those

administrators they are typically connected to parallel pictures, despite the fact that there are additionally dark dimension forms.

An opening is characterized as an erosion pursued by an enlargement utilizing the equivalent organizing component for the two tasks. The essential impact of an opening is to some degree like disintegration in that it will in general expel a portion of the frontal area (brilliant) pixels from the edges of districts of closer view pixels. Anyway it is less ruinous than disintegration as a rule. Similarly, as with other morphological administrators, the definite task is dictated by an organizing component. The impact of the administrator is to protect closer view areas that have a comparable shape to this organizing component, or that can totally contain the organizing component, while killing every other district of frontal area pixels.

Closing is opening performed backward. It is characterized essentially as a dilation pursued by a disintegration utilizing the equivalent organizing component for the two activities. Shutting is comparable somehow or another to expansion in that it will in general expand the limits of frontal area (brilliant) districts in a picture (and psychologist foundation shading gaps in such locales), yet it is less ruinous of the first limit shape. Similarly, as with other morphological administrators, the accurate activity is dictated by an organizing component. The impact of the administrator is to save foundation districts that have a comparative shape to this organizing component, or that can totally contain the organizing component, while disposing of every single other area of foundation pixels.

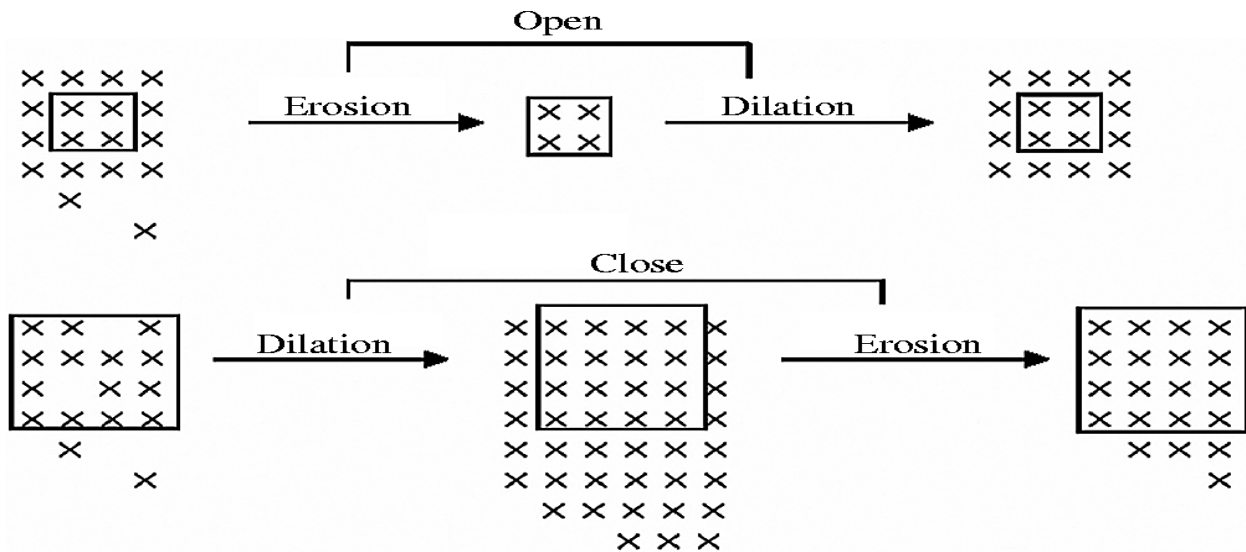


Fig 3: Open and closed morphological operations

## Dilation

1 Consider a matrix  $A = [1\ 0\ 1\ 1; 1\ 1\ 0\ 0; 1\ 0\ 0\ 1]$  and a structuring element  $B = [1\ 0\ 1]$ .

2 Set the value of a matrix of size  $A$  with 0 i.e.  $D =$

$$\begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

3 Put the matrix  $A$  with zeros on both the sides;  $A =$

$$\begin{pmatrix} 0 & 1 & 0 & 1 & 1 & 0 \\ 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 \end{pmatrix}$$

4 Now put the structuring element  $B$  on the matrix  $A$  and perform logical AND operation  $[0\ 1\ 0] \& [1\ 0\ 1] = [0\ 0\ 0]$ . if all the values in the matrix are zero the update matrix  $D$  with zero in position  $(1,1)$ .

5 Now slide the structuring element to next value and perform logical AND operation  $[1\ 0\ 1] \& [1\ 0\ 1] = [1\ 0\ 1]$ , i.e. non-zero so update matrix  $D$  with one.

6 Final matrix  $D =$

$$\begin{pmatrix} 0 & 1 & 1 & 1 \\ 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 0 \end{pmatrix}$$



## Erosion

1. Consider a matrix  $A = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 \\ 1 & 0 & 1 & 0 & 0 \\ 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 & 1 \end{bmatrix}$  and Structuring Element  $B = [1 \ 1 \ 0]$ .

2. Set the value of a matrix of size A with zeros i.e.  $D =$

$$\begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

3. Put the value of the matrix A with ones on both the sides i.e.

$$\begin{pmatrix} 1 & 1 & 0 & 0 & 0 & 1 & 1 \\ 1 & 1 & 0 & 1 & 0 & 0 & 1 \\ 1 & 1 & 1 & 1 & 0 & 0 & 1 \\ 1 & 0 & 0 & 1 & 1 & 1 & 1 \end{pmatrix}$$

4. Now place the element B on A and note whether the ones in the structure element overlaps only the ones in the matrix A, if this is true the update matrix D with one otherwise with zero.

5. Compare  $[1 \ 1 \ 0]$  and  $[1 \ 10]$ ;  $[1 \ 0 \ 0]$  and  $[1 \ 1 \ 0]$  Final result  $D =$

$$\begin{pmatrix} 1 & 0 & 0 & 1 & 1 \\ 1 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 \end{pmatrix}$$

### 3.3.3 Block diagram

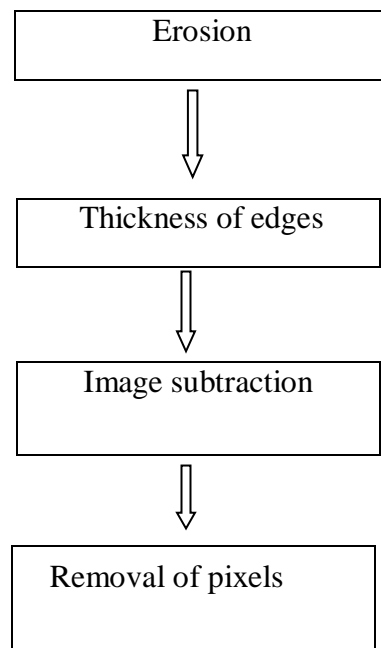


Fig 4: Steps involved in segmentation

### 3.3.4 Segmentation of cursive Characters-Watershed Algorithm

Any gray level image can be considered a topographic surface:

- Points belonging to regional minimum.
- Catchment basin is the geographical area draining into a river or reservoir
- Divide lines or watershed lines.

#### **Aim of the Watershed Algorithm –**

To find watershed lines.

- Punch the provincial least and flood the whole geography at uniform rate from underneath.
- A dam is worked to keep the rising water from particular catchment bowls from blending.
- These dam limits compare to the gap lines of the watersheds.

### 3.4.5 Block diagram

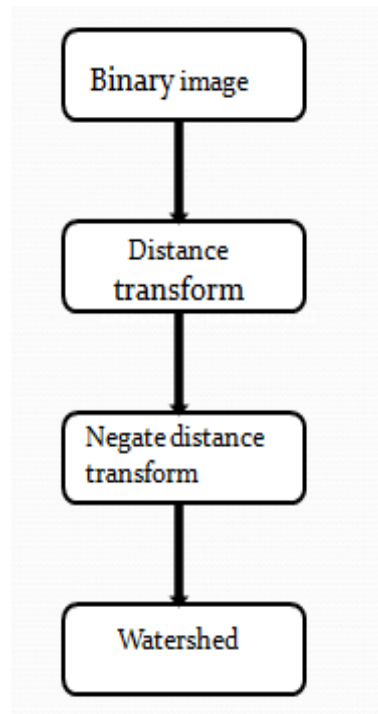


Fig 5: Steps involved in watershed algorithm

### 3.4.1 Recognition

The character acknowledgment calculation has two basic segments include extractor and the classifier. Highlight examination decides the descriptors, or the list of capabilities used to depict all characters. Given a character picture, the element extractor determines the highlights that the character has. The determined highlights are then utilized as contribution to the character classifier.

Format coordinating or network coordinating, is a standout amongst the most widely recognized grouping strategies. Here individual picture pixels are utilized as highlights. Characterization is performed by contrasting an info character and a lot of formats (or models) from each character class. Every correlation results in a closeness measure between the info characters with a lot of layouts. One measure expands the measure of closeness when a pixel in the watched character is indistinguishable to a similar pixel in the format picture. On the off chance that the pixels contrast the proportion of closeness might be diminished. After the sum total of what layouts have been contrasted and the watched character picture, the character's personality is appointed

the character of the most comparative format. Format coordinating is a trainable procedure as layout characters can be changed.

### **3.4.1 Template Matching**

The estimation associated with see the characters. Characters to be attempted are letters all together (A – Z). Black and white pictures were used with Times New Roman literary style type and here we take a gander at between two pictures of letters all together.

#### **Template matching steps for recognition**

1. Firstly the character picture from the perceived string is picked.
2. After that, the image to the proportion of the fundamental design is rescaled.
3. After rescale the image to the extent of the primary layout (unique) picture, the coordinating measurement is figured.
4. Then the most elevated match found is put away. On the off chance that the picture isn't coordinate rehash the third step.
5. The document of the best match is secured as the apparent character.

#### **Template Matching Algorithm**

This procedure includes the utilization of a database of characters or templates. the exists format for all conceivable info characters. For acknowledgment to happen, the present information character is contrasted with every layout to discover either a careful match, or the format with the nearest portrayal of the info character. On the off chance that  $I(x, y)$  is the information character,  $TN(x, y)$  is the format  $n$ , at that point the coordinating capacity  $s(I, TN)$  will restore an esteem showing how well layout  $n$  coordinates the info character. The strategy must be effective if the information character can the put away formats are of the equivalent or comparative text style. layout coordinating can be performed on twofold, edge characters or on dim dimension characters. For dark dimension characters, it is progressively normal or Normalized Correlation to be utilized as this gives improved protection from varieties in splendor and complexity between the information character and the put away layout.

Template matching models were developed as an answer to the problem of object recognition, and they incorporate at a simplicity the idea of similarity comparison. The representations assumed by template models carry much more detailed information about stimulus structure than

do the element representations just described. These models are usually applied to spatially extend visual objects, and their representation can be thought of as being spatially organized. There are a couple of procedures that were engaged with this framework model. The methods are starting from the acquiring system, isolating procedure, edge the image, gathering the image of letter set lastly see the letter set. These procedures are essential to get the aftereffect of acknowledgment subsequent to contrasting the two character pictures.

### **Types of template matching-**

There are two types of template matching

Correlation- This method is used in cases where we need to search for some alphabet and in recognition process.

Method based on pixel order-This method involves recognizing character based on pixels' order.

### **Correlation:**

In factual mechanics, the connection work is a proportion of the request in a framework, as portrayed by a numerical relationship work, and depicts how infinitesimal factors at various positions are corresponded. Connection work is a factual relationship between's irregular factors at two unique focuses in space or time, for the most part as a component of the spatial or fleeting separation between the focuses. In the event that one considers the relationship work between irregular factors speaking to a similar amount estimated at two unique focuses then this is regularly alluded to as an autocorrelation work being comprised of autocorrelations.

Connection elements of various arbitrary factors are once in a while called cross relationship functions to underscore that various factors are being considered and on the grounds that they are comprised of cross connections. Connection capacities are a helpful pointer of conditions as an element of separation in time or space, and they can be utilized to survey the separation required between test indicates for the qualities be viably uncorrelated. Likewise, they can frame the premise of standards for introducing esteems at focuses for which there are perceptions.

### **Correlation is of two types: -**

#### **Autocorrelation**

Autocorrelation is simply the cross-connection of a sign with itself. it is the closeness between discernments as a component of the time slack between them. This is a scientific instrument for discovering rehashing designs, for example, the nearness of an occasional sign darkened by commotion, or recognizing the missing crucial recurrence in a sign inferred by its symphonious

frequencies. Typically used in sign planning for exploring limits or course of action of characteristics, for instance, time zone signals.

### **Cross-Correlation**

In sign preparing, cross-connection is a proportion of similitude of two waveforms as a component of a period slack connected to one of them. This is otherwise called a sliding spot item or sliding internal item. It is normally utilized for hunting a long sign down a shorter, known element. It has applications in example acknowledgment, single molecule examination, averaging, cryptanalysis, and neurophysiology. The cross-relationship is comparative in nature to the convolution of two capacities.

In this project we have used correlation during the time spent finding the area of a sub picture called a layout inside a picture. Suppose we want to search for some particular alphabet in a given string then we go for correlation method if the alphabet is similar to template image then it will return value one otherwise it will show an error.

#### **Template matching based on pixel order: -**

For two binary images, expecting that they have a similar goals and same introduction of object(s) in the pictures, the most instinctive approach to complete a similitude examination between the pictures will be to complete a precise pixel by pixel coordinating. It resembles overlaying two shapes one over the other and perceiving the amount of the shapes fit into one another. The piece of the shape that is in abundance is a pointer of how divergent the given shapes are. It looks over the picture and takes each pixel esteem and contrasts this and the pixel esteem in the database picture at the comparing area. In the event that it finds a similar incentive at a similar position in the database picture, this will be taken as a hit tally. Else, it will be taken as a miss check.

# CHAPTER-4

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## IMPLEMENTATION

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### 4 Introduction

**Software Used:** MATLAB (R2009a)

### MATLAB

MATLAB is a numerical registering condition and fourth-age programming language. Created by Math Works, MATLAB permits grid controls, plotting of capacities and information, execution of calculations, formation of UIs, and interfacing with projects written in different dialects.

### SYNTAX

The MATLAB application is worked around the MATLAB language, also, most usage of MATLAB incorporates forming MATLAB code into the Command Window (as a natural numerical shell), or executing content records containing MATLAB code and limits.

### 4.1 Technology

MATLAB is an elite language for specific figuring. It encounters competition portrayal and programming in an easy to use condition where issues and courses of action are imparted in surely understood logical documentation. Typical utilizations join

1. Math's and calculation
2. Algorithm advancement
3. Data obtaining
4. Modeling reenactment and prototyping
5. Data examination, investigation and perception
6. Scientific designing illustrations
7. Application advancement, including graphical UI building

MATLAB is a smart system whose fundamental data segment is a display that does not require dimensioning. This empowers you to handle various specific enrolling issues especially those with system and vector definition, in a little measure of the time it would take to make a program in a scalar canny language, for instance, C or FORTRAN. The name MATLAB speaks to lattice laboratory.

MATLAB features a gathering of additional application express course of action called device stash. Imperative to most customers of MATLAB, toolbars empower you to learn apply specific development. Device stash are sweeping amassing of MATLAB limits (M-archives) that comprehensive the MATLAB condition to handle explicit classes of issues. Areas in which device compartments are open join sign dealing with control structure, neural frameworks, soft justification wavelets, propagation and various others.

#### **4.1.1 The MATLAB system**

The MATLAB system consists of these main parts:

##### **Desktop Tools and Development Environment**

This is a great deal of instruments and workplaces that help you use MATLAB limit and records. Many of these mechanical assemblies are graphical UIs. It fuses the MATLAB work territory and Command Window, a request history, a publication supervisor and debugger, a code analyzer and various reports, and projects for audit help, the workspace, records, and the chase way.

##### **The MATLAB Mathematical Function Library**

This is a gigantic aggregation of computational figuring running from simple limit, like sum cosine and complex number juggling, to progressively refined limits like structure in reverse, framework Eigen regard Bessel work, and brisk Fourier changes.

##### **The MATLAB language**

This is an irregular state system/display language with control stream announcements, limits, data structures input/yield and article arranged programming features. It licenses both "programming in the little" to rapidly make smart dispose of activities, and "programming in the far reaching" to make broad and complex application programs.



## **Graphics**

MATLAB has wide workplaces for appearing and graphs, similarly as remarking on and printing these outlines. It fuses unusual state capacities with respect to two-dimensional and three dimensional data recognition, picture planning, action and presentation representations. It similarly joins low measurement limits that empowers you to totally change the nearness of structures similarly as to complete graphical UI on your MATLAB application.

### **The MATLAB External Interfaces/API**

This is a library that empowers you to create C and FORTRAN programs that speak with MATLAB. It joins workplaces for calling plans from MATLAB calling MATLAB as a computational engine, and for examining and forming MAT-reports.

#### **4.1.2 Concept involved: Image Processing (Image Recognition Principle)**

#### **4.1.3 Analysis**

##### **Economic Analysis**

The most significant data contained in practicality is money saving advantage examination a course of action of the monetary avocation for a PC based framework venture. Money saving advantage investigation decreases cost for venture improvement and gauges them against immaterial advantages of a framework. The cost incurred in development of the present project was outweighed by the benefits offered. Benefits of a new system were determined relative to the existing system.

##### **Technical Analysis**

In the midst of particular examination, the specific advantages of the system thought are evaluated, while meanwhile assembling additional information about execution, steadfast quality and reducibility. Particular examination begins with an assessment of the specific common sense of proposed structure. It analysis what kind of development environment is required, what new methods and processes are required to accomplish system function and performance. A model is made dependent on the perception of this present reality or estimation dependent on framework objective.

Economic and Technical analysis help in system designing. Moreover, the designed system is more efficient, reliable and economic.

## 4.2 Simulation Model

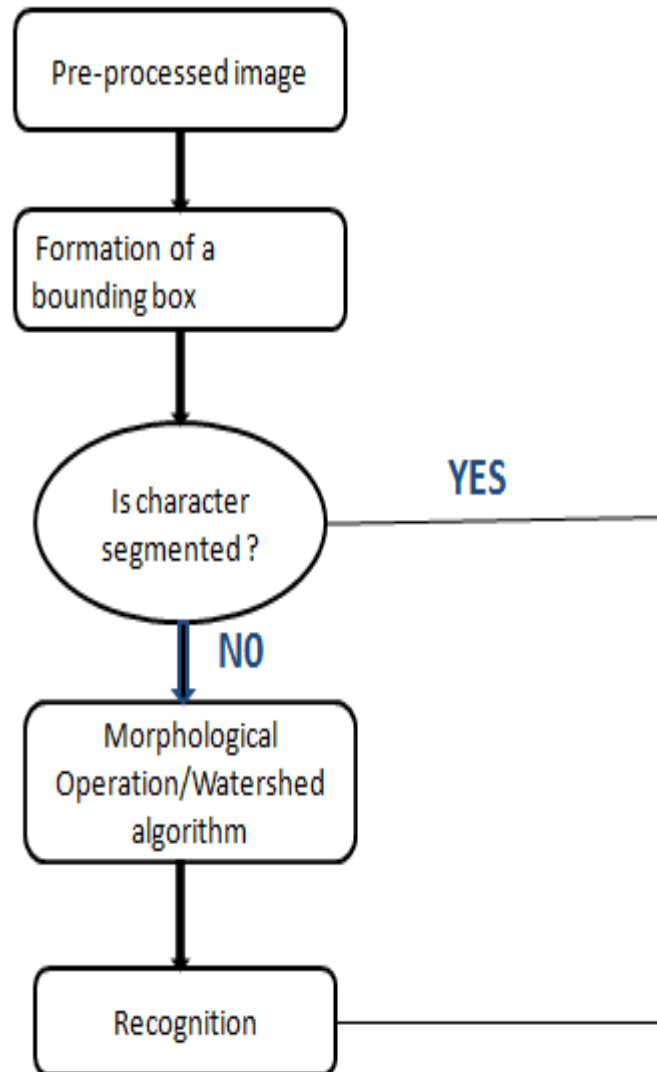


Fig 6: Flowchart representing steps involved in character recognition

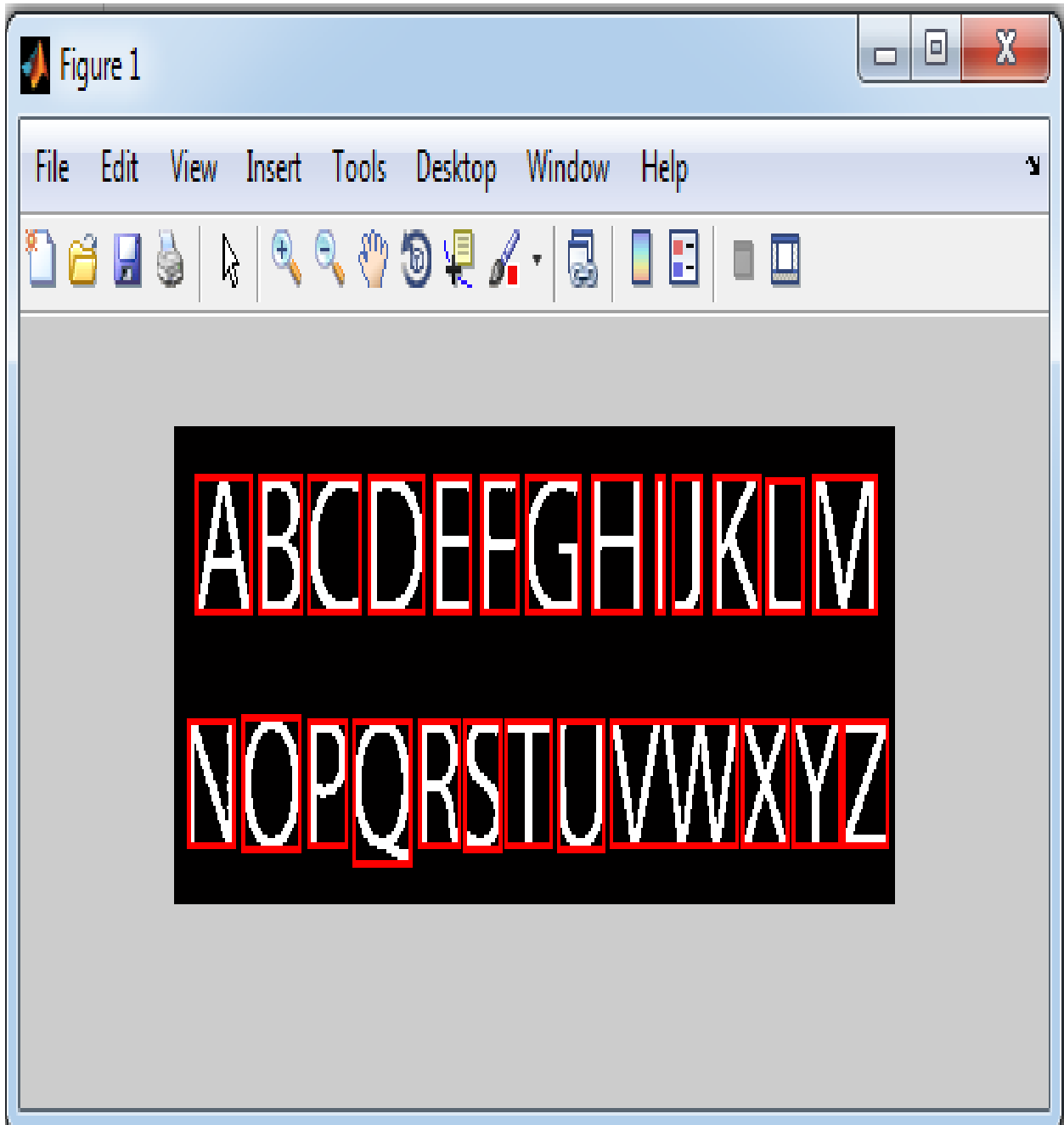
## 4.3 Simulation Results

### 4.3.1 Segmentation using a bounding box

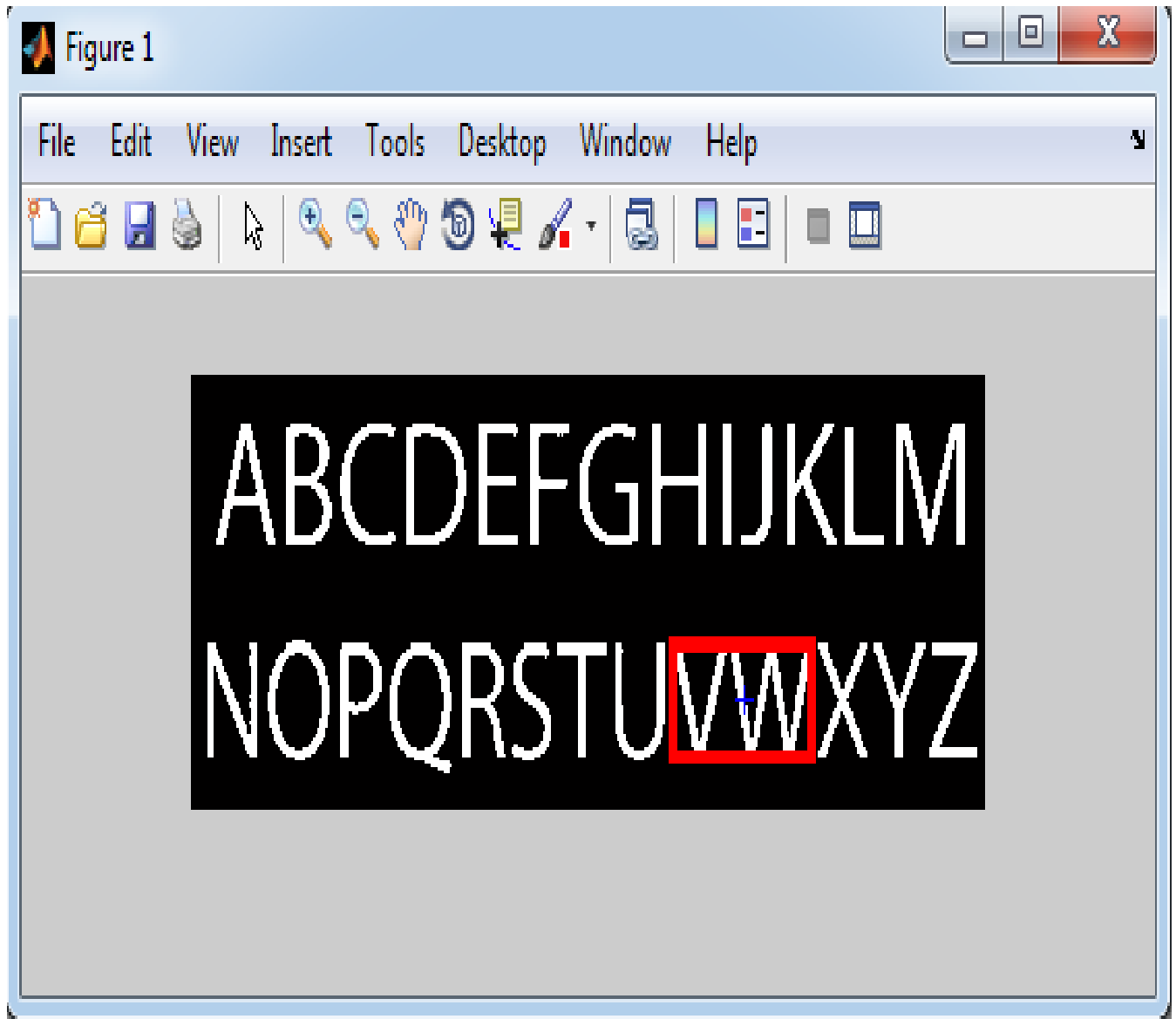
#### 1. Input Image



## 2. Formation of Bounding Box on each character

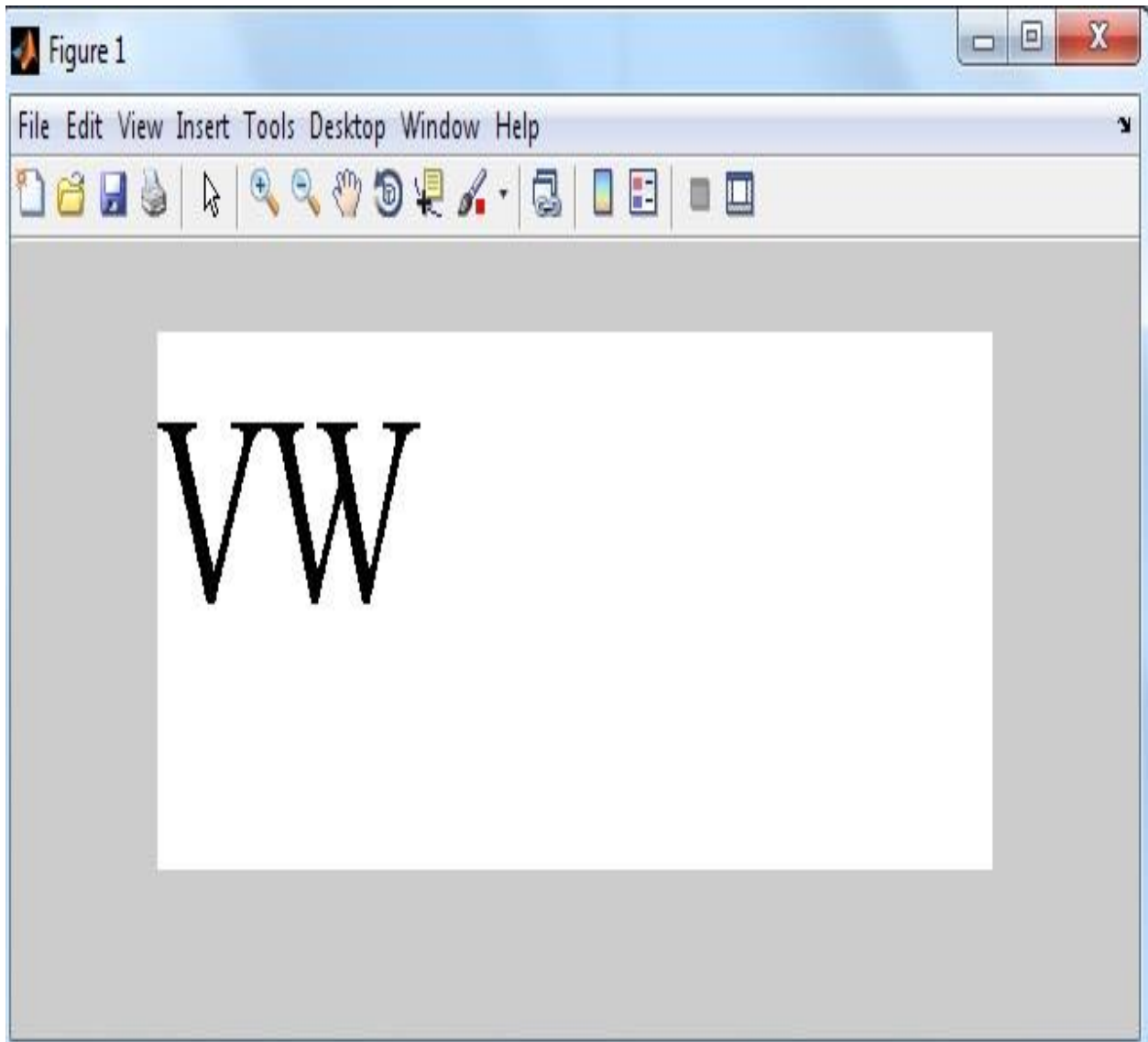


3. Here 'vw' is recognized as a single object

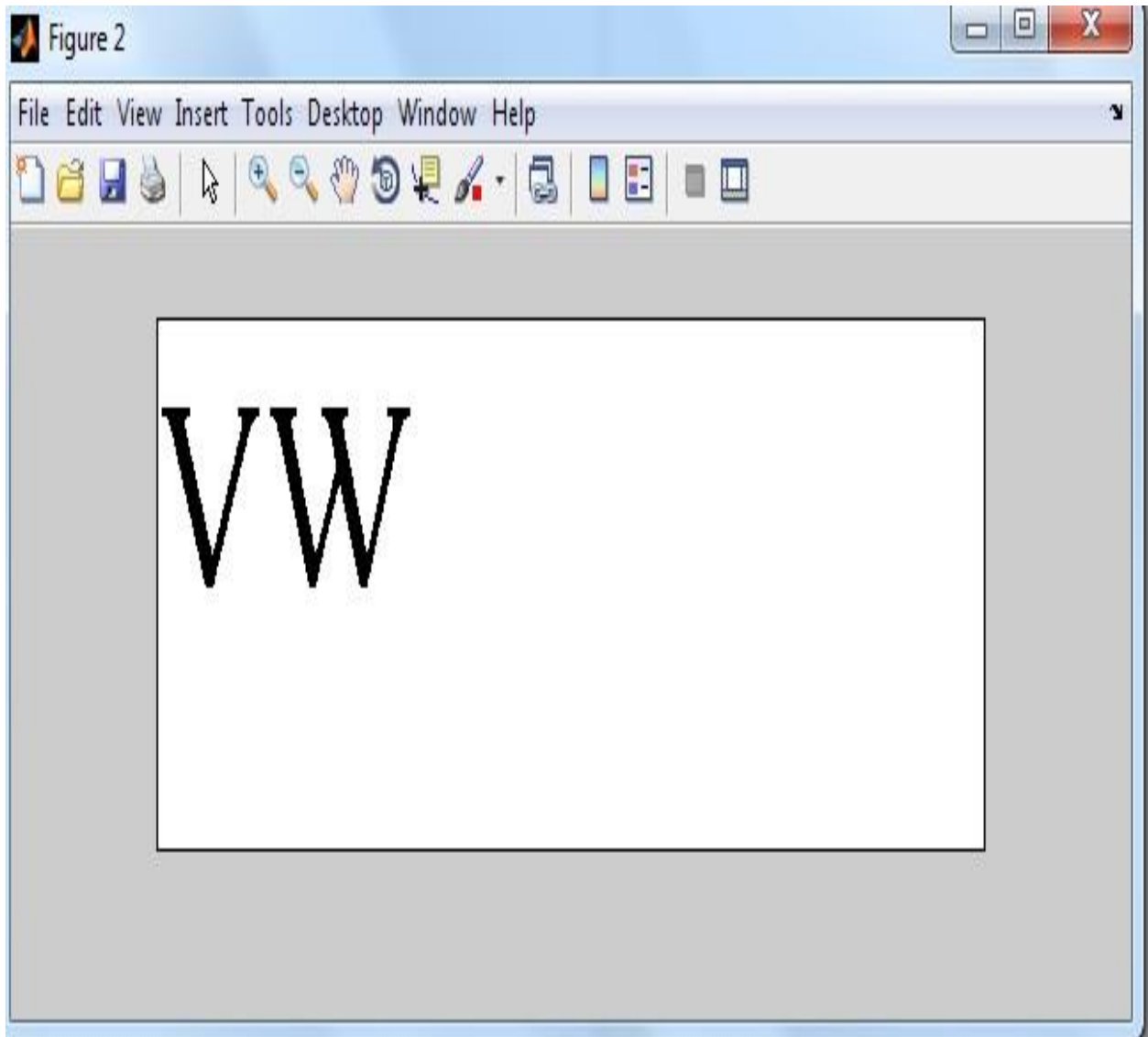


### 4.3.2 Simulation results of connected characters

#### 1. Input Image



## 2. Final Image After Performing Morphological Operation



## 4.4 Critically overlapped characters

Letters 'T' and 'V' are overlapped.

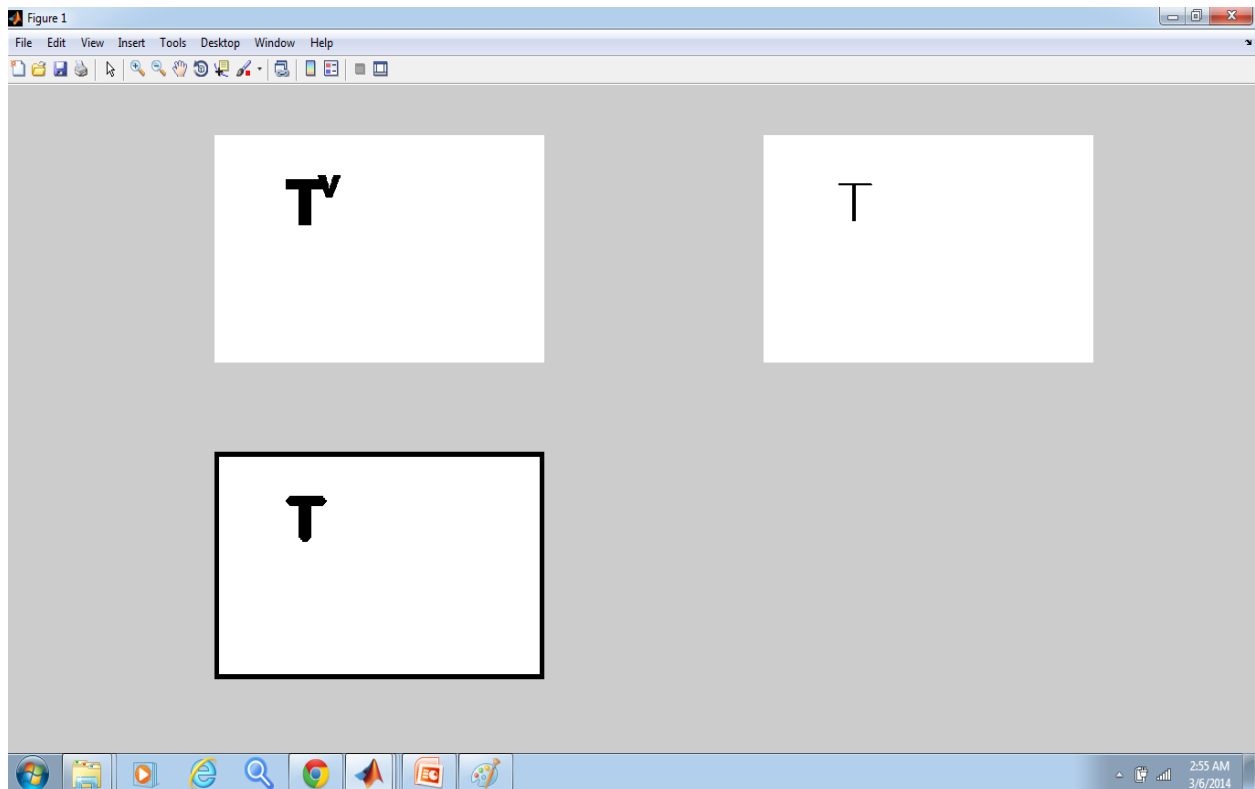


When segmented using bounding box they are detected as one entire symbol.

Difficult to segment due to common pixel area.

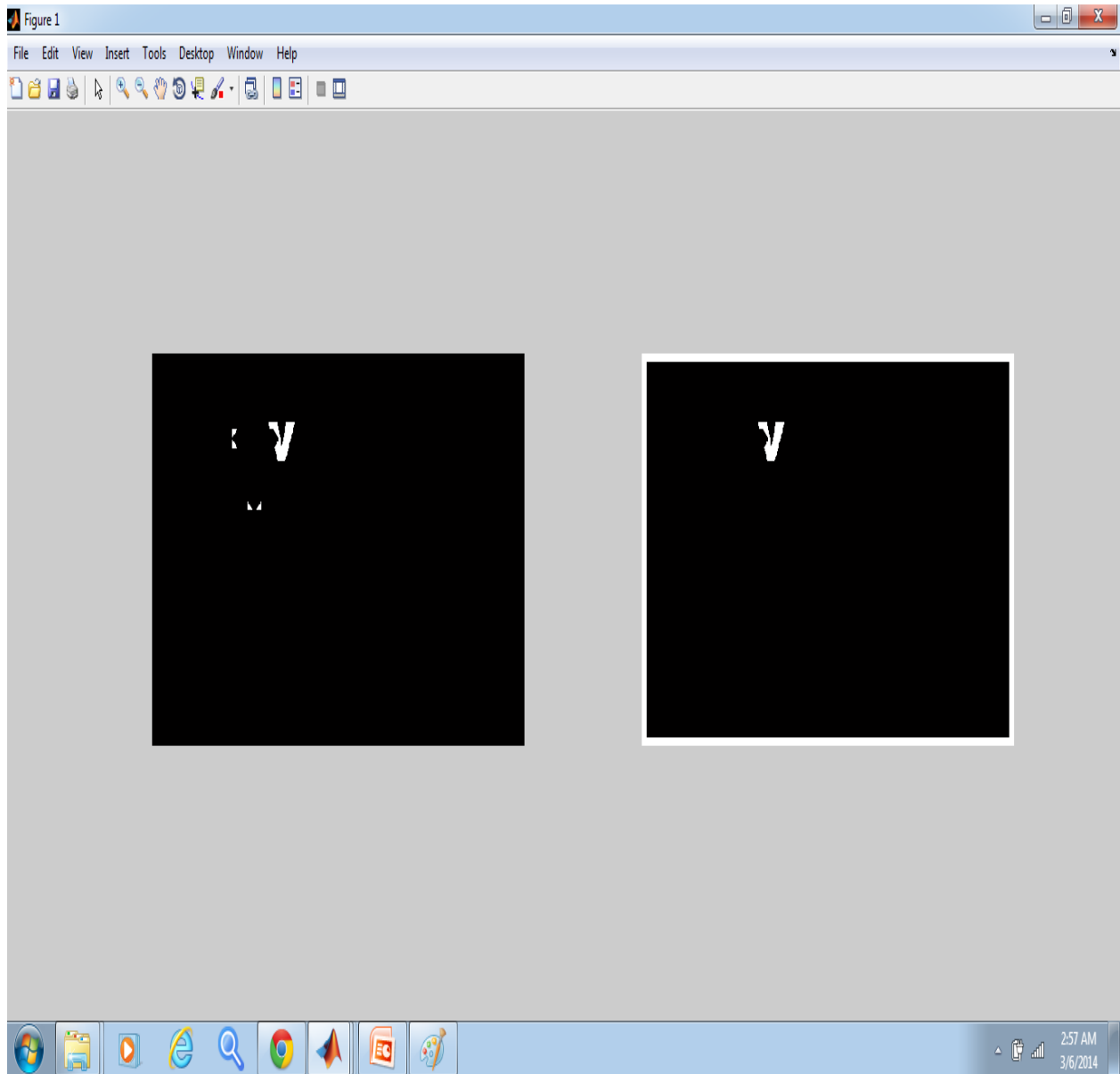
### 4.4.1 Simulation results of critically overlapped characters

The first image is the input image. Second and third image correspond to the image obtained after thinning and thickening respectively.



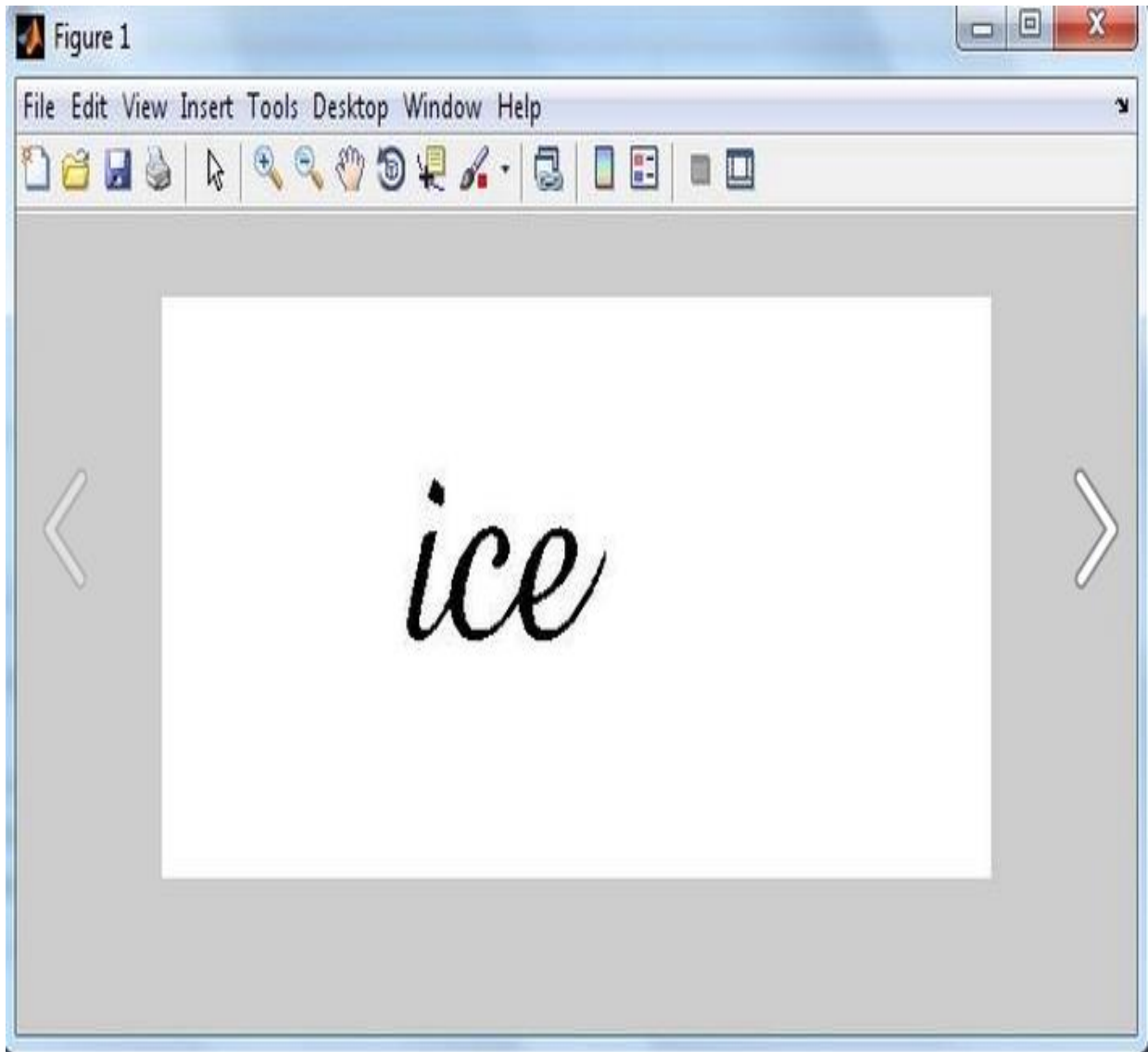


2. The next step is image subtraction and complement of image.

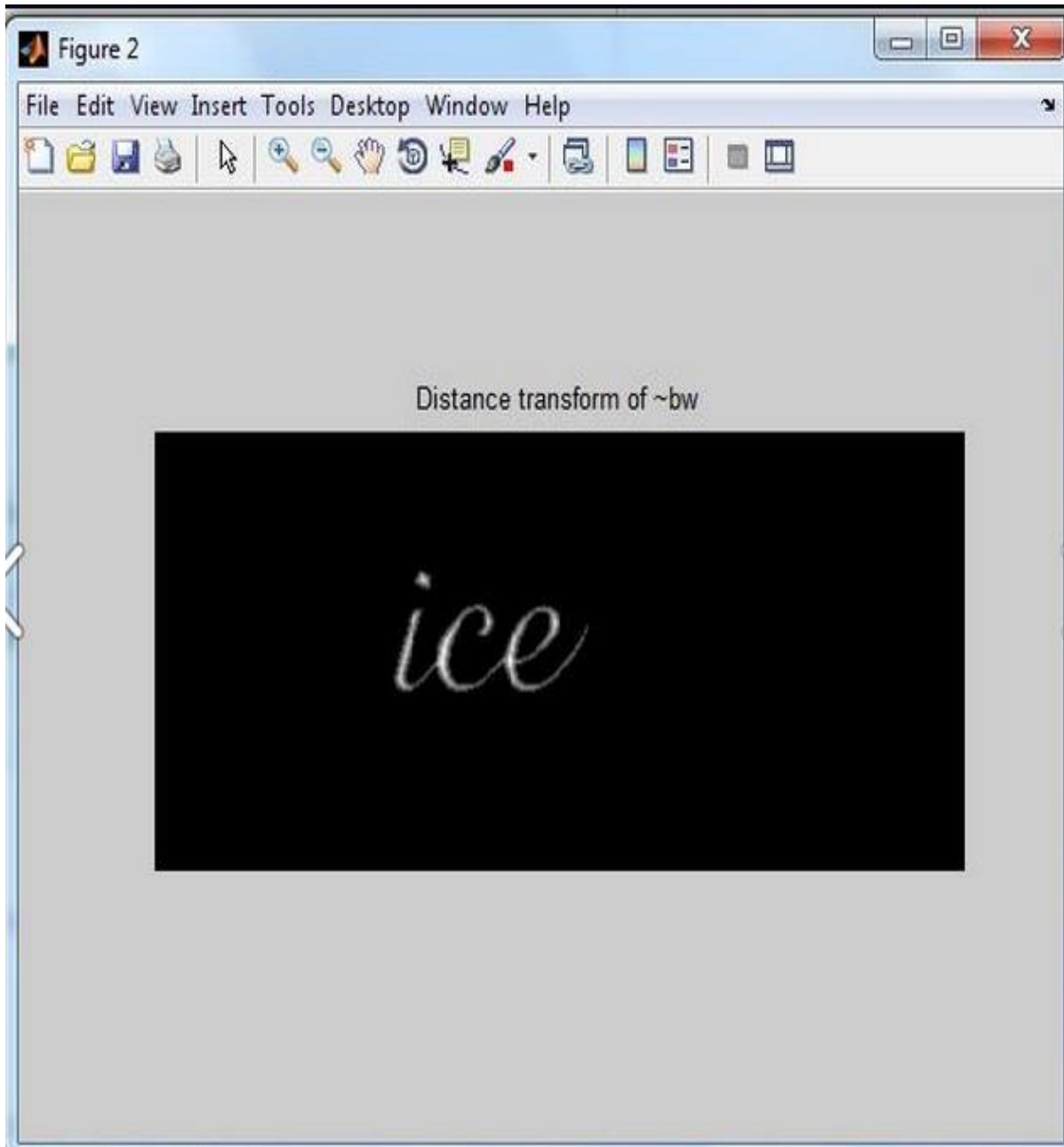


## 4.5 Simulation Results for Cursive Text (Watershed Algorithm)

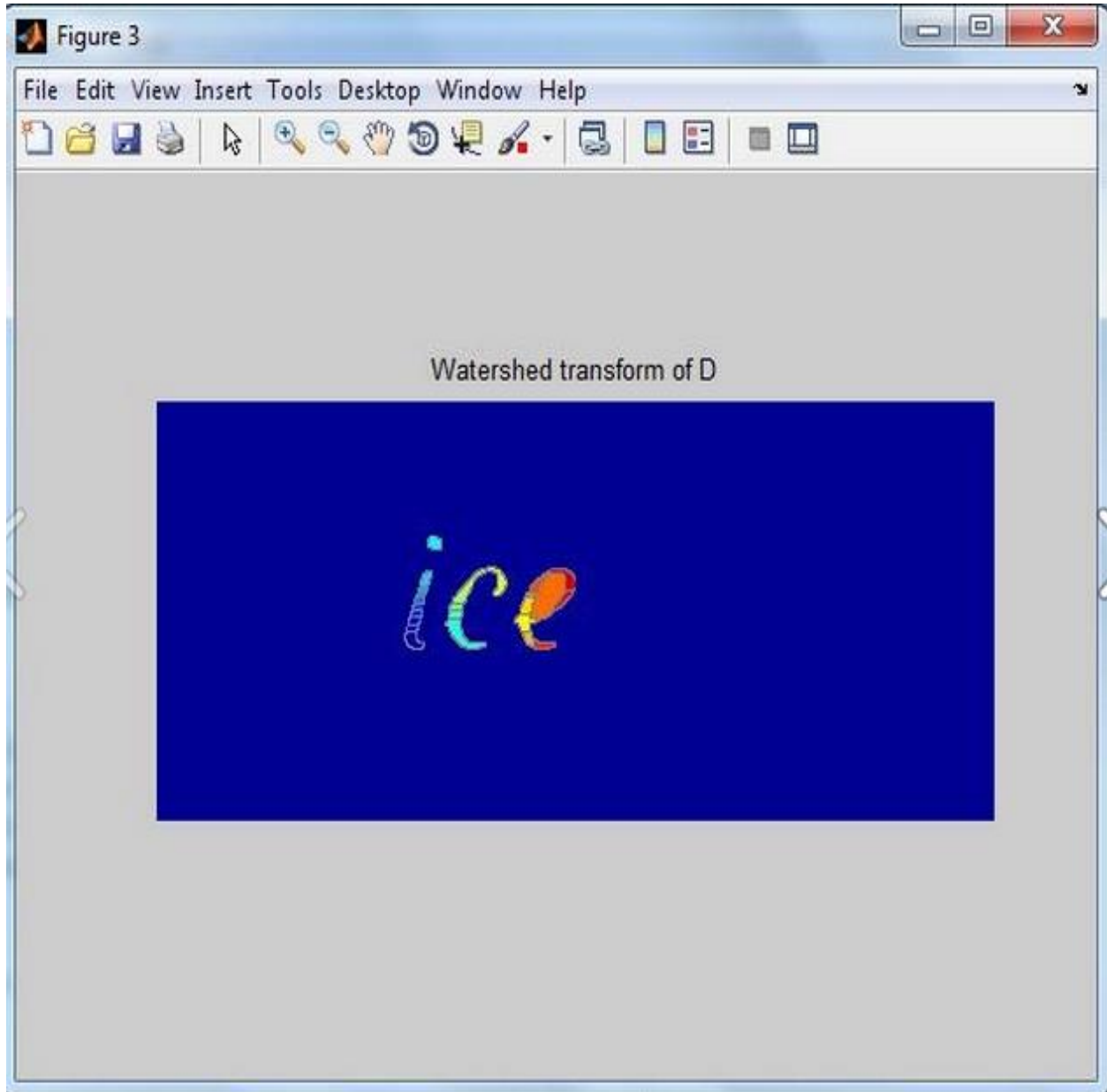
### 1. Input Image



## 2. Intermediate Image

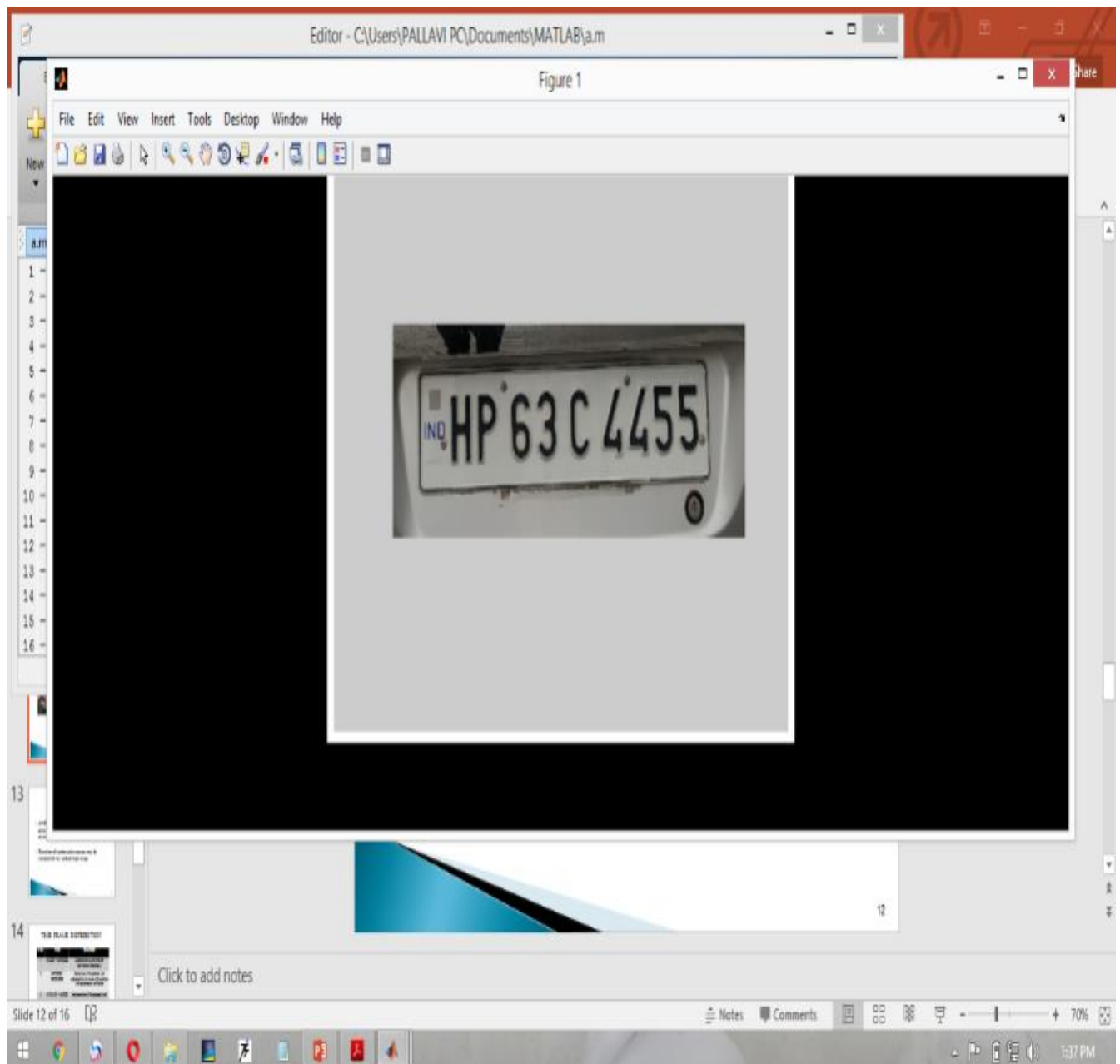


#### 4. Output Image

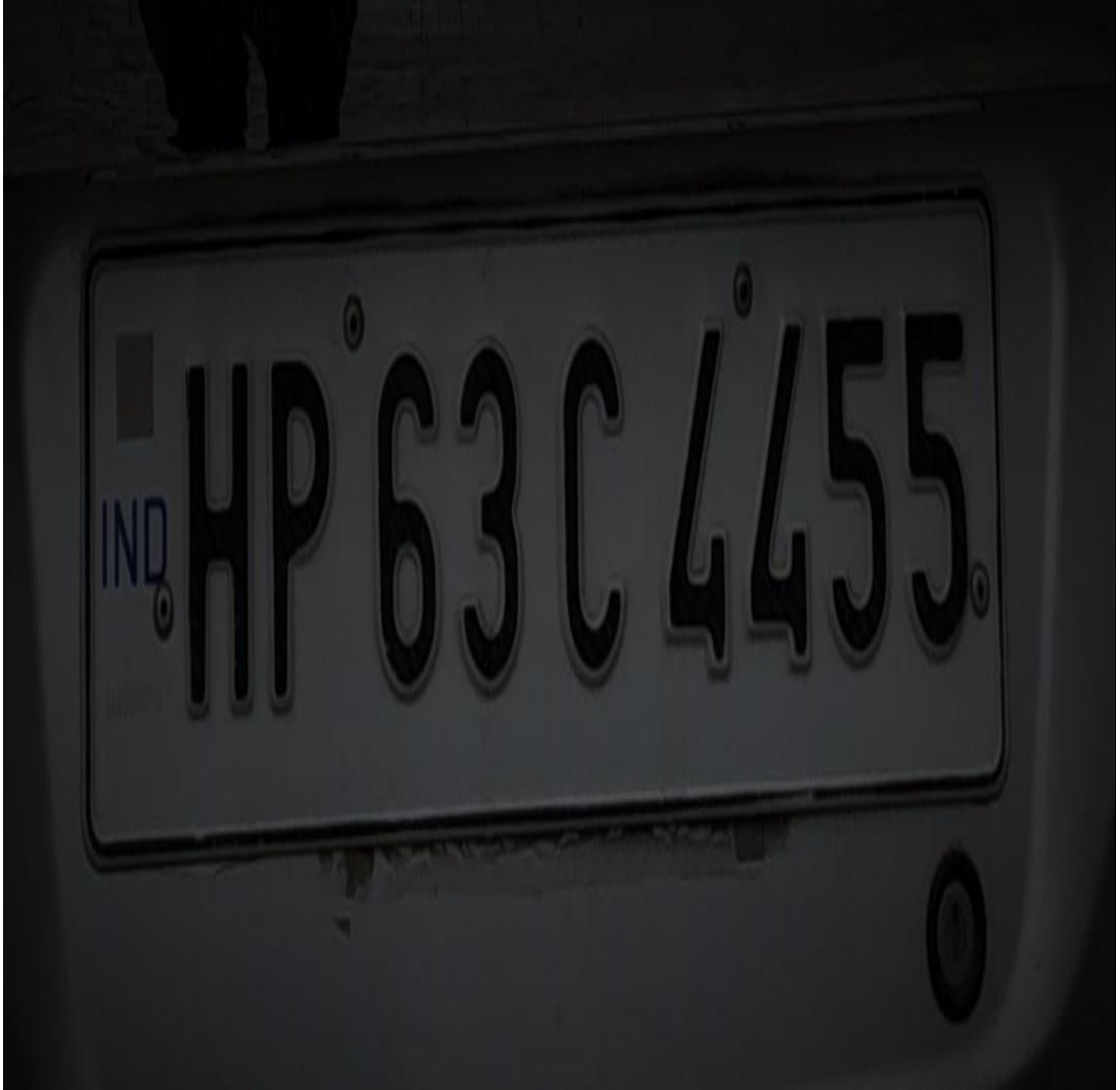


## 4.6 Simulation Results for automatic number plate recognition

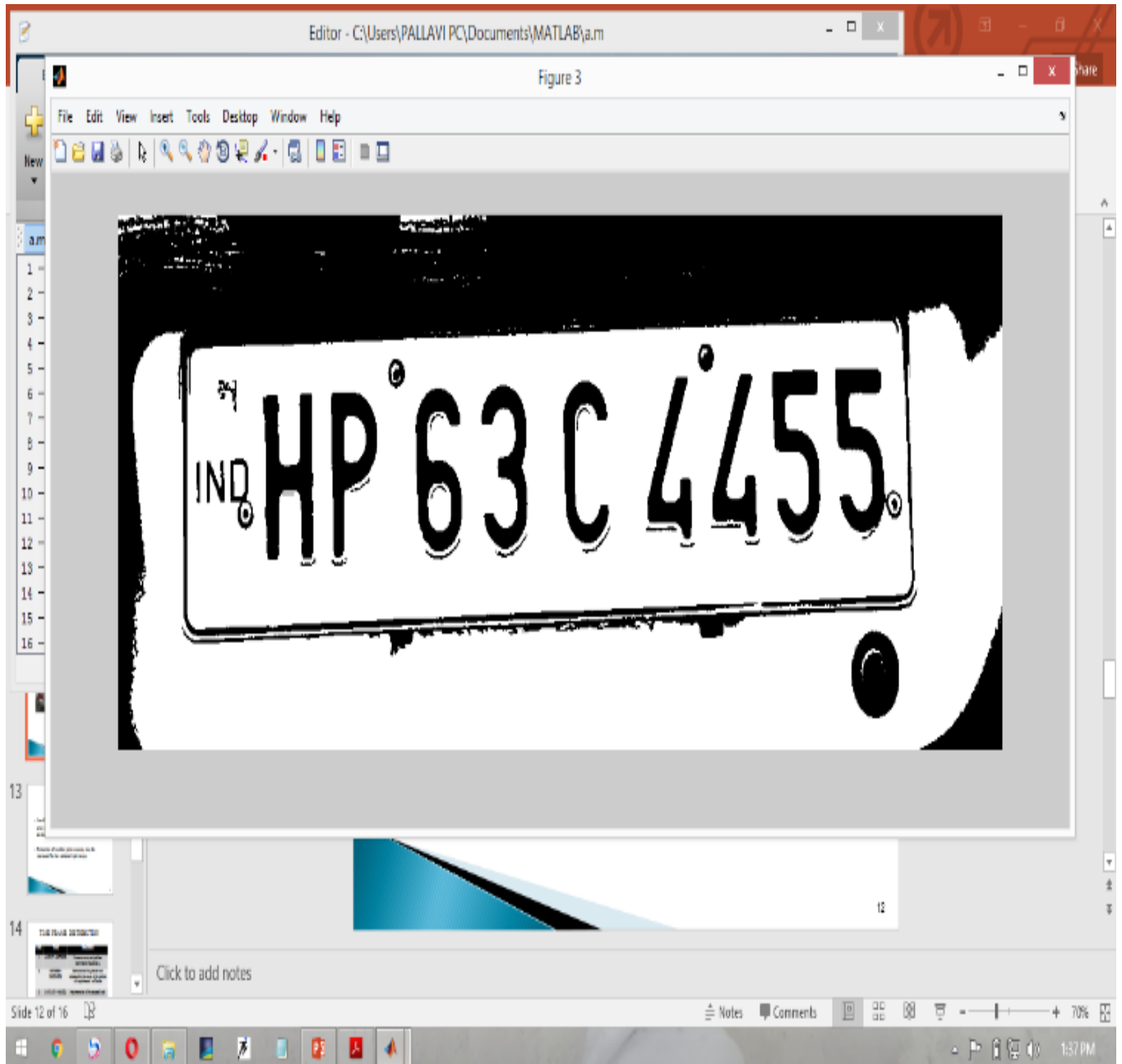
### 1.The input image



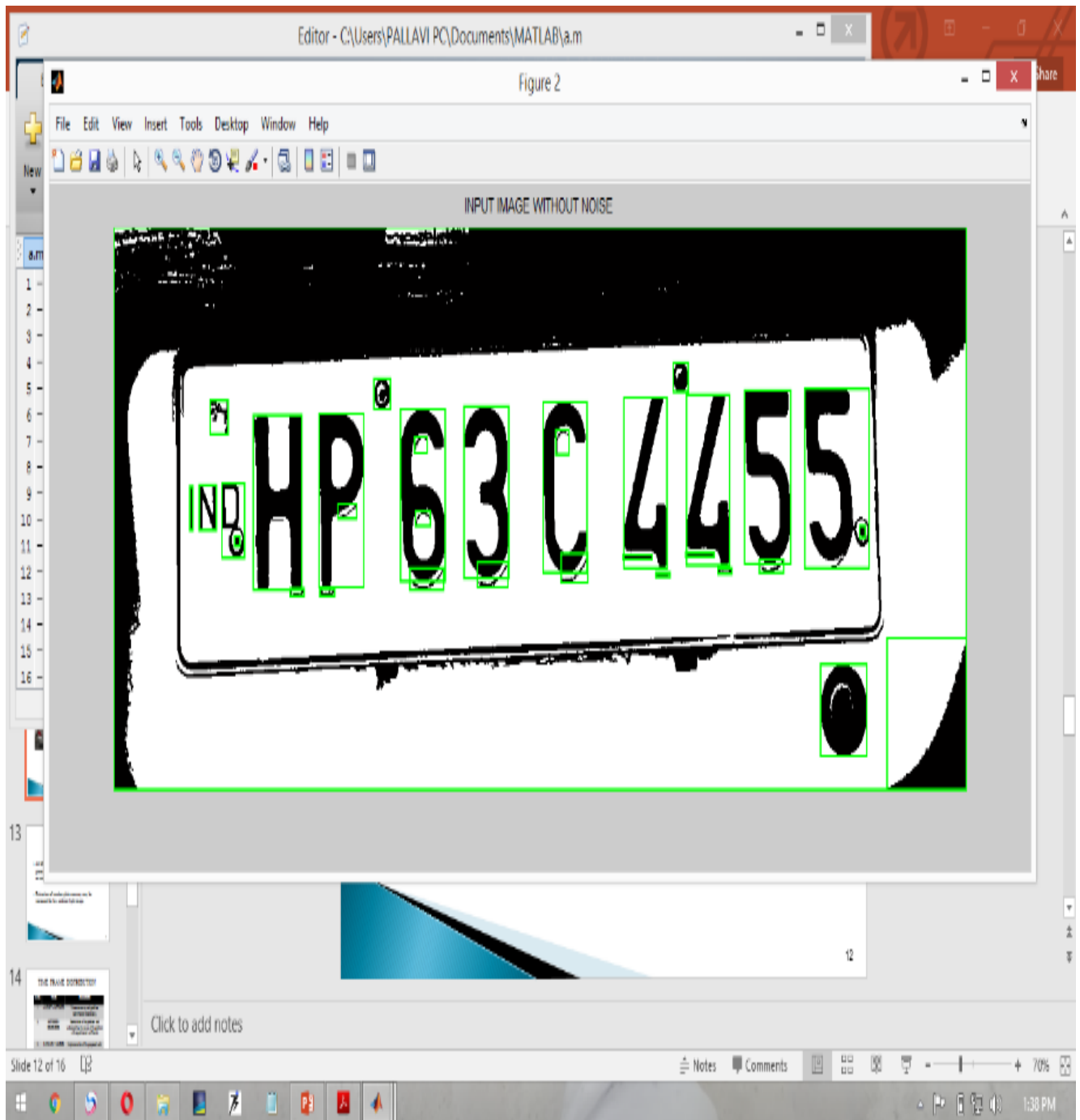
**2. Image converted into gray scale image**



### 3. Image localization



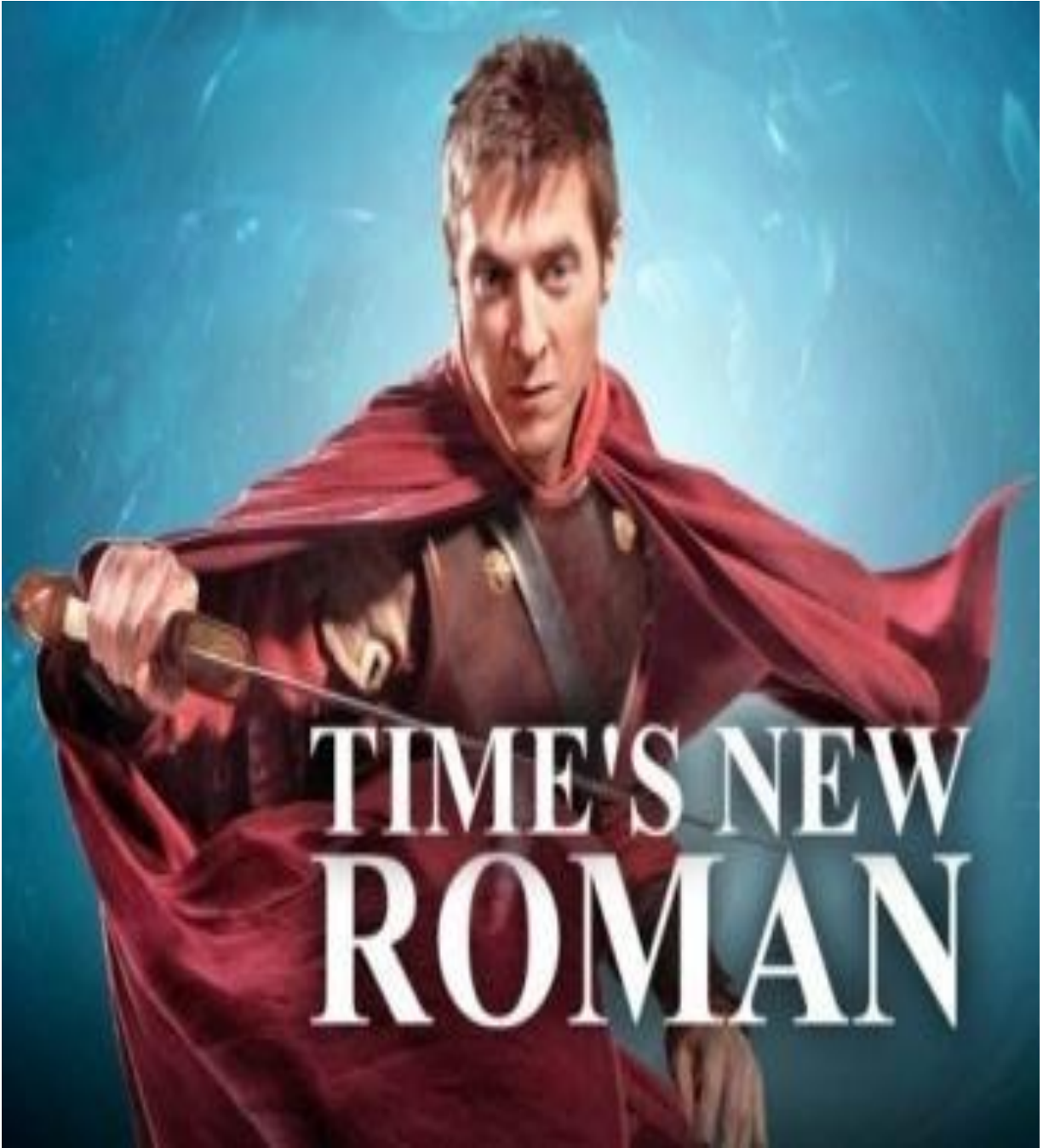
## 5. After Segmentation of characters



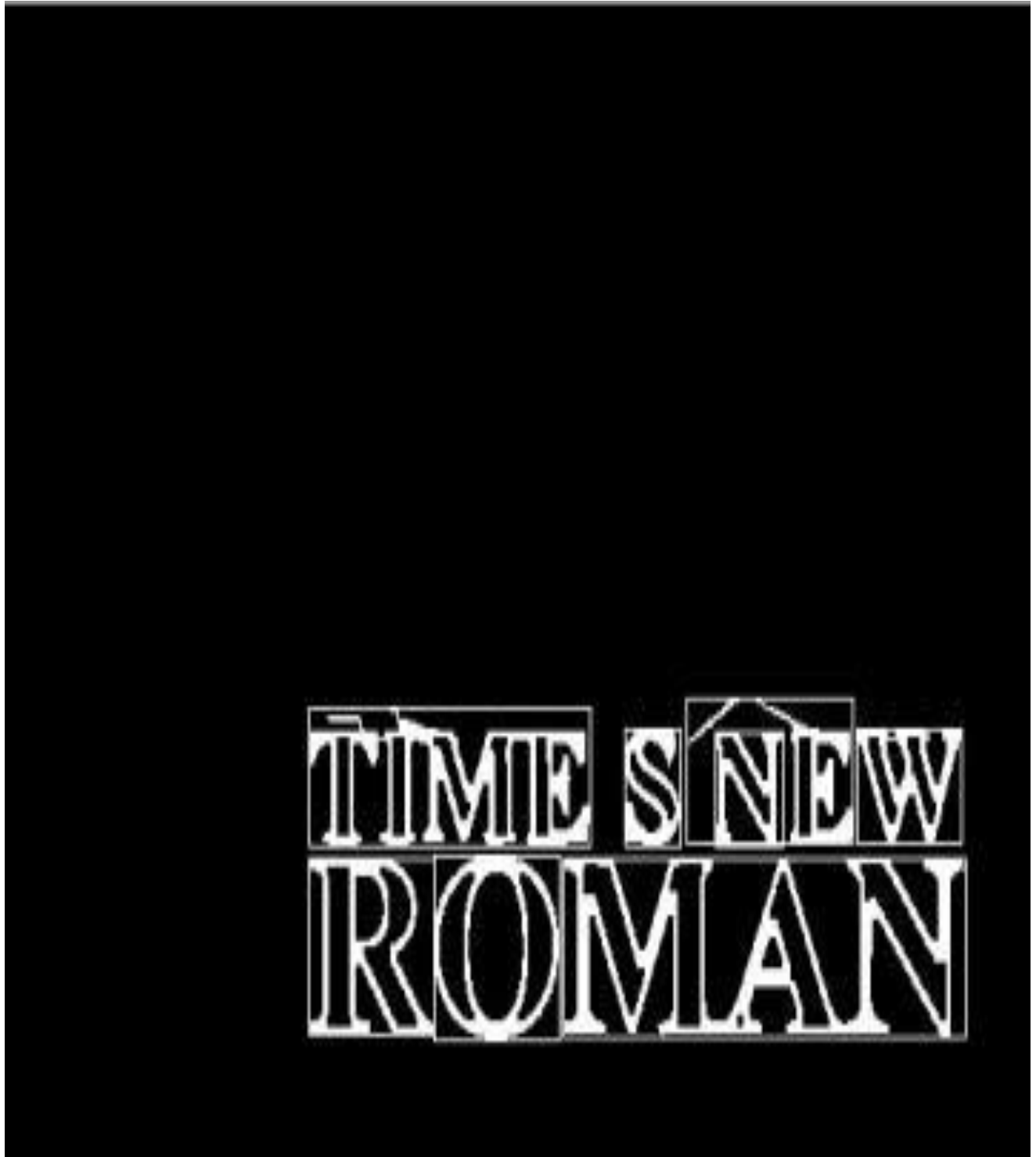


## 4.7 Simulation Results for Text Detection and Character Recognition using Morphological Operations

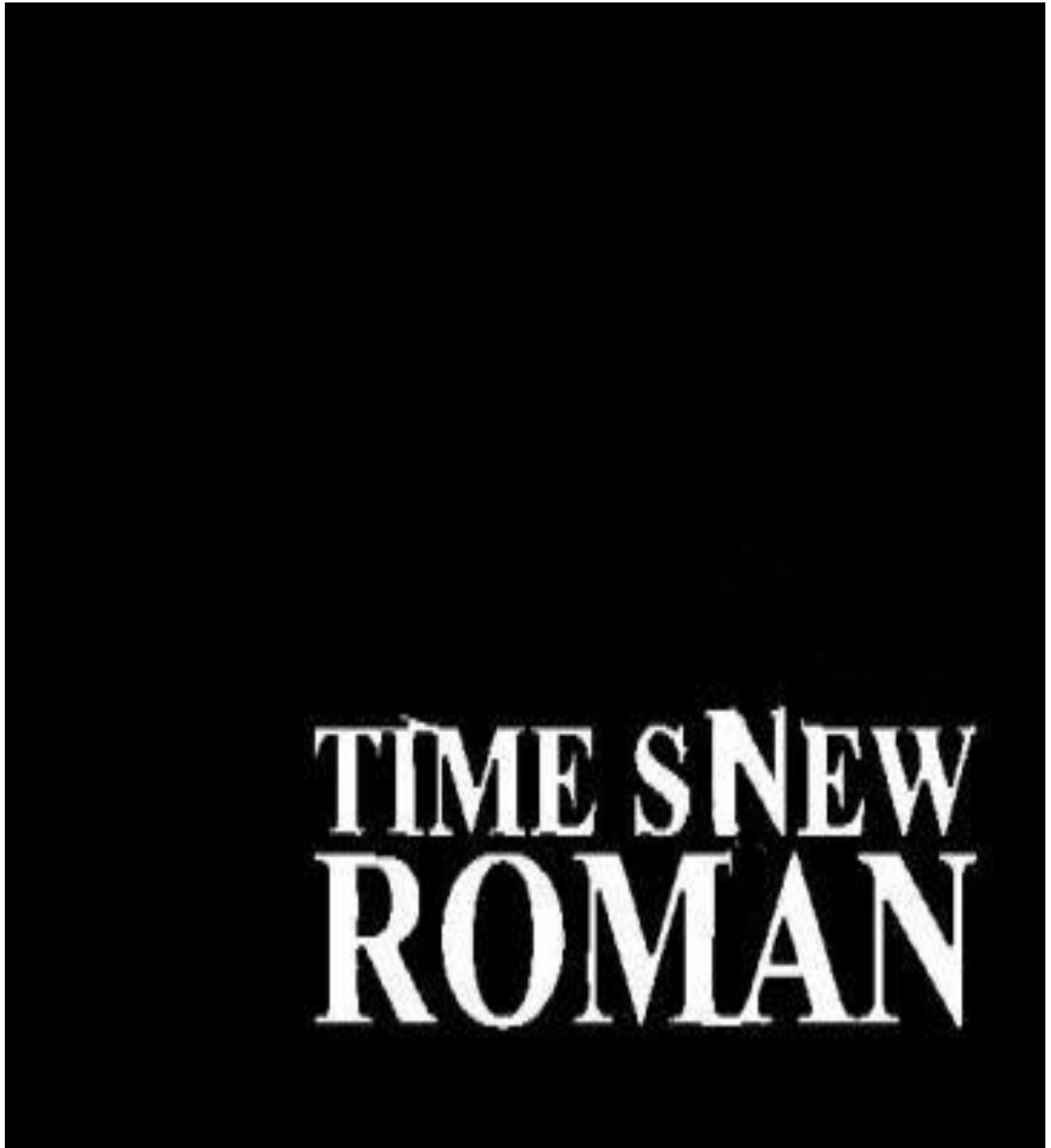
(a)Original image



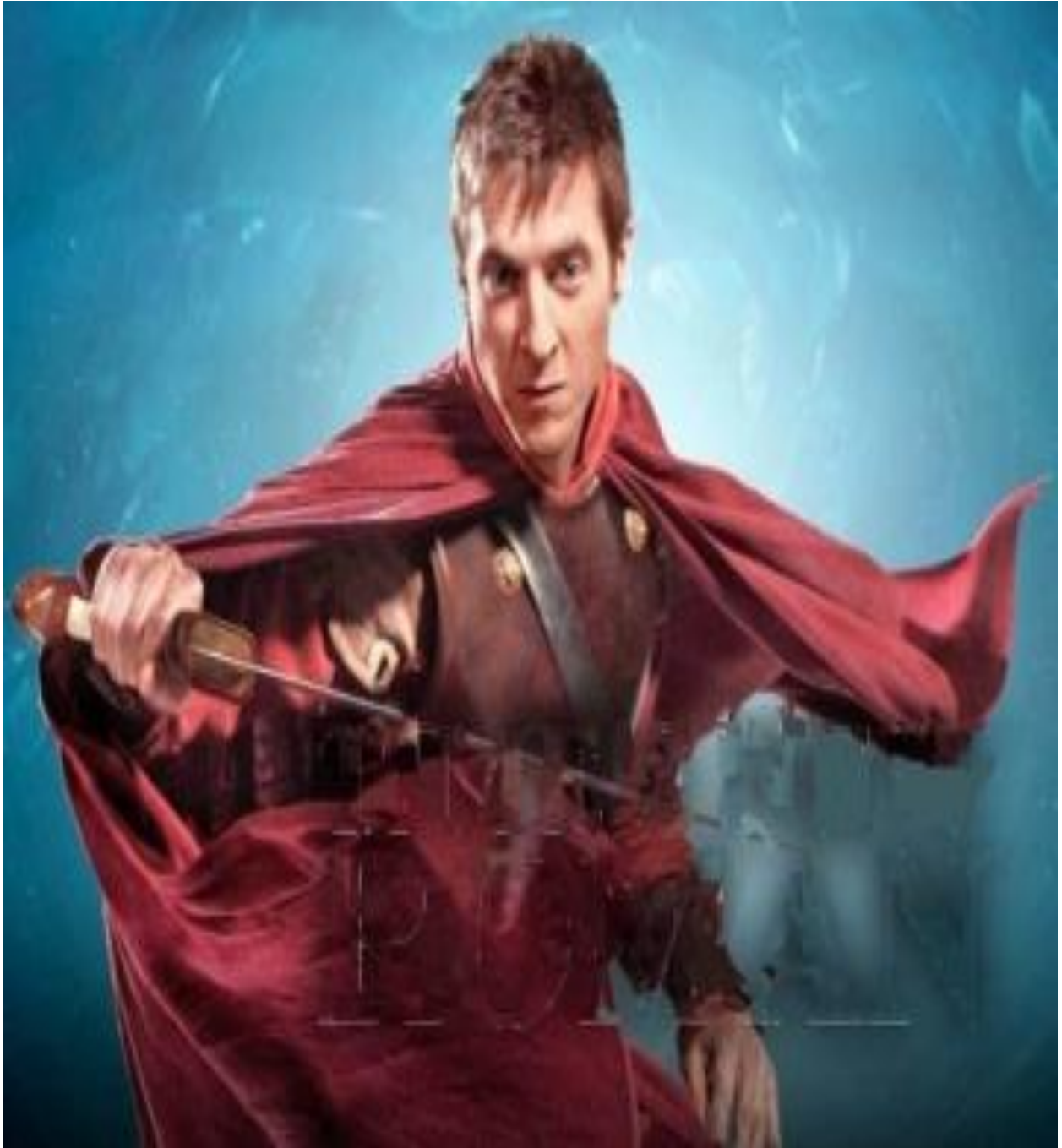
(b) Image after applying a algorithm



(c) Image



**(d) Image after text detection**



## 4.8 Comparison with Optical Character Recognition

**Table 1: Key differences**

<b>Optical Character Recognition</b>	<b>Character Recognition of Overlapped and Touched Objects using morphology operation</b>
Formation of image boundaries, determination of strongest curve and angle of rotation.	Formation of bounding box on each character.
Recognition by extraction of features – orientation, angle of rotation.	Recognition by template matching algorithm.
Limitations: Connected and overlapped characters cannot be recognized. Also cursive letters were not recognized.	Advantage: Connected and overlapped characters can be recognized using morphological operations. Cursive characters recognized using watershed algorithm.

**Table 2 : Key differences between different techniques use for number plate detection**

<b>Automatic Car Plate Detection and Recognition using morphological operation</b>	<b>Vehicle-License-Plate Recognition Based on Neural Networks</b>	<b>Automatic License Plate Recognition</b>
Just a single picture is utilized, from advanced camera in various conditions	Two modules video picture is utilized for preparing module	Only one image is used for the LPR system .
Picture is preprocessed for further acknowledgment,	The video from the image sensor is sent to video module	The plate area is preprocessed by applying the histogram

after that morphological operation is used for picture area.	of the chip. The part vector is typically made by the chip from the area of intrigue given by customer.	equalization technique
Advantage: High recognition rate.	Limitation: Less recognition rate.	Limitation: Less recognition rate.
Advantage: Character segmentation rate is high.	Limitation: Character segmentation rate is very low.	Limitation: Character segmentation rate is slightly low.

## 4.9 Applications

1. Character recognition technique used in the following fields:
2. It is commonly used in the bank to mechanically read names and addresses of envelopes and notes
3. To read number plates of vehicles
4. In libraries to read bar codes.
5. In post office needs to recognize zip-codes
6. For blind and visually impaired users- This requires the use of two enabling technologies – the CCD flatbed scanner and the text-to-speech synthesizer.

## 4.10 Advantage

**Efficient Technique:** The main requirement for the market's purpose is to find out the most efficient character recognition system.

**Reliable system:** The developed character recognition system should minimize error or accuracy rate in order to recognize hand written character or numbers.

**Faster System:** Speed is important factor for the character recognition system. The translation of optically scanned image into computer written document such as ASCII code should be faster such that it could save time and work efficiently.

**Cost Saving:** It will be economical in terms of cost because you don't need the paper document once you have converted it in computer written document.

**Reduce long haul stockpiling necessity:** Reduced long haul stockpiling prerequisite, records could be annihilated after the underlying checking, acknowledgment and fix.

**Save time:** Quick retrieval for editing and reprocessing therefore it saves time.

**Minimize Errors:** it minimizes error as compared to physical handling of the documents.

## Chapter-5

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# CONCLUSION AND FUTURE WORK

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### 5. Introduction

The end product will be comparative analysis of various OCR system that are available in the market. In addition, as this we will also suggest some modification in the existing technique to improve the performance in terms accuracy rate in order to read handwritten characters or numbers.

#### 5.1 Observations

By using the proposed method of bounding box for segmentation, all the alphabets were segmented except the connected and overlapped characters. Connected and overlapped characters were however segmented successfully using morphological operations. Watershed algorithm was used for segmentation of cursive characters. The coding used for noise reduction was also successful and capable of removing stray marks from image. The segmented characters were successfully recognized by using template matching technique.

#### 5.2 Comparison with Optical Character Recognition

Optical character recognition successfully recognizes characters by formation of image boundaries, determination of strongest curve and angle of rotation but nothing has been mentioned about connected and overlapped characters. Moreover, the case of cursive text is not considered. Our project however uses morphological operations (dilation and erosion) to segment connected and overlapped characters and template matching for recognition. All the characters are segmented and recognized successfully.

#### 5.3 Future Scope and Modifications

Further modifications in the Character Recognition system are possible.

The proposed character recognition system can be further extended to recognize small letters, numerals and text in other languages with different font styles and different font sizes.



- Character Recognition systems with higher efficiency can be designed to minimize errors associated with physical handling of the documents and in order to reduce long term storage requirements of documents.
- The suggested character recognition system could be further used for pattern recognition as well as voice recognition.

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## APPENDIX

### MATLAB Code

#### 1. Read the input image and perform pre-processing.

```
clc;
clear all;
% Template
a=imread('a.jpg');
a=im2bw(a,graythresh(a));
a=imcomplement(a);
t1=bwlabel(a,8);
```

#### 2. After preprocessing segment each character in the image by forming a bounding box.

```
f=regionprops(t1,'BoundingBox','Centroid');
figure(1);
imshow(a);
hold on
for i=1

    B=f(i).BoundingBox;
    C=f(i).Centroid;

    rectangle('Position',B,'EdgeColor','r','LineWidth',0.5);
    q1=text(10,10,strcat('\color {red} find this alphabet in the given string ', ''));
    set(q1,'FontName','arial','FontWeight','bold','FontSize',12);
```

```

    set(q,'FontName','arial','FontWeight','bold','FontSize',12);
    plot(round(C(1)),round(C(2)), 'b+');
end

```

**3. In case of connected characters the characters are first separated using morphological operations and then a bounding box is formed.**

```

a1=imread('over1.jpg');
a1=im2bw(a1,graythresh(a1));
a1=imcomplement(a1);
a2=bwmorph(a1,'majority');
figure(1),imshow(a1);
figure(2),imshow(a2);
t8=bwlabel(a2,8)
f=regionprops(t8,'BoundingBox','Centroid');
figure(1);
imshow(a2);
hold on
for i=1:length(f)

    B=f(i).BoundingBox;
    C=f(i).Centroid;

    rectangle('Position',B,'EdgeColor','r','LineWidth',0.5);
end

```

#### 4. In case of cursive text, it is segmented using watershed algorithm.

```
h=imread('ice.jpg');
h=im2bw(h,100/255);
D2 = bwdist(h);
D2=-D2;
D2(h) = -Inf;
L2 = watershed(D2);
rgb2 = label2rgb(L2,'jet',[.5 .5 .5]);
imshow(rgb2,'InitialMagnification','fit')
title('Watershed transform of D2')
rgb2=im2bw(rgb2,graythresh(rgb2));
t9=bwlabel(rgb2,8)
f=regionprops(t9,'BoundingBox','Centroid');
figure(1);
imshow(rgb2);
hold on
for i=1:length(f)

    B=f(i).BoundingBox;
    C=f(i).Centroid;

    rectangle('Position',B,'EdgeColor','r','LineWidth',0.5);
end
```

#### 5. After segmentation, recognition is performed using template matching.

```
r=corr2(bb1,bb5)
if (r == 1)
```

```
q=text(10,10,strcat('\color {red} alphabet is ', ' A'));  
set(q,'FontName','arial','FontWeight','bold','FontSize',12);  
else  
q=text(10,10,strcat('\color {red} alphabet is not', ' A'));  
set(q,'FontName','arial','FontWeight','bold','FontSize',12);  
end
```

## Results

