

Graduate Project:
Visual Comparison of Edge Detection Algorithms

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1 Introduction

Running through the edge detection project, I noticed that there are a lot of different methods and algorithms for detecting edges. I decided to take a few choice algorithms, which are considered the most common methods -Sobel, Canny, LePlacian convolution mask, Gaussian convolution mask, Frei-Chen, Prewitt, Difference Edge Detection, and Homogeneity Edge Detection techniques- and test them using the human eye as a measure of goodness. I used 11 of the 3 most commonly detected images -4 images of fingerprints, 4 images of text, and 3 images of faces- to run the techniques on and measure their goodness. I hope to find the best technique for each type of image and perhaps even the best technique overall. The benefits of finding the best edge detection algorithm will be that we will know what technique to use when faced with a specific problem among the 3 most commonly analyzed types of images.

2 Method

The Sobel, Canny, Frei-Chen, Prewitt, Difference edge detection, and Homogeneity edge detection algorithms were all canned methods that were found in the biOps package for the R scripting language. The biOps package contains many methods and tools for image analysis and processing.

For the programming portion of this project, I wrote a method to create and return a LePlacian mask. I wrote a method to return a weighted, normalized, distance matrix for the Gaussian mask. Then I wrote a method to iterate over each BLOB (Binary Large Object), which is a collection of pixels in an image matrix, and apply any given mask to the BLOB. I saved the pixel information in a copy of the image matrix and then returned the image matrix as an imagedata object. I wrote wrappers for each of the canned methods to maintain a standard method call for each. That way you can call *plotFreiChen(imageData)*, for example, and know that it will plot using the Frei-Chen algorithm, rather than having to remember to set $y = \text{imgFreiChen}(x)$, $y = \text{imgNegative}(y)$, $\text{plot}(y)$ which may be different syntax for each canned method. I finished by writing a method to plot using whichever algorithm is chosen as a parameter. The user can also choose to plot using all algorithms sequentially. I fixed a bug in my original project where the borders were showing up black instead of white using the LePlacian and/or the Gaussian masks. I also performed pre-processing on each of the images to maintain standards for image analysis. All images are RGB, .png, and each image is sized (keeping proportions) with their largest size being 500 pixels (either height or width). so the user doesn't have to change anything in the script.

3 Results

The following are a series of 11 images that I ran through the 9 algorithms, for a total of 99 final images. The first image in each series is the original and each subsequent image will explain itself.

3.1 Fingerprint Recognition



Figure 1.0 Large fingerprint (Original)



Figure 1.1 Large fingerprint analyzed using the Sobel edge detection algorithm.



Figure 1.2 Large fingerprint analyzed using the Canny edge detection algorithm.



Figure 1.3 Large fingerprint analyzed using the LePlacian mask edge detection technique.



Figure 1.4 Large fingerprint analyzed using a Gaussian Mask and a LePlacian Mask in succession. Threshold = 0.



Figure 1.5 Large fingerprint analyzed using the LePlacian Gaussian mask technique with a threshold of 100.



Figure 1.6 Large fingerprint analyzed using the Frei-Chen edge detection algorithm.



Figure 1.7 Large fingerprint analyzed using the Prewitt edge detection algorithm.



Figure 1.8 Large fingerprint analyzed using the Difference edge detection algorithm.



Figure 1.9 Large fingerprint analyzed using the Homogeneity edge detection algorithm.



Figure 2.0 Handprint (Original)



Figure 2.1 Handprint analyzed using the Sobel edge detection algorithm.

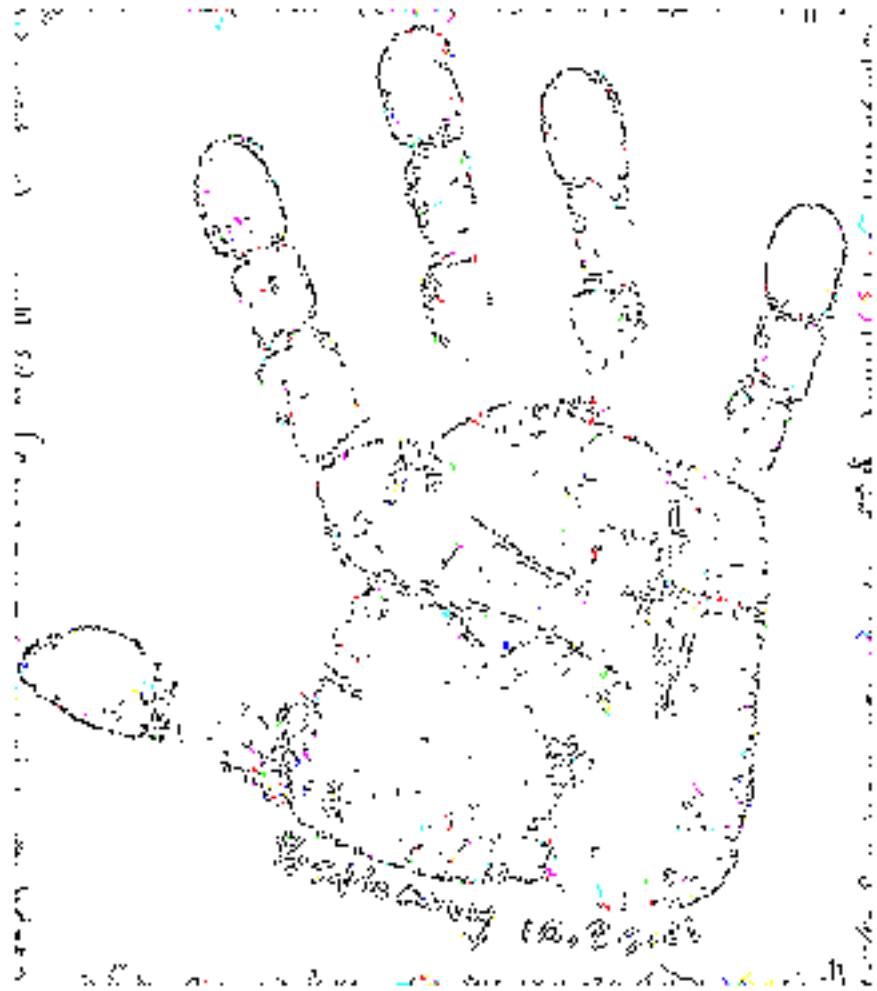


Figure 2.2 Handprint analyzed using the Canny edge detection algorithm.

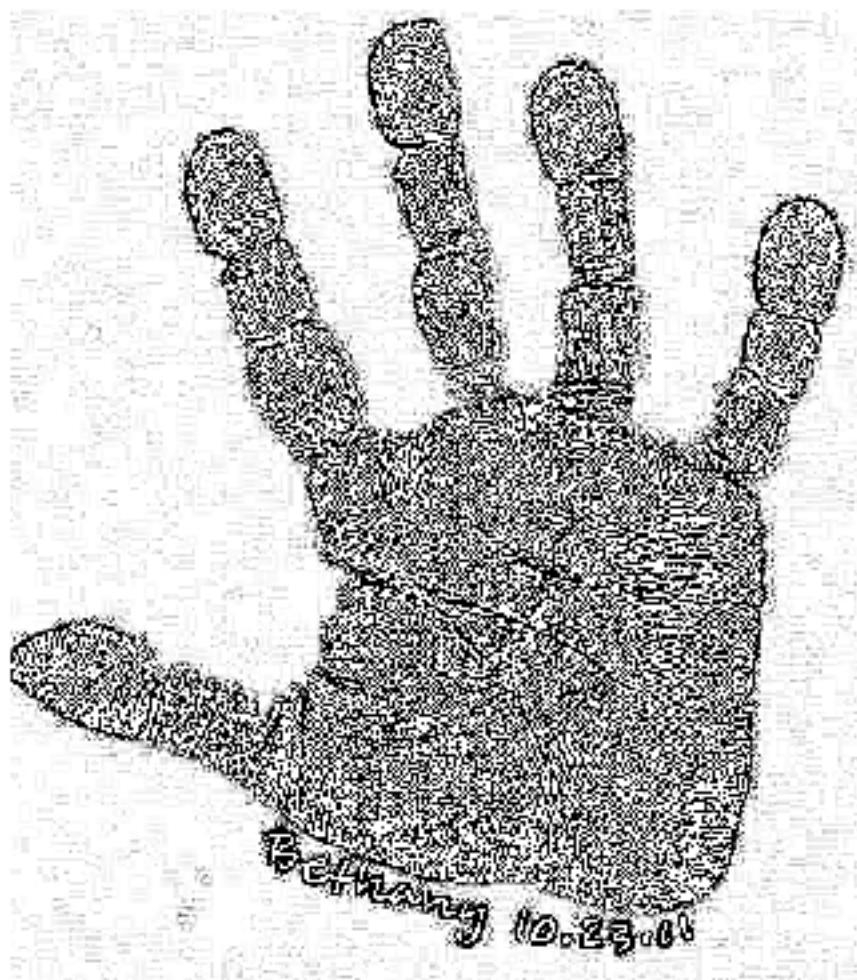


Figure 2.3 Handprint analyzed using the LePlacian mask edge detection algorithm.



Figure 2.4 Handprint analyzed using a Gaussian Mask and a LePlacian Mask in succession. Threshold = 0.



Figure 2.5 Handprint analyzed using the LePlacian-Gaussian mask algorithm with a threshold of 100.



Figure 2.6 Handprint analyzed using the Frei-Chen edge detection algorithm.



Figure 2.7 Handprint analyzed using the Prewitt edge detection algorithm.



Figure 2.8 Handprint analyzed using the Difference edge detection algorithm.



Figure 2.9 Handprint analyzed using the Homogeneity edge detection algorithm.



Figure 3.0 Dark Handprint (Original)



Figure 3.1 Dark Handprint analyzed using the Sobel edge detection algorithm.



Figure 3.2 Dark Handprint analyzed using the Canny edge detection algorithm.

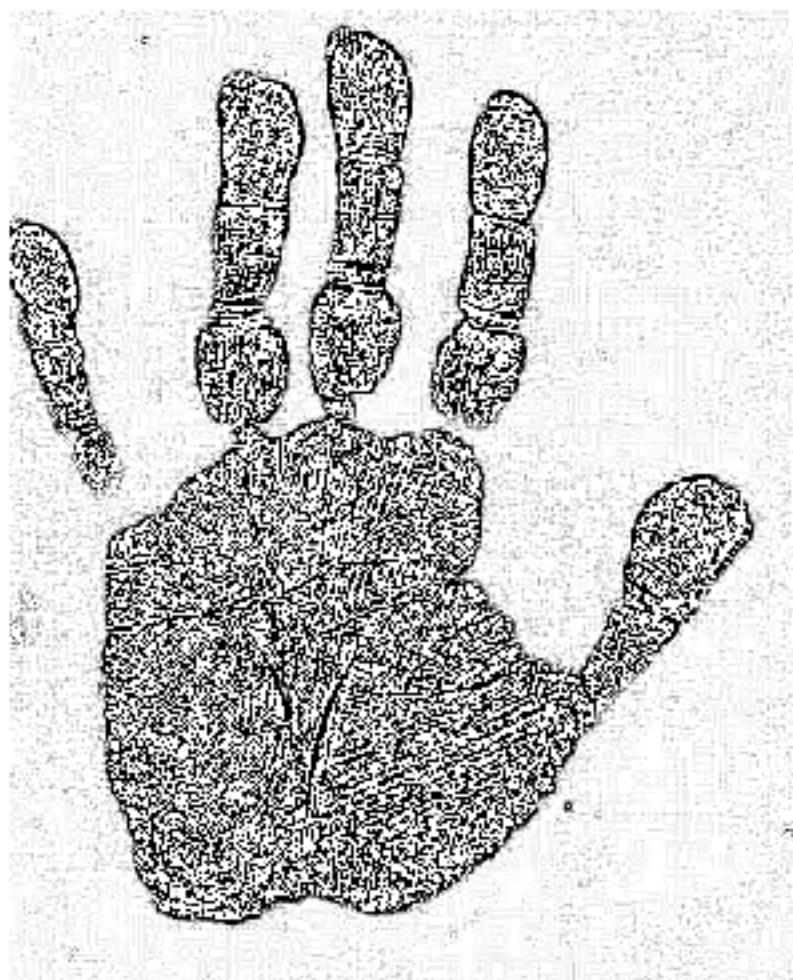


Figure 3.3 Dark Handprint analyzed using the LePlacian mask edge detection algorithm.



Figure 3.4 Dark Handprint analyzed using a Gaussian Mask and a LePlacian Mask in succession. Threshold = 0.



Figure 3.5 Dark Handprint analyzed using the LePlacian-Gaussian mask algorithm with a threshold of 100.



Figure 3.6 Dark Handprint analyzed using the Frei-Chen edge detection algorithm.



Figure 3.7 Dark Handprint analyzed using the Prewitt edge detection algorithm.



Figure 3.8 Dark Handprint analyzed using the Difference edge detection algorithm.



Figure 3.9 Dark Handprint analyzed using the Homogeneity edge detection algorithm.

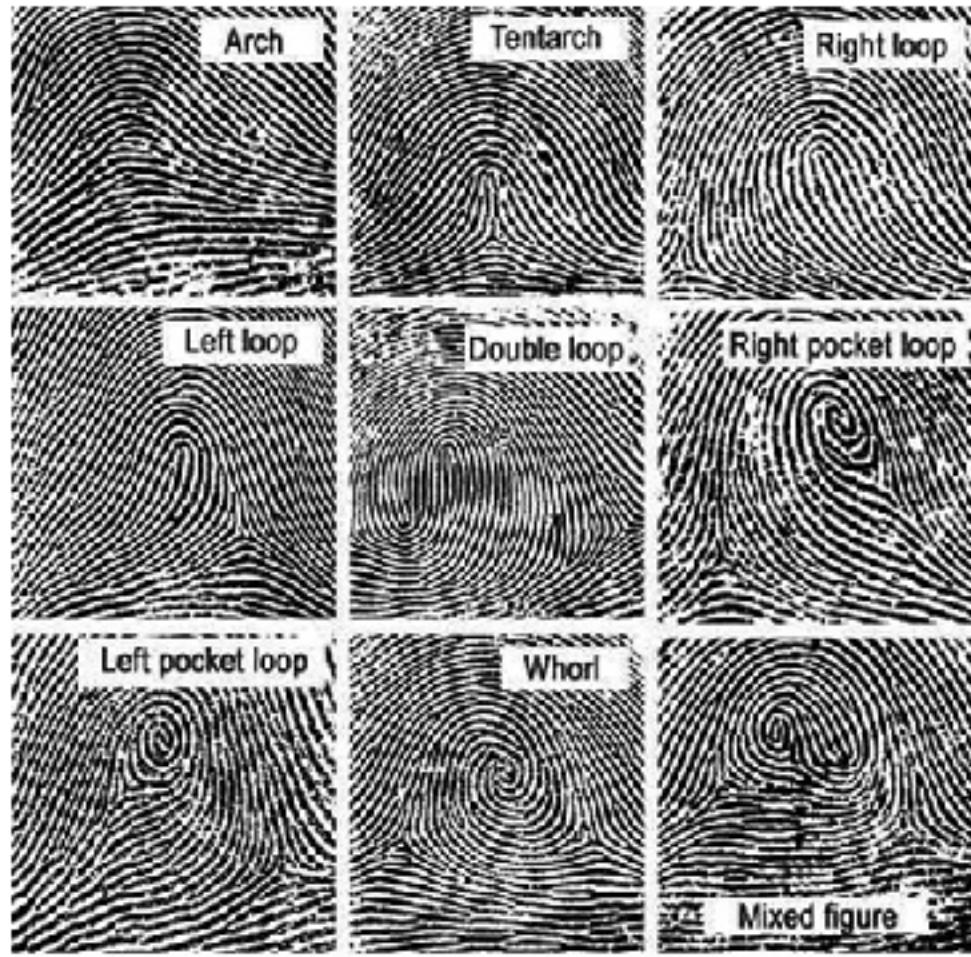


Figure 4.0 Different Fingerprint Patterns (Original)

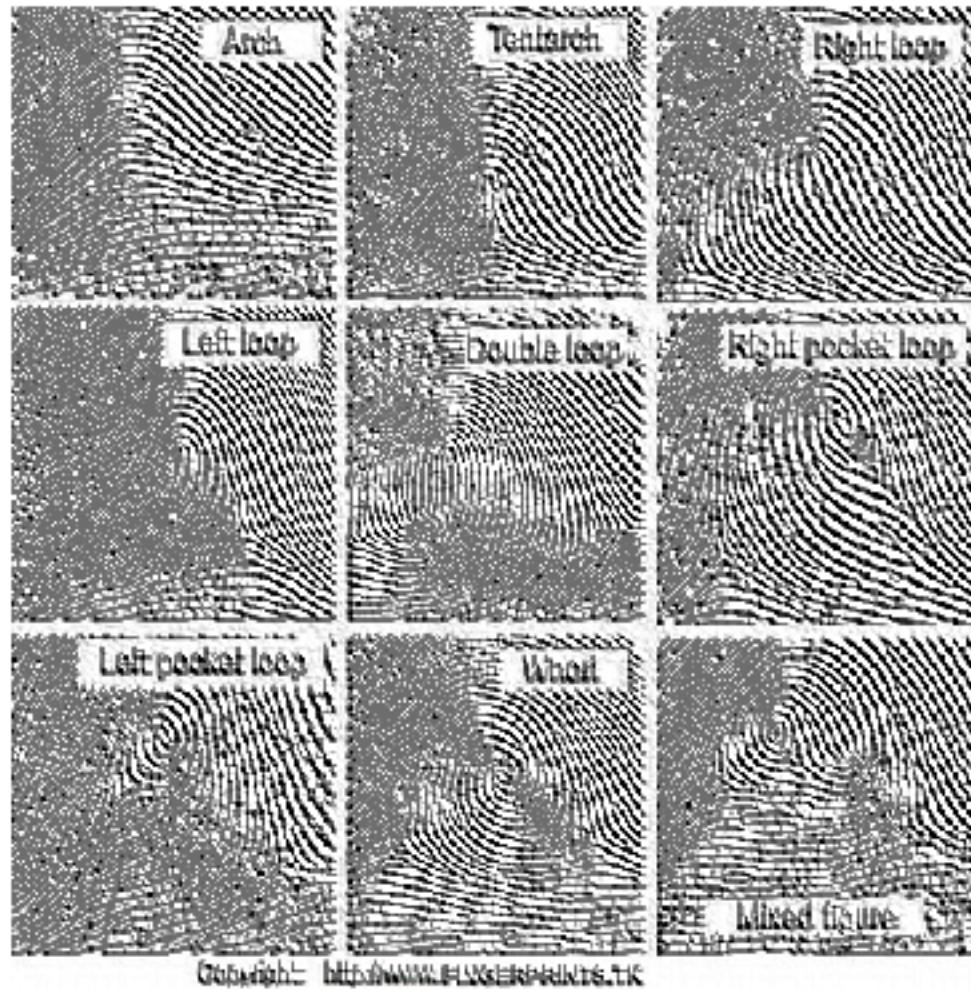


Figure 4.1 Different Fingerprint Patterns analyzed using the Sobel edge detection algorithm.

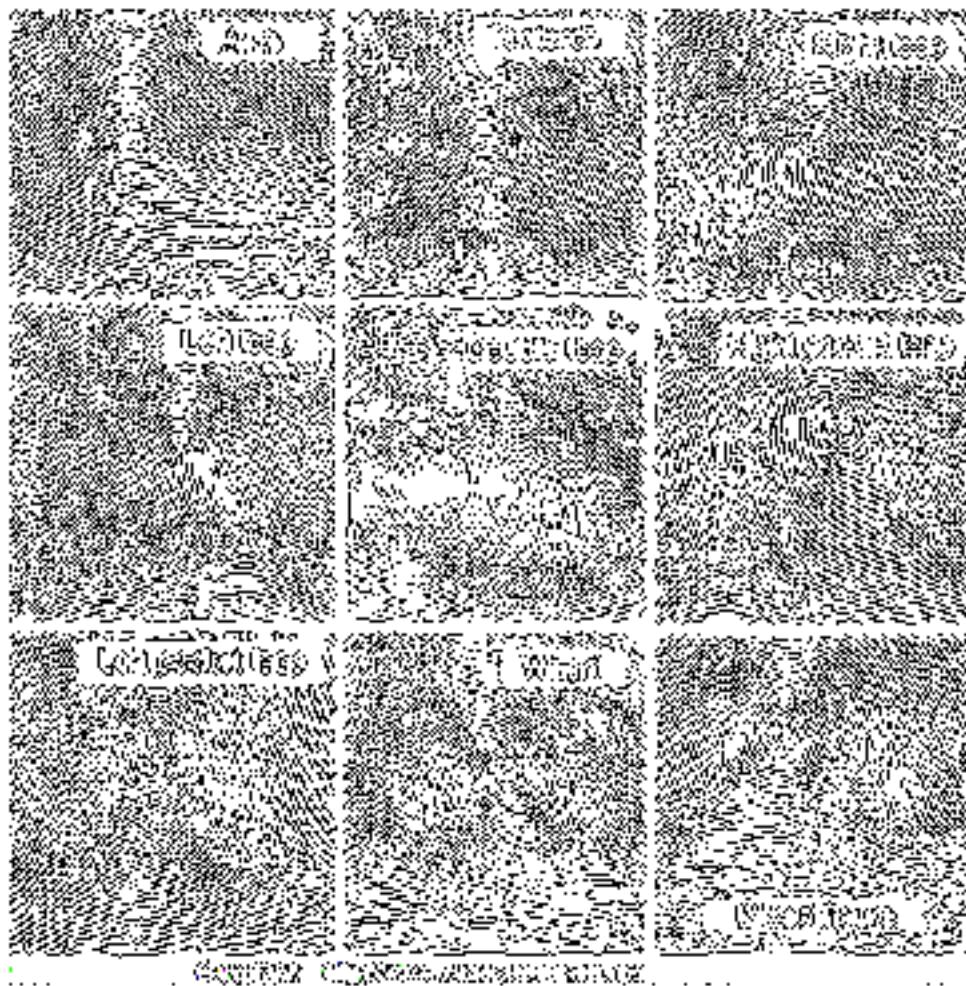


Figure 4.2 Different Fingerprint Patterns analyzed using the Canny edge detection algorithm.

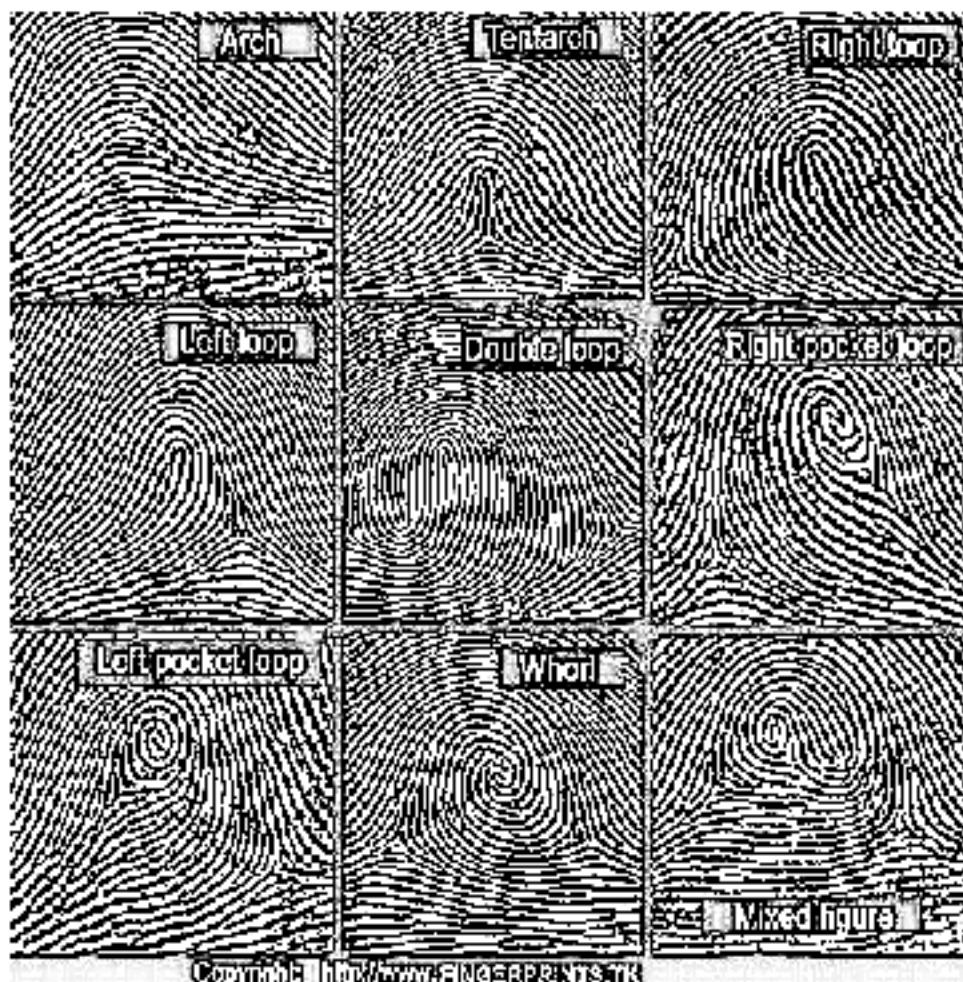


Figure 4.3 Different Fingerprint Patterns analyzed using the LePlacian mask edge detection algorithm.

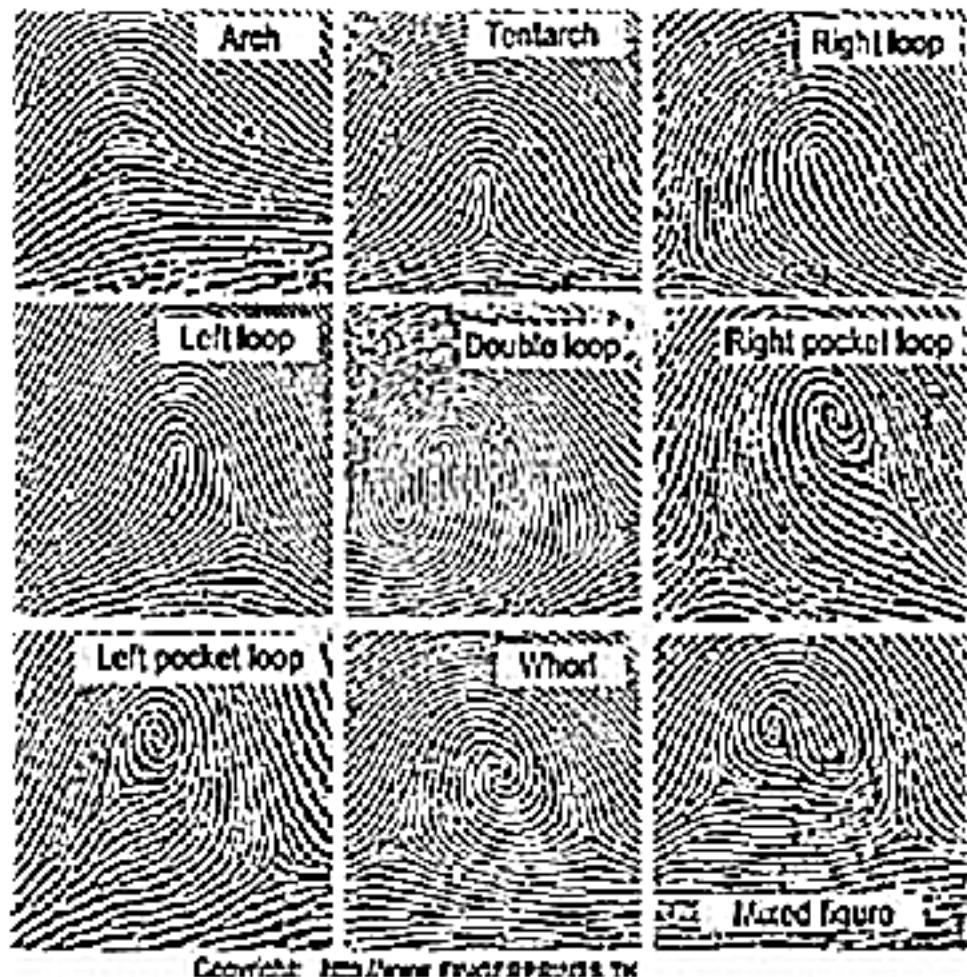


Figure 4.4 Different Fingerprint Patterns analyzed using a Gaussian Mask and a LePlacian Mask in succession.
Threshold = 0.

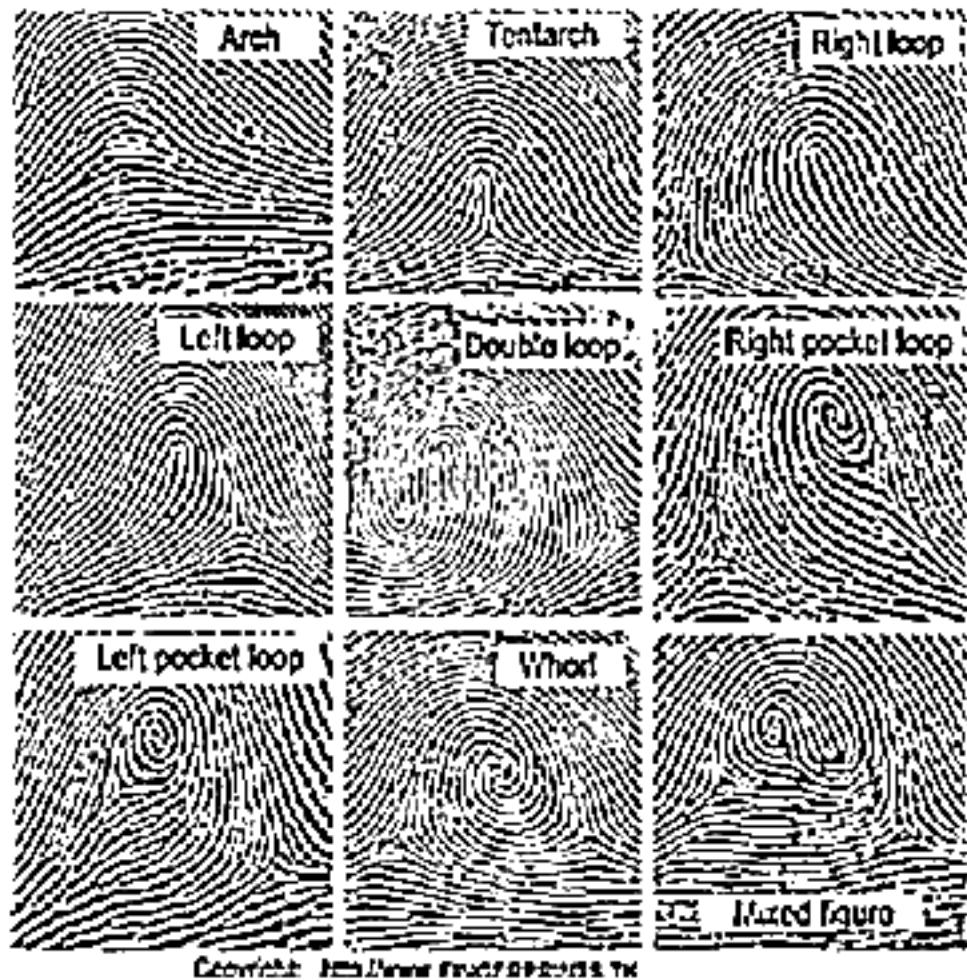


Figure 4.5 Different Fingerprint Patterns analyzed using the LePlacian-Gaussian mask algorithm with a threshold of 100.

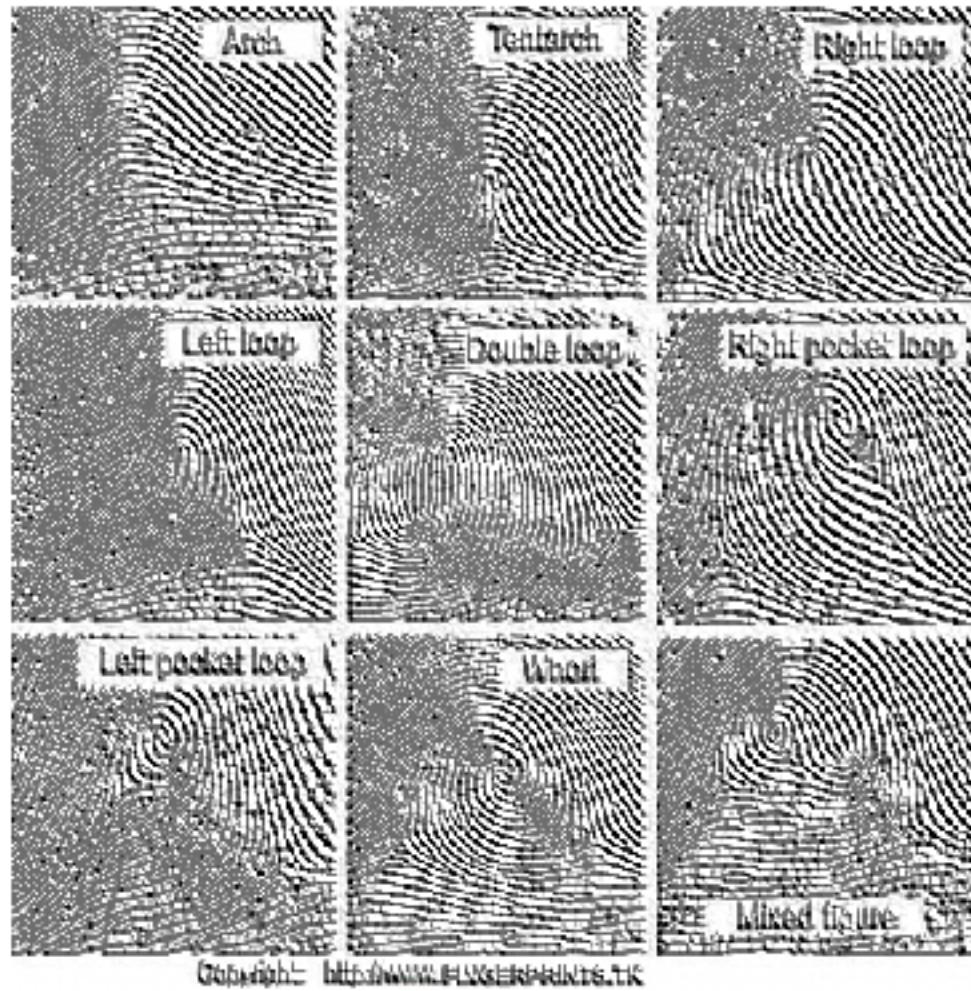


Figure 4.6 Different Fingerprint Patterns analyzed using the Frei-Chen edge detection algorithm.

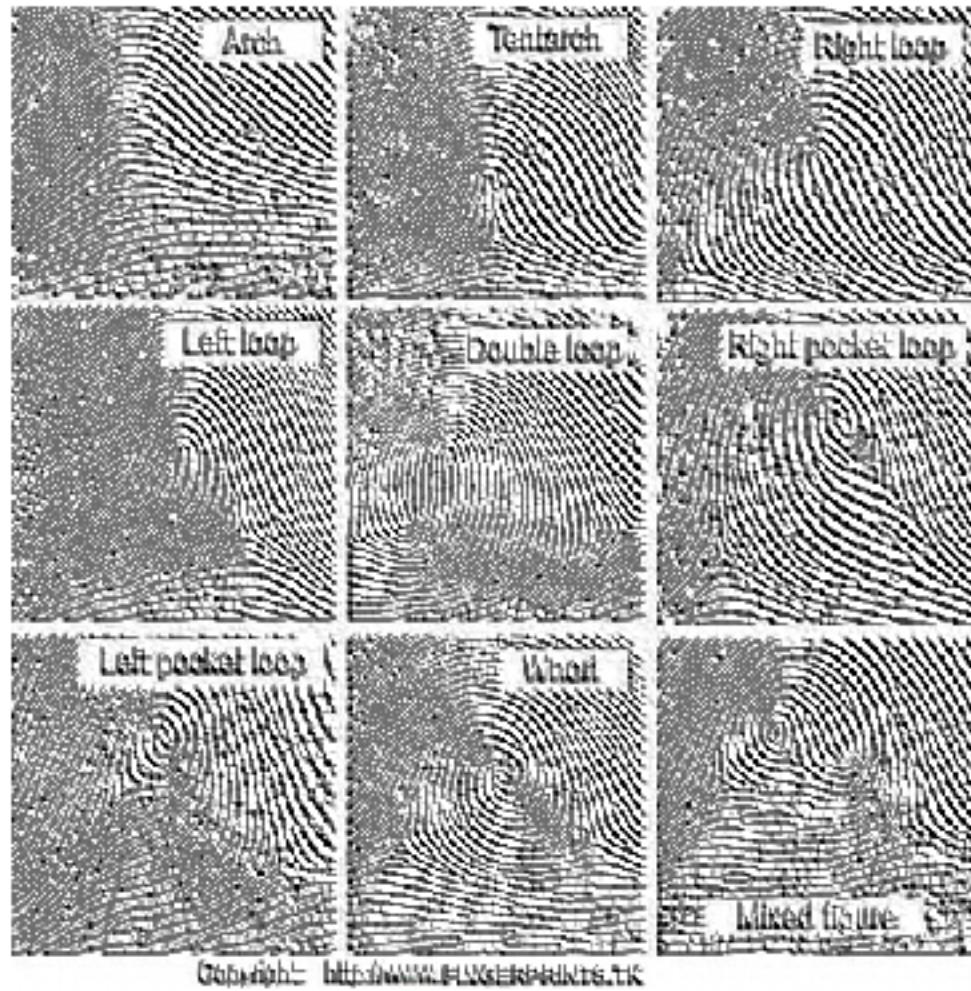


Figure 4.7 Different Fingerprint Patterns analyzed using the Prewitt edge detection algorithm.

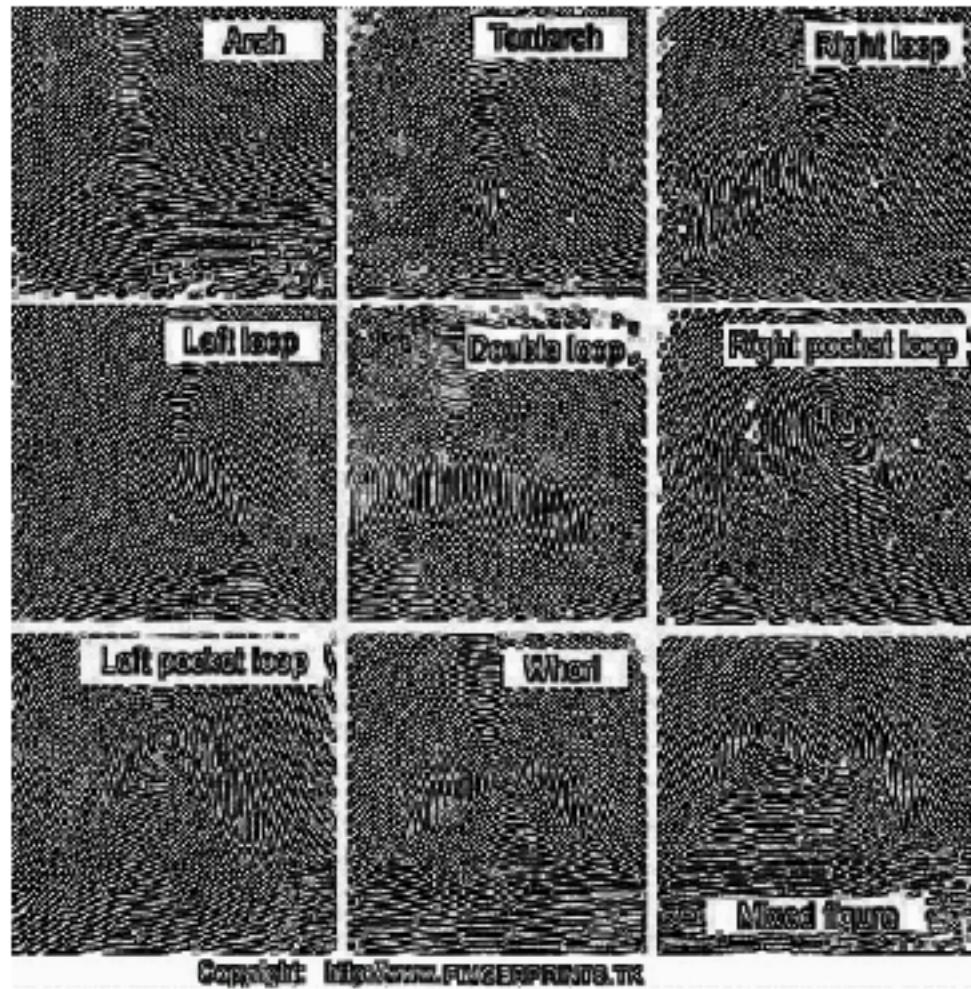


Figure 4.8 Different Fingerprint Patterns analyzed using the Difference edge detection algorithm.

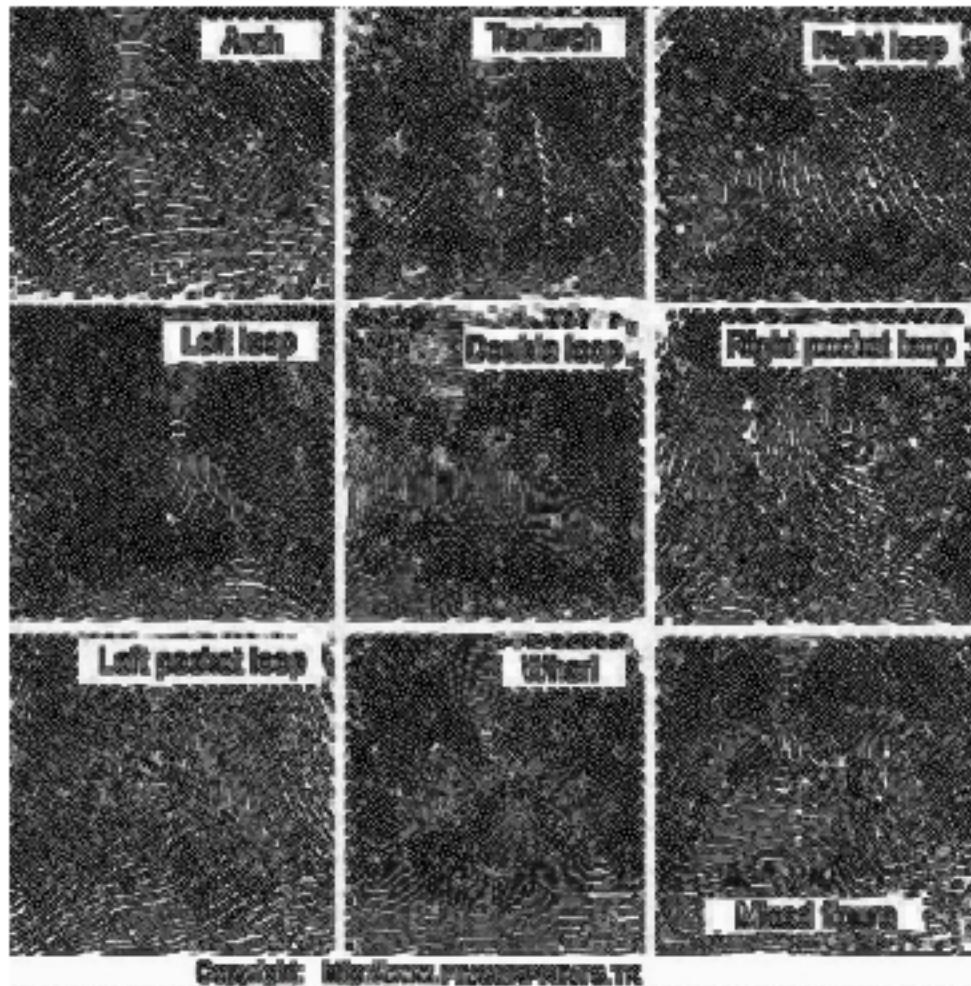


Figure 4.9 Different Fingerprint Patterns analyzed using the Homogeneity edge detection algorithm.

3.2 Text Recognition

In July 1845 Texas formally accepted an American proposal to be annexed to the United States. Already strained relations between the United States and Mexico rapidly worsened. President James K. Polk ordered General Zachary Taylor and his troops to Corpus Christi. In March 1846, under instructions, Taylor took up positions on the Rio Grande. On April 26 an American squadron of dragoons surrounded by Mexicans and unable to fight its way out surrendered. Several Americans lost their lives in the defeat.

On May 8 the Mexicans intercepted Taylor at Palo Alto but were driven back. The next day Mexicans again gave way in battle at Resaca de la Palma. In June Taylor began a march toward Monterrey, taking that city on September 25. Two months later the Americans took Saltillo and with little effort filed into Tampico.

Santa Anna now took the field against the American forces in northern Mexico, finally engaging the Americans at Buena Vista in February. Upon learning of the Mexican's design, General John E. Wool, marched from San Antonio to join Taylor's forces, abandoning his prior plans to take Chihuahua. After extremely bitter fighting Santa Anna pulled out his army, leaving Taylor in control of northern Mexico.

While Taylor pursued the enemy, Colonel Stephen W. Kearny took the "Army of the West" into New Mexico, capturing Santa Fe on August 16, 1846. Kearny then divided his forces, taking part to California and sending the remainder under Alexander W. Doniphan against Chihuahua. After General Winfield Scott captured Mexico City the two countries finally reached a settlement.

Sources: Maps adapted from *The West Point Atlas of American Wars*, Volume 1, Frederick A. Praeger, 1959.

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Figure 5.0 Normal Text (Original)

In July 1845 Texas formally accepted an American proposal to be annexed to the United States. Already strained relations between the United States and Mexico rapidly worsened. President James K. Polk ordered General Zachary Taylor and his troops to Corpus Christi. In March 1846, under instructions, Taylor took up positions on the Rio Grande. On April 25 an American squadron of frigates surrounded by Mexicans and unable to fight its way out surrendered. Several Americans lost their lives in the defeat.

On May 9 the Mexicans intercepted Taylor & Co's. Atac but were driven back. The next day Mexicans again gave way in battle at Rivas de la Palma. In June Taylor began a march toward Monterrey, taking that city on September 26. Two months later the Americans took Saltillo and with little effort filed into Tapatio.

Santa Anna now took the field against the American forces in northern Mexico, finally engaging the Americans at Buena Vista in February. Upon learning of the Mexican's design, General John E. Wool, marched from San Antonio to join Taylor's forces, abandoning his prior plan to take Chihuahua. After extremely bitter fighting Santa Anna pulled out his army, leaving Taylor in control of northern Mexico.

While Taylor pursued the enemy, Colonel Stephen W. Kearny took the "Army of the West" into New Mexico, capturing Santa Fe on August 18, 1846. Kearny then divided his forces, taking part to California and sending the remainder under Alexander W. Doniphan against Chihuahua. After General Winfield Scott captured Mexico City the two countries finally reached a settlement.

Source: Map copied from *The West Point Atlas of American Wars*, Volume I, Frederick A. Praeger, 1963.

Digitized by the Internet Archive in 2007 with funding from The University of Montana Library.

Figure 5.1 Normal Text analyzed using the Sobel edge detection algorithm.

「我國之民族主義者，其心地雖無大過，但其方法實有失當之處。」

该书由美国学者吉尔伯特·R·米勒编著，于1995年首次出版，是关于中国近现代史研究的一部重要著作。

Scanned with CamScanner

Figure 5.2 Normal Text analyzed using the Canny edge detection algorithm.

In July 1845 Texas formally accepted an American proposal to be annexed to the United States. Already strained relations between the United States and Mexico rapidly worsened. President James K. Polk ordered General Zachary Taylor and his troops to Corpus Christi. In March 1846, under instructions, Taylor took up positions on the Rio Grande. On April 20 an American squadron of dragoons surrounded by Mexicans and unable to fight its way out surrendered. Several Americans lost their lives in the defeat.

On May 8 the Mexicans intercepted Taylor at Palo Alto but were driven back. The next day Mexicans again gave way in battle at Resaca de la Palma. In June Taylor began to march toward Monterrey, taking that city on September 20. Two months later the Americans took Saltillo and with little effort filed into Tampico.

Santa Anna now took the field against the American forces in northern Mexico, finally engaging the Americans at Cerro Vista in February. Upon learning of the Mexican's design, General John E. Wool, marched from San Antonio to join Taylor's forces, abandoning his prior plans to take Chihuahua. After extremely bitter fighting Santa Anna pulled out his army, leaving Taylor in control of northern Mexico.

While Taylor pursued the enemy, Colonel Stephen W. Kearny took the "Army of the West" into New Mexico, capturing Santa Fe on August 16, 1846. Kearny then divided his forces, taking part to California and sending the remainder under Alexander W. Doniphan against Chihuahua. After General Winfield Scott captured Mexico City the two countries finally reached a settlement.

Source: Maps adapted from *The West Point Atlas of American History*, Volume 1, Fredrik A. Preuss, 1959.

<http://www.westpointatlas.com/atlases/1846-1848-war-mexico.html>

Figure 5.3 Normal Text analyzed using the LePlacian mask edge detection algorithm.

In July 1845 Texas formally accepted an American proposal to be annexed to the United States. Already strained relations between the United States and Mexico rapidly worsened. President James K. Polk ordered General Zachary Taylor and his troops to Corpus Christi. In March 1846, under instructions, Taylor took up positions on the Rio Grande. On April 20 an American squadron of dragoons surrounded by Mexicans and unable to fight its way out surrendered. Several Americans lost their lives in the defeat.

On May 8 the Mexicans intercepted Taylor at Palo Alto but were driven back. The next day Mexicans again gave way in battle at Resaca de la Palma. In June Taylor began a march toward Monterrey, taking that city on September 25. Two months later the Americans took Saltillo and with little effort moved into Tampico.

Santa Anna now took the field against the American forces in northern Mexico, finally engaging the Americans at Buena Vista in February. Upon learning of the Mexican's design, General John E. Wool, marched from San Antonio to join Taylor's forces, abandoning his prior plans to take Chihuahua. After extremely bitter fighting Santa Anna pulled out his army, leaving Taylor in control of northern Mexico.

While Taylor pursued the enemy, Colonel Stephen W. Kearny took the "Army of the West" into New Mexico, capturing Santa Fe on August 16, 1846. Kearny then divided his forces, taking parts to California and sending the remainder under Alexander W. Doniphan against Chihuahua. After General Winfield Scott captured Mexico City the two countries finally reached a settlement.

Source: Map adapted from *The West Point Atlas of American History*, Volume II, Frederick A. Praeger, 1952.

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Figure 5.4 Normal Text analyzed using a Gaussian Mask and a LePlacian Mask in succession. Threshold = 0.

In July 1845 Texas formally accepted an American proposal to be annexed to the United States. Already strained relations between the United States and Mexico rapidly worsened. President James K. Polk ordered General Zachary Taylor and his troops to Corpus Christi, 14 March 1846, under instructions, Taylor took up positions on the Rio Grande. On April 20 an American squadron of dragoons surrounded by Mexicans and unable to fight its way out surrendered. Several Americans lost their lives in the defeat.

On May 8 the Mexicans intercepted Taylor at Palo Alto but were driven back. The next day Mexicans again gave way in battle at Resaca de la Palma. In June Taylor began a march toward Monterrey, taking that city on September 25. Two months later the Americans took Saltillo and with little effort took into Tampico.

Santa Anna now took the field against the American forces in northern Mexico, finally engaging the Americans at Buena Vista in February. Upon learning of the Mexican's design, General John E. Wool, marched from San Antonio to join Taylor's forces, abandoning his prior plan to take Chihuahua. After extremely bitter fighting Santa Anna pulled out his army, leaving Taylor in control of northern Mexico.

While Taylor pursued the enemy, Colonel Stephen W. Kearny took the "Army of the West" into New Mexico, capturing Santa Fe on August 10, 1846. Kearny then divided his forces, taking parts to California and sending the remainder under Alexander W. Doniphan against Chihuahua. After General Winfield Scott captured Mexico City the two countries finally reached a settlement.

Source: Map adapted from *The West Point Atlas of American History*, Volume II, Frederick A. Plogue, 1974.

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Figure 5.5 Normal Text analyzed using the LePlacian-Gaussian mask algorithm with a threshold of 100.

In July 1845 Texas formally accepted an American proposal to be annexed to the United States. Already strained relations between the United States and Mexico rapidly worsened. President James K. Polk ordered General Zachary Taylor and his troops to Corpus Christi. In March 1846, under instructions, Taylor took up positions on the Rio Grande. On April 25 an American squadron of frigates surrounded by Mexicans and unable to fight its way out surrendered. Several Americans lost their lives in the defeat.

On May 8 the Mexicans intercepted Taylor at Resaca de la Palma but were driven back. The next day Mexicans again gave way in battle at Resaca de la Palma. In June Taylor began a march toward Monterrey, taking that city on September 26. Two months later the Americans took Saltillo and with little effort filed into Tampico.

Santa Anna now took the field against the American forces in northern Mexico, finally engaging the Americans at Buena Vista in February. Upon learning of the Mexican's design, General John E. Wool, marched from San Antonio to join Taylor's forces, abandoning his prior plan to take Chihuahua. After extremely bitter fighting Santa Anna pulled out his army, leaving Taylor in control of northern Mexico.

While Taylor pursued the enemy, Colonel Stephen W. Kearny took the "Army of the West" into New Mexico, capturing Santa Fe on August 18, 1846. Kearny then divided his forces, taking part to California and sending the remainder under Alexander W. Doniphan against Chihuahua. After General Winfield Scott captured Mexico City the two countries finally reached a settlement.

Source: Map adapted from The West Point Atlas of American Wars, Volume I, Frederick A. Plogue, 1983.

Digitized by the Internet Archive in 2007 with funding from The University of Montana.

Figure 5.6 Normal Text analyzed using the Frei-Chen edge detection algorithm.

In July 1845 Texas formally accepted an American proposal to be annexed to the United States. Already strained relations between the United States and Mexico rapidly worsened. President James K. Polk ordered General Zachary Taylor and his troops to Corpus Christi. In March 1846, under instructions, Taylor took up positions on the Rio Grande. On April 25 an American squadron of frigates surrounded by Mexican and unable to fight its way out surrendered. Several Americans lost their lives in the defeat.

On May 8 the Mexicans intercepted Taylor at Resaca de la Palma but were driven back. The next day Mexicans again gave way in battle at Resaca de la Palma. In June Taylor began a march toward Monterrey, taking that city on September 26. Two months later the Americans took Saltillo and with little effort filed into Tampico.

Santa Anna now took the field against the American forces in northern Mexico, finally engaging the Americans at Buena Vista in February. Upon learning of the Mexican's design, General John E. Wool, marched from San Antonio to join Taylor's forces, abandoning his prior plan to take Chihuahua. After extremely bitter fighting Santa Anna pulled out his army, leaving Taylor in control of northern Mexico.

While Taylor pursued the enemy, Colonel Stephen W. Kearny took the "Army of the West" into New Mexico, capturing Santa Fe on August 16, 1846. Kearny then divided his forces, taking part to California and leading the remainder under Alexander W. Doniphan against Chihuahua. After General Winfield Scott captured Mexico City the two countries finally reached a settlement.

Source: Map adapted from The West Point Atlas of American Wars, Volume I, Frederick A. Plogue, 1963.

Digitized by the Internet Archive in 2007 with funding from The University of Montana.

Figure 5.7 Normal Text analyzed using the Prewitt edge detection algorithm.

In July 1845 Texas formally accepted an American proposal to be annexed to the United States. Already strained relations between the United States and Mexico rapidly worsened. President James K. Polk ordered General Zachary Taylor and his troops to Corpus Christi. In March 1846, under instructions, Taylor took up positions on the Rio Grande. On April 20 an American squadron of dragoons surrounded by Mexicans and unable to fight its way out surrendered. Several Americans lost their lives in the attack.

On May 8 the Mexicans intercepted Taylor at Palo Alto but were driven back. The next day Mexicans again gave way in battle at Resaca de la Palma. In June Taylor began a march toward Monterrey, taking that city on September 25. Two months later the Americans took Saltillo and with little effort filed into Tampico.

Santa Anna now took the field against the American forces in northern Mexico, finally engaging the Americans at Buena Vista in February. Upon learning of the Mexican's design, General John E. Wool, marched from San Antonio to join Taylor's forces, abandoning his prior plans to take Chihuahua. After extremely bitter fighting Santa Anna pulled out his army, leaving Taylor in control of northern Mexico.

While Taylor pursued the enemy, Colonel Stephen W. Kearny took the "Army of the West" into New Mexico, capturing Santa Fe on August 18, 1846. Kearny then divided his forces, taking part to California and sending the remainder under Alexander W. Doniphan against Chihuahua. After General Winfield Scott captured Mexico City the two countries finally reached a settlement.

Source: Notes adapted from *The West Point Atlas of American History*, Volume I, Presidents A, Prentice A, Penguin, 1993.

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Figure 5.8 Normal Text analyzed using the Difference edge detection algorithm.

In July 1845 Texas formally accepted an American proposal to be annexed to the United States. Already strained relations between the United States and Mexico rapidly worsened. President James K. Polk ordered General Zachary Taylor and his troops to Corpus Christi. In March 1846, under instructions, Taylor took up positions on the Rio Grande. On April 20 an American squadron of dragoons commanded by Dodge and unable to fight its way out surrendered. Several Americans lost their lives in the defeat.

On May 8 the Mexicans intercepted Taylor at Palo Alto but were driven back. The next day Mexicans again gave way in battle at Resaca de la Palma. In June Taylor began a march toward Monterrey, taking that city on September 25. Two months later the Americans took Chihuahua and with little effort fled into Tampico.

Santa Anna now took the field against the American forces in northern Mexico, finally engaging the Americans at Buena Vista in February. Upon learning of the Mexican's design, General John E. Wool, marched from San Antonio to join Taylor's forces, abandoning his prior plan to take Chihuahua. After extremely bitter fighting Santa Anna pulled out his army, leaving Taylor in control of northern Mexico.

While Taylor pursued the enemy, Colonel Stephen W. Kearny took the "Army of the West" into New Mexico, capturing Santa Fe on August 18, 1846. Kearny then divided his forces, taking part to California and sending the remainder under Alexander W. Doniphan against Chihuahua. After General Winfield Scott captured Mexico City the two countries finally reached a settlement.

Source: Mass adapted from *The First Four Years of American History*, Volume I, Frederick A. Poynter, 1888.

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Figure 5.9 Normal Text analyzed using the Homogeneity edge detection algorithm.

ENTERTAINING CONSOLE
152 Vacuum Tubes to Be Replaced
Radiophile
SONIC ENVELOPE
Position yourself between the speakers
Modulated
PHASE SHIFTING
64 Easy-Listening Broadcast Stations
Revolutionary X-Ray Headphones
Echo Chamber
YOU CAN NEVER HAVE TOO MUCH REVERB!
In One Ear, Out the Other

Figure 6.0 Normal Text with Differing Font Sizes (Original)

ENTERTAINING CONSOLE
152 Vacuum Tubes to Be Replaced
Radiophile
SONIC ENVELOPE
Position yourself between the speakers
Modulated
PHASE SHIFTING
64 Easy-Listening Broadcast Stations
Revolutionary X-Ray Headphones
Echo Chamber
YOU CAN NEVER HAVE TOO MUCH REVERB
In One Ear, Out the Other

Figure 6.1 Normal Text with Differing Font Sizes analyzed using the Sobel edge detection algorithm.

ENCOURAGING CONSOLE
एक्सेसिल विकास के लिए अप्रत्यापनी
एक्सेसिल विकास के लिए अप्रत्यापनी
SONIC ENVELOPE
सोनिक एंवलोप
Modulated
PHASE SHIFTING
मॉड्यूलेटेड फेस शिफ्टिंग
ECHO Chamber
एचो चैम्बर
In One Ear, Out the Other

Figure 6.2 Normal Text with Differing Font Sizes analyzed using the Canny edge detection algorithm.

ENTERTAINING CONSOLE
152 Vacuum Tubes to Be Replaced

Radiophile

SONIC ENVELOPE
Position yourself between the speakers

Modulated

PHASE SHIFTING
64 Easy-Listening Broadcast Stations

Revolutionary X-Ray Headphones

Echo Chamber

YOU CAN NEVER HAVE TOO MUCH REVERB!

In One Ear, Out the Other.

Figure 6.3 Normal Text with Differing Font Sizes analyzed using the LePlacian mask edge detection algorithm.

ENTERTAINING CONSOLE
152 Vacuum Tubes to Be Replaced
Radiophile
SONIC ENVELOPE
Position yourself between the speakers
Modulated
PHASE SHIFTING
64 Easy-Listening Broadcast Stations
Revolutionary X-Ray Headphones
Echo Chamber
YOU CAN NEVER HAVE TOO MUCH REVERB!
In One Ear, Out the Other

Figure 6.4 Normal Text with Differing Font Sizes analyzed using a Gaussian Mask and a LePlacian Mask in succession. Threshold = 0.

ENTERTAINING CONSOLE
152 Vacuum Tubes to Be Replaced
Radiophile
SONIC ENVELOPE
Position yourself between the speakers
Modulated
PHASE SHIFTING
8-1 Easy-Listening Broadcast Stations
Revolutionary X-Ray Headphones
Echo Chamber
YOU CAN NEVER HAVE TOO MUCH REVERB!
In One Ear, Out the Other

Figure 6.5 Normal Text with Differing Font Sizes analyzed using the LePlacian-Gaussian mask algorithm with a threshold of 100.

ENTERTAINING CONSOLE
152 Vacuum Tubes to Be Replaced
Radiophile
SONIC ENVELOPE
Position yourself between the speakers
Modulated
PHASE SHIFTING
64 Easy-Listening Broadcast Stations
Revolutionary X-Ray Headphones
Echo Chamber
YOU CAN NEVER HAVE TOO MUCH REVERB
In One Ear, Out the Other

Figure 6.6 Normal Text with Differing Font Sizes analyzed using the Frei-Chen edge detection algorithm.

ENTERTAINING CONSOLE
152 Vacuum Tubes to Be Replaced
Radiophile
SONIC ENVELOPE
Position yourself between the speakers
Modulated
PHASE SHIFTING
64 Easy-Listening Broadcast Stations
Revolutionary X-Ray Headphones
Echo Chamber
YOU CAN NEVER HAVE TOO MUCH REVERB!
In One Ear, Out the Other

Figure 6.7 Normal Text with Differing Font Sizes analyzed using the Prewitt edge detection algorithm.

ENTERTAINING CONSOLE
152 Vacuum Tubes to Be Replaced
Radiophile
SONIC ENVELOPE
Position yourself between the speakers
Modulated
PHASE SHIFTING
64 Easy-Listening Broadcast Stations
Revolutionary X-Ray Headphones
Echo Chamber
You CAN NEVER HAVE TOO MUCH REVERB!
In One Ear, Out the Other

Figure 6.8 Normal Text with Differing Font Sizes analyzed using the Difference edge detection algorithm.

ENTERTAINING CONSOLE
152 Vacuum Tubes to Be Replaced
Radiophile
SONIC ENVELOPE
Position yourself between the speakers
Modulated
PHASE SHIFTING
64 Easy-Listening Broadcast Stations
Revolutionary X-Ray Headphones
Echo Chamber
YOU CAN NEVER HAVE TOO MUCH REVERB!
In One Ear, Out the Other

Figure 6.9 Normal Text with Differing Font Sizes analyzed using the Homogeneity edge detection algorithm.



Figure 7.1 Weird Text with Differing Font Sizes analyzed using the Sobel edge detection algorithm.



Figure 7.2 Weird Text with Differing Font Sizes analyzed using the Canny edge detection algorithm.



Figure 7.3 Weird Text with Differing Font Sizes analyzed using the LePlacian mask edge detection algorithm.

words supported select
orange another Sources reading introduction
by click people part implementation
use our memory technical used
about computer post explain can make blog will articles
this examples Approach idea associations
funny rather semantic really sway
pink something button gives practical
titles abilities new search web presentation
engine better articles data books information
Google Harver offer www very for published other format
users etc

Figure 7.4 Weird Text with Differing Font Sizes analyzed using a Gaussian Mask and a LePlacian Mask in succession. Threshold = 0.

words supports select reading interaction
source writer Sources part Information
use click people computer post technical used
explain information make blog will articles
with examples Approach idea Web associations
many rather semantic ready to is way
find something better gives practical
results Search web presentation
Google articles data books information
Hanseloff www very for published other format
webs etc

Figure 7.5 Weird Text with Differing Font Sizes analyzed using the LePlacian-Gaussian mask algorithm with a threshold of 100.



Figure 7.7 Weird Text with Differing Font Sizes analyzed using the Prewitt edge detection algorithm.



Figure 7.8 Weird Text with Differing Font Sizes analyzed using the Difference edge detection algorithm.



Figure 8.0 Text with Differing Font Sizes and Differing Languages (Original)



Figure 8.1 Text with Differing Font Sizes and Differing Languages analyzed using the Sobel edge detection algorithm.



Figure 8.2 Text with Differing Font Sizes and Differing Languages analyzed using the Canny edge detection algorithm.



Figure 8.3 Text with Differing Font Sizes and Differing Languages analyzed using the LePlacian mask edge detection algorithm.



Figure 8.4 Text with Differing Font Sizes and Differing Languages analyzed using a Gaussian Mask and a LePlacian Mask in succession. Threshold = 0.

תודה
Dankie Gracias شکر
Спасибо Merci Takk
Köszönjük Terima kasih
Grazie Dziękujemy Děkuji
Ďakujeme Vielen Dank Paldies
Kiitos Tänkme teid 謝謝
Thank You Tak
ଓন্দৰা Obrigado Terciada/Educa
Σας Ευχαριστούμε 감사합니다
Bedankt Děkujemec vám ありがとうございます
Tack

Figure 8.5 Text with Differing Font Sizes and Differing Languages analyzed using the LePlacian-Gaussian mask algorithm with a threshold of 100.

תודה
Danke Gracias
شُكْرًا
Cuacubó Merci Takk
Köszönjük Terima kasih
Grazie Dziękujemy Děkuji
Ďakujeme Vteřen Dank Paldies
Kittos Tähänne tuli 謝謝
感謝您 Obrigado 謝謝您
Σας Eυχαριστώμε 合사합니다
Bedankt Děkuji vám
ありがとうございます
Tack

Figure 8.6 Text with Differing Font Sizes and Differing Languages analyzed using the Frei-Chen edge detection algorithm.

Many
Danke Gracias
Cuacubo Merci تشكر
Köszönjük Terima kasih
Grazie Dziękujemy Děkuji
Dankjeme Vieles Dank Paldies
Kitos Tähän tied 優遇
感謝您 Obrigado 謝謝
Σας Eυχαριστώμ ㅂ셔抨민
Bedankt Děkujiem ván
ありがとうございます
Tack

Figure 8.7 Text with Differing Font Sizes and Differing Languages analyzed using the Prewitt edge detection algorithm.



Figure 8.8 Text with Differing Font Sizes and Differing Languages analyzed using the Difference edge detection algorithm.



Figure 8.9 Text with Differing Font Sizes and Differing Languages analyzed using the Homogeneity edge detection algorithm.

3.3 Face Recognition



Figure 9.0 Photo of Smiling Person (Original)



Figure 9.1 Photo of Smiling Person analyzed using the Sobel edge detection algorithm.

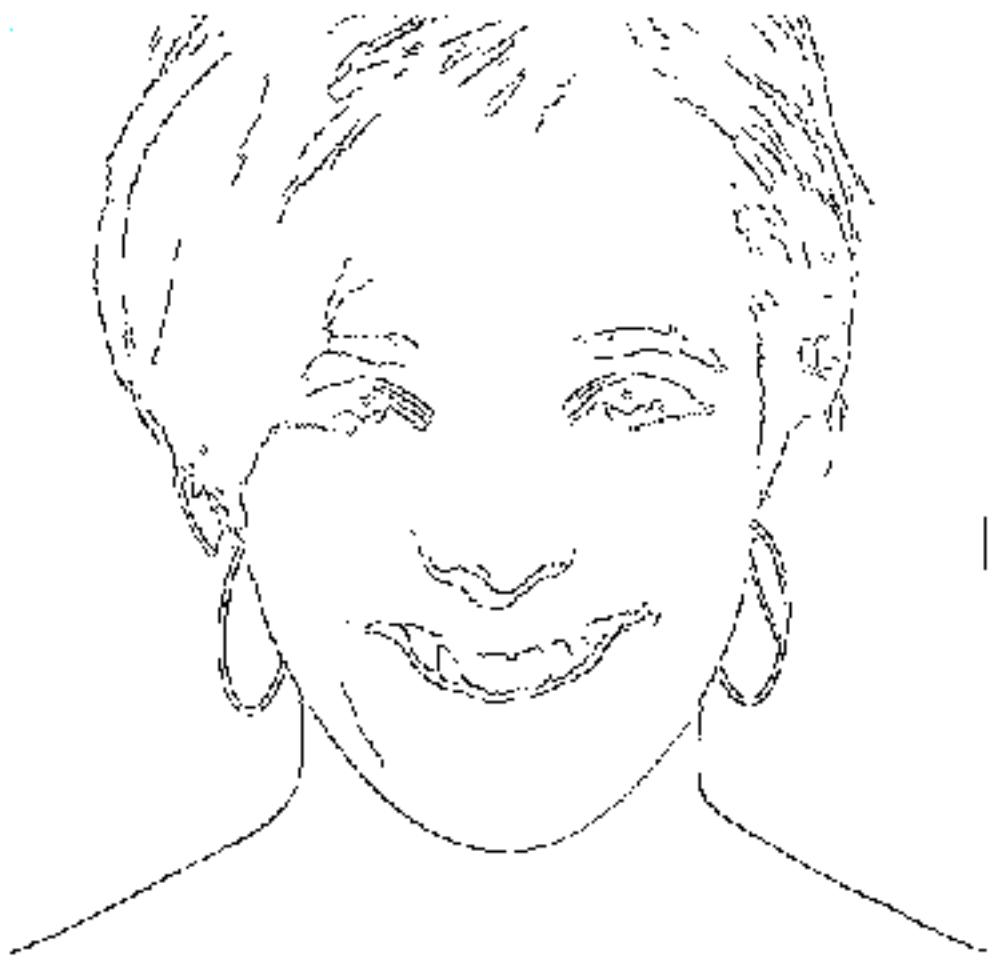


Figure 9.2 Photo of Smiling Person analyzed using the Canny edge detection algorithm.



Figure 9.3 Photo of Smiling Person analyzed using the LePlacian mask edge detection algorithm.



Figure 9.4 Photo of Smiling Person analyzed using a Gaussian Mask and a LePlacian Mask in succession. Threshold = 0.



Figure 9.5 Photo of Smiling Person analyzed using the LePlacian-Gaussian mask algorithm with a threshold of 100.



Figure 9.6 Photo of Smiling Person analyzed using the Frei-Chen edge detection algorithm.



Figure 9.7 Photo of Smiling Person analyzed using the Prewitt edge detection algorithm.



Figure 9.8 Photo of Smiling Person analyzed using the Difference edge detection algorithm.



Figure 9.9 Photo of Smiling Person analyzed using the Homogeneity edge detection algorithm.



Figure 10.0 Photo of Old Person (Original)



Figure 10.1 Photo of Old Person analyzed using the Sobel edge detection algorithm.



Figure 10.2 Photo of Old Person analyzed using the Canny edge detection algorithm.



Figure 10.3 Photo of Old Person analyzed using the LePlacian mask edge detection algorithm.



Figure 10.4 Photo of Old Person analyzed using a Gaussian Mask and a LePlacian Mask in succession. Threshold = 0.



Figure 10.5 Photo of Old Person analyzed using the LePlacian-Gaussian mask algorithm with a threshold of 100.



Figure 10.6 Photo of Old Person analyzed using the Frei-Chen edge detection algorithm.

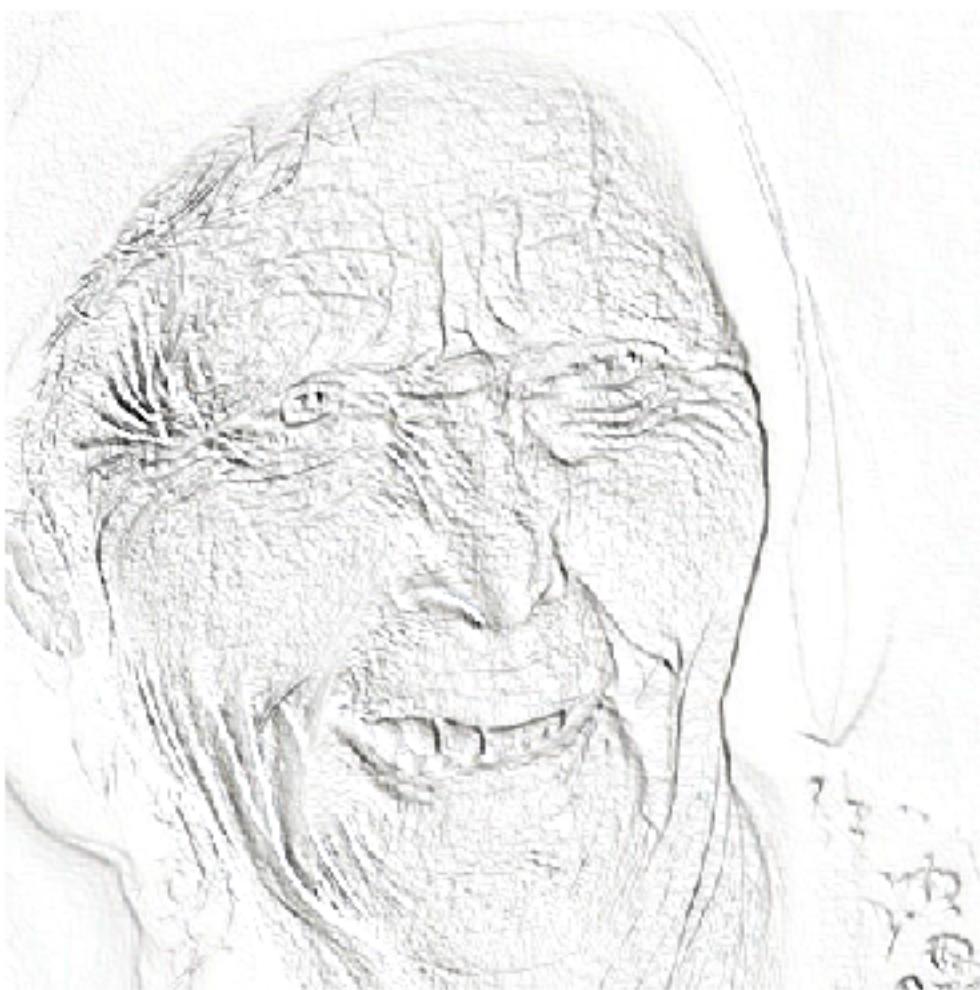


Figure 10.7 Photo of Old Person analyzed using the Prewitt edge detection algorithm.



Figure 10.8 Photo of Old Person analyzed using the Difference edge detection algorithm.



Figure 10.9 Photo of Old Person analyzed using the Homogeneity edge detection algorithm.



Figure 11.0 Photo of Young Person (Original)



Figure 11.1 Photo of Young Person analyzed using the Sobel edge detection algorithm.



Figure 11.2 Photo of Young Person analyzed using the Canny edge detection algorithm.



Figure 11.3 Photo of Young Person analyzed using the LePlacian mask edge detection algorithm.



Figure 11.4 Photo of Young Person analyzed using a Gaussian Mask and a LePlacian Mask in succession. Threshold = 0.



Figure 11.5 Photo of Young Person analyzed using the LePlacian-Gaussian mask algorithm with a threshold of 100.



Figure 11.6 Photo of Young Person analyzed using the Frei-Chen edge detection algorithm.



Figure 11.7 Photo of Young Person analyzed using the Prewitt edge detection algorithm.



Figure 11.8 Photo of Young Person analyzed using the Difference edge detection algorithm.



Figure 11.9 Photo of Young Person analyzed using the Homogeneity edge detection algorithm.

4 Discussion

The final results show a definite winner. With text recognition, LePlacian to Gaussian masking technique seemed to be the best. All of the algorithms had quite a bit of noise, especially after normalizing the images to 500 pixels as their longest side, but Canny was almost completely unreadable. With facial recognition, Canny seemed to show the most edges the clearest with the least noise, but LePlacian to Gaussian was definitely a contender. The LePlacian to Gaussian with a threshold of 0 seemed to be too noisy, while the LePlacian to Gaussian with a threshold of 100 seemed to be too light. If we used the LePlacian to Gaussian with a threshold between 0 and 100, we could probably have a good facial recognition. Finally, fingerprints were difficult to tell once the images were resized to 500 pixels as their longest side. LePlacian to Gaussian definitely performed the best, but again it was difficult to tell at 500 pixels.

Clearly, my custom LePlacian to Gaussian mask technique outperformed all the others by a good number of images. I would recommend using this for all 3 types of images, but remember to check Canny when doing facial recognition.

Overall, the most difficult part of this project was needing to continually resize the images and try different formats because L^AT_EX is very picky about its images. The resized images seemed to carry a lot of noise with them, which carried into the processed image. I think this is because the original images were .JPG, which is a very lossy format. The original plots looked much more crisp, but the resulting PDF was about 500 mb in size, so I needed to resize the images to create a workable final document.

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