Μαρία Αρετή

Γερμανού 57807

7ο Εξάμηνο 2022

Όραση Υπολογιστών

Τεχνική Αναφορά - Εργασία 1η

Η τεχνική αναφορά περιλαμβάνει:

I. Την θεωρητική ανάλυση της εργασίας.

II. Την περιγραφή του κώδικα που παραδόθηκε.

III. Την ανάλυση των αποτελεσμάτων.

Ι. Θεωρητική ανάλυση της εργασίας.

Σύμφωνα με την εκφώνηση της πρώτης εργασίας, θα πρέπει να αναλυθούν δομές εγγράφων που δίνονται σε αντίστοιχο φάκελο, να αναλυθούν οι υποπεριοχές τους και να τα αποτελέσματα να αποθηκευτούν εκ νέου με τις υποπεριοχές πλέον αναγνωρισμένες. Αναλυτικά θα παρουσιαστεί κάθε βήμα στην περιγραφή του κώδικα που θα γίνει παρακάτω και μαζί θα αναλυθούν και τα αποτελέσματα. Προς το παρόν ας παρουσιαστεί βηματικά η θεωρητική ανάλυση και μεθοδολογία που θα ακολουθηθεί παρακάτω.

// Εφαρμογή Φίλτρου Απόρριψης Θορύβου:

Αρχικά πρέπει να επιλέξουμε ένα φίλτρο αποθορυβοποίησης καθώς οι εικόνες που δίνονται έχουν θόρυβο τύπου “salt and pepper” ή αλλιώς “impulse noise”. Ο συγκεκριμένος θόρυβος, χαρακτηρίζεται από την τοποθέτηση με τυχαίο τρόπο, μαύρων και λευκών εικονοστοιχείων μέσα στην εικόνα, δηλαδή τιμές 255 και 0 σε ένα grayscale κανάλι. Υπάρχουν διάφοροι τρόποι για να γίνει η αποθορυβοποίηση. Πριν παρουσιάσουμε τους τρόπους ας δείξουμε ένα παράδειγμα τέτοιου θορύβου.

Salt Noise Image Pepper Noise Image Both Salt and Pepper Noise Image

// Τρόποι Αποθορυβοποίησης:

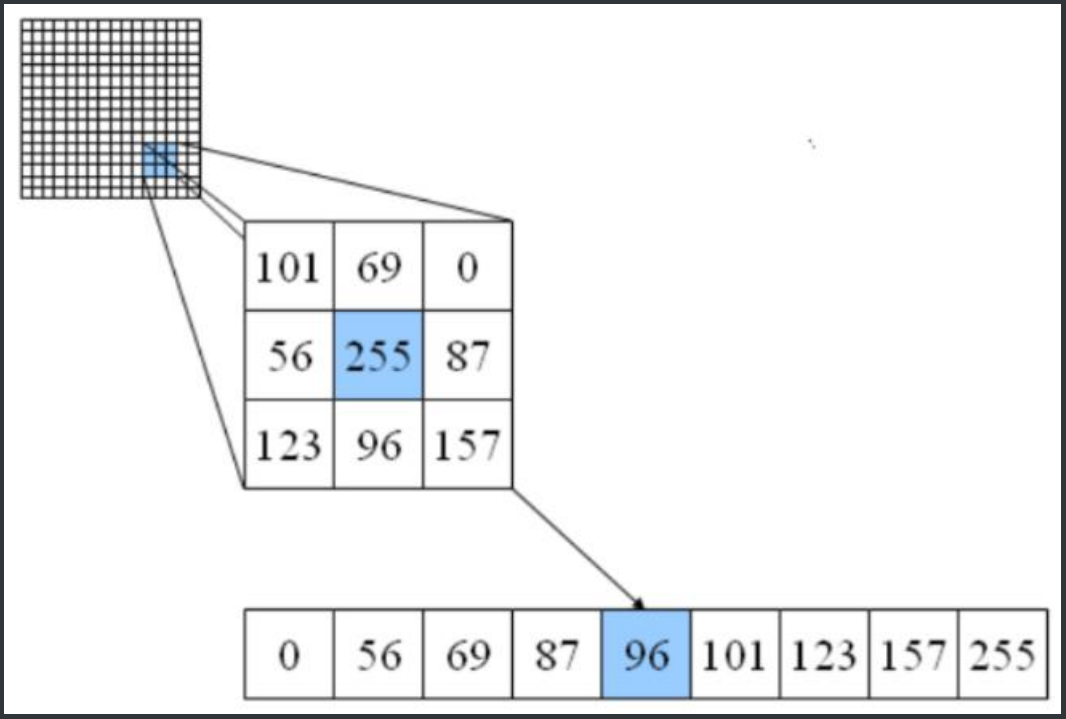
Υπάρχουν περισσότεροι τρόποι αποθορυβοποίησης από αυτούς που θα χρησιμοποιηθούν σε αυτή την εργασία εστιάζοντας κυρίως στα “Median Filters”.

Ι. Θεωρητική ανάλυση της εργασίας.

Συγκεκριμένα μερικοί τρόποι:

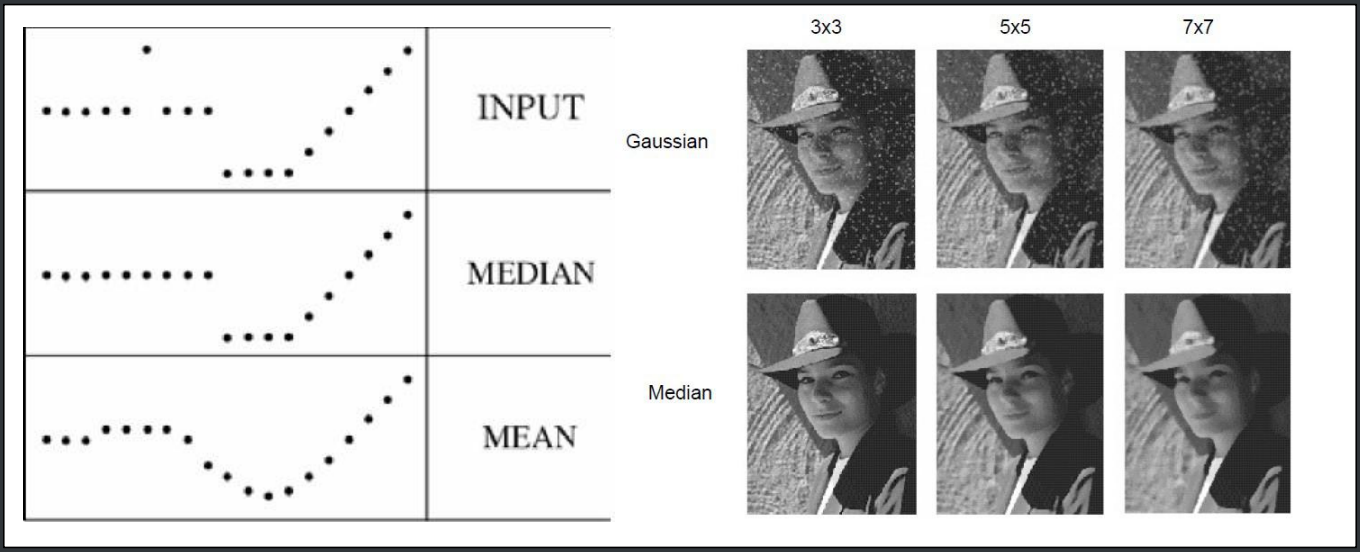
- Median Filtering.
- Gaussian Filtering.
- Mean Filtering.
- Opening.
- Closing.

Στην συγκεκριμένη περίπτωση θα γίνει χρήση ενός median filter, καθώς είναι απλή η υλοποίηση του, ακόμη και χωρίς την χρήση συναρτήσεων της βιβλιοθήκης "OpenCV". Συγκεκριμένα αυτό που κάνει ένα median filter είναι να αντικαθιστά την τιμή ενός pixel με την μεσαία τιμή των pixels ενός παραθύρου όπου κέντρο του είναι το pixel το οποίο θέλουμε να αντικαταστήσουμε. Ενδείκνυται σε αντίθεση με το "Mean Filtering" διότι το πρώτο είναι λιγότερο θολό από το δεύτερο και επιπλέον δέχεται τιμές που δεν δέχεται ένα απλό φίλτρο υπολογισμού μέσου όρου.



Στην υλοποίηση επίσης θα διασφαλιστεί πως το φίλτρο δεν θα βγαίνει εκτός των ορίων της εικόνας, έτσι επιλέχθηκε να γίνεται "padding" στην εικόνα ανάλογα με το μέγεθος του φίλτρου. Μόλις παραχθεί το αποτέλεσμα θα αφαιρείται και δεν θα εφαρμόζεται το φίλτρο στα όρια.

Ι. Θεωρητική ανάλυση της εργασίας.



// Υλοποίηση "Median Filter":

Αρχικά λοιπόν διαβάζουμε μία εικόνα και στην συνέχεια την μετατρέπουμε σε grayscale. Έπειτα δημιουργούμε μια νέα εικόνα, η οποία είναι αντίγραφο της αρχικής με padding κατά 1. Δημιουργούμε δύο πίνακες στους οποίους τοποθετούμε τις τιμές των κεντρικών pixels και των γειτονικών pixels, που διαβάζονται στην επανάληψη, αντίστοιχα δημιουργώντας το παράθυρο για κάθε pixel. Στην συνέχεια ταξινομούμε τις τιμές και επιλέγουμε την μεσαία τιμή κάθε παραθύρου. Με αυτόν το τρόπο σαρώνουμε όλη την εικόνα. Τέλος αφαιρούμε το περίγραμμα που προσθέσαμε και η εικόνα επανέρχεται στις αρχικές της διαστάσεις. Παρατηρούμε ότι το αποτέλεσμα από την αποθορυβοποίηση και στις δυο περιπτώσεις είναι ικανοποιητικό. Πιο συγκεκριμένα όταν εφαρμόζουμε το median filter στην εικόνα με θόρυβο μπορούμε να δούμε πως όταν ο θόρυβος ήταν πάνω σε γράμματα τότε υπάρχει αλλοίωση σε αυτό ενώ όταν εφαρμόζουμε το φίλτρο στην αρχική εικόνα απλά αλλοιώνεται ελάχιστα η ποιότητα της εικόνας. Επιπλέον γίνεται σύγκριση και των αποτελεσμάτων της χρήσης του "Median Filtering" της "OpenCV" με την συνάρτηση που δημιουργήθηκε ώστε να ικανοποιεί τις λειτουργίες του "Median Filtering".

Σύγκριση αποθορυβοποιημένης εικόνας με την χρήση του φίλτρου και της "original" αποθορυβοποιημένης:

implications of building viewer or consumer profiles through data mining, within the context of VPM and in light of the reaction it already has prompted [2]. Our intent is not to answer all of the questions here, but rather to outline the issues and to propose a framework within which both academics and practitioners can further explore the issue of privacy. Our analysis centers around three essential issues involving technology and privacy: stakeholder perceptions regarding the fairness of the *process* used by a company for collecting and distributing personal information, including the level of choice provided to the individual regarding whether and to what extent they will provide access to their personal characteristics; stakeholder perceptions regarding the fairness of the *outcomes* of those processes, including the cost-benefit trade-offs inherent in the exchange of personal information for some real or perceived gain; and stakeholder perceptions regarding the *accuracy of inferred personal information*—particularly the differential perceptions of consumers and advertisers regarding the impact of accurate versus inaccurate profiles. The analytic capability of VPM adds a layer of complexity to these issues by increasing the ability of a company to gather personal (viewing) information in an exceptionally unobtrusive manner, and then to use that information to infer individual demographic characteristics.

TiVo was able to determine precisely who watched which commercials during the Super Bowl, the amount of time viewers spent watching commercials, and the number of times a particular viewer might have paused, rewound, and rewatched a particular segment of the game or commercial.

New Threats to Privacy through Viewer Profiling

The new threat to privacy begins with the basic technology of the Personal Video Recorder (PVR), which is able to directly monitor and report the viewing choices of individuals. To some extent, this is a reflection of the increased monitoring of individual behavior through a variety of data-gathering means, including point-of-sale devices, online ordering forms, and product registration requests. It also includes less salient technologies such as spyware, which is conceptually similar to the PVR in its PC-based monitoring and reporting capabilities [10]. As we note later, the main difference between the PVR and spyware is that while PVR companies attempt to communicate their data collection and usage procedures in clearly worded privacy policies, spyware often skirts ethical constraints by installing itself on a user's PC with little or no advance warning.

The other major privacy issue in turn involves treatment of the information after it is collected. TiVo, a leading PVR manufacturer and service provider, is selling the viewing behaviors of its customers to Nielsen Media Research, which in turn will use that information to enhance its own collection and analysis of television viewing [6]. The type of information collected can be exceptionally detailed. TiVo was able to determine precisely who watched which commercials during the Super Bowl, the amount of time viewers spent watching commercials, and the number of times a particular viewer might have paused, rewound, and rewatched a particular segment of the game or commercial. Not surprisingly, this simple ability to collect viewing data, combined with the increasing number of PVRs in homes, has raised concerns from privacy advocates [1, 3].

The monitoring-profiling capabilities of the PVR have a direct impact on each of the stakeholders involved in the creation, distribution, and consumption of television advertising. In the domain of PVR-based targeted advertising, the direct stakeholders include television viewers, PVR providers, service providers (for example, cable and satellite companies), content providers (for example, broadcast and cable networks), and advertisers. The impact on these stakeholders can be explored, in turn, in the context of the three privacy issues raised earlier: procedures used to collect and distribute information, the perceived outcomes of those procedures, and the accuracy of inferred personal information. We discuss each of these issues, in part using TiVo as an example when appropriate, and then summarize the issues within a proposed framework for further investigation.

My Median denoised image

(not OpenCV function)

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Original denoised image

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Median denoised image

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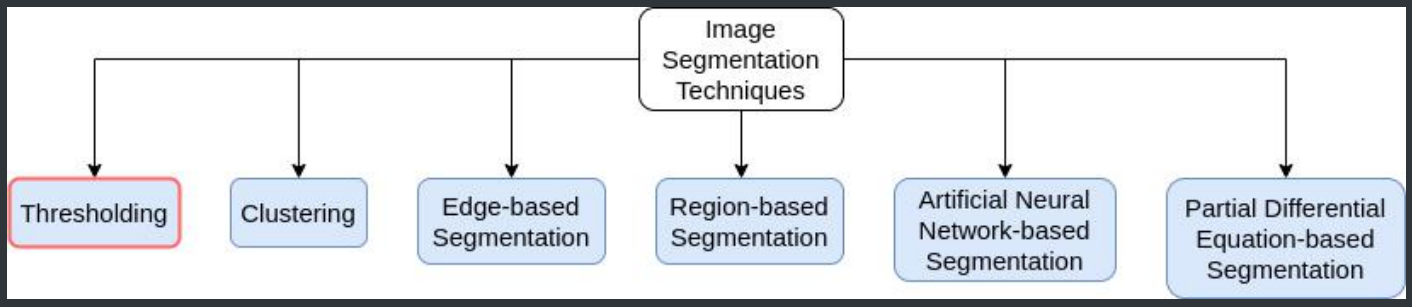
My Median denoised image

Ι. Θεωρητική ανάλυση της εργασίας.

// Ανίχνευση όλων των υποπεριοχών και μετρήσεις: Δημιουργία Δυαδικής Εικόνας

Για να μπορέσουμε να εντοπίσουμε και έπειτα να χωρίσουμε την εικόνα σε υποπεριοχές, πρέπει να γίνουν κάποιες μορφολογικές πράξεις στις οποίες θα αναφερθούμε στην συνέχεια. Για να είναι δυνατό να κάνουμε αυτές τις πράξεις πρέπει να μετατρέψουμε την εικόνα σε δυαδική (Binary Image). Πριν την μετατροπή μιας grayscale εικόνας σε binary επιλέγεται μια τιμή του γκρι, "threshold", όπου αν κάποιο pixel έχει τιμή μεγαλύτερη από αυτή θα γίνει τελείως λευκό(255) ενώ αν έχει μικρότερη από αυτή θα γίνει τελείως μαύρο(0). Αυτή η τιμή μπορεί να βρεθεί με δύο τρόπους, ένας τρόπος είναι κάθε φορά με trial and error να βρίσκεται μια καλή τιμή. Άλλος τρόπος που θα χρησιμοποιηθεί και στην εργασία είναι η χρήση του αλγόριθμου "Otsu's Thresholding", η οποία επιλέγει αυτόματα την καταλληλότερη τιμή για threshold για κάθε περίπτωση. Συγκεκριμένα ο αλγόριθμος επεξεργάζεται την εικόνα της εισόδου, αποκτά το "histogram" της εικόνας, την κατανομή των pixels και υπολογίζει την ζητούμενη τιμή της μεταβλητής αυτόματα. Στην ανάλυση του κώδικα θα φανεί η τιμή του threshold που επιλέχθηκε και το αποτέλεσμα που εκτυπώνουμε στην οθόνη. Η μέθοδος που αναλύθηκε είναι μία από τις τεχνικές "Image Segmentation". Σε επόμενες εργασίες θα χρησιμοποιηθούν και άλλες τεχνικές όπως αναφέρονται στην παρακάτω εικόνα.



// Επιλογή συνδυασμού μορφολογικών μετασχηματισμών:

Σε αυτό το σημείο θα επιλεχθούν οι μετασχηματισμοί για τον χωρισμό των περιοχών και έπειτα για την καταμέτρηση των λέξεων. Υπάρχουν διάφοροι συνδυασμοί μετασχηματισμών ο οποίοι μπορούν να μας οδηγήσουν στο επιθυμητό αποτέλεσμα. Μερικοί μετασχηματισμοί που θα χρησιμοποιηθούν είναι το dilation και το erosion. Υπάρχουν και οι opening και closing αλλά είναι συνδυασμός των dilation και erosion με διαφορετική σειρά. Opening είναι η ακολουθία

μετασχηματισμών erosion και στην συνέχεια dilation και closing είναι η ακολουθία με την αντίθετη σειρά μετασχηματισμών. Η διαδικασία των μετασχηματισμών θα αναλυθεί περισσότερο στο κομμάτι του κώδικα παρακάτω. Ουσιαστικά στο erosion δηλαδή διάβρωση, υπάρχει ένα kernel το οποίο ονομάζεται Structuring Element και μπορεί να έχει διαφορετικά σχήματα και μεγέθη. Αυτό εφαρμόζεται σε όλη την εικόνα και για κάθε pixel δίνει τιμή 255 αν και μόνο αν όλα τα γειτονικά του έχουν τιμή 255, διαφορετικά το κάνει 0. Το dilation, δηλαδή διαστολή λειτουργεί αντίθετα δηλαδή ένα pixel παίρνει την τιμή 255 αν τουλάχιστον ένα από τα γειτονικά του έχουν τιμή 255. Όσον αφορά το opening αυτό δεν είναι τίποτε περισσότερο από erosion το οποίο ακολουθείται από dilation ενώ στην περίπτωση του closing εφαρμόζεται αρχικά dilation και στη συνέχεια erosion. Τώρα όσον αφορά την επιλογή μετασχηματισμών επιλέγεται η διάβρωση με μικρό kernel ώστε κάθε περιοχή να γίνει ένα μεγάλο component που θα εντοπιστεί από την συνάρτηση που ανιχνεύει τα στοιχεία με το ίδιο pixel την “Connected Components”. Πιο απλά χρησιμοποιώ μικρότερο μέγεθος kernel ώστε να ενωθούν μεταξύ τους οι λέξεις και οι σειρές και στην συνέχεια closing ώστε να μεν να είναι κάθε υποπεριοχή σίγουρα ένα στοιχείο αλλά να μην αυξάνεται υπερβολικά το μέγεθος και έχουμε λάθος αποτελέσματα. Θα χρησιμοποιηθούν δύο πίνακες ένας για την καταμέτρηση λέξεων και ένας για την καταμέτρηση υποπεριοχών.

// Σχεδίαση περιβάλλοντος κουτιού - Bounding Box:

Για να σχεδιαστεί ένα bounding box χρειαζόμαστε τουλάχιστον τις συντεταγμένες της επάνω-αριστερά γωνίας και τις κάτω-δεξιά. Την πληροφορία αυτήν για κάθε περιοχή μπορούμε να την λάβουμε μέσω της συνάρτησης “Bounding Rect” η οποία επιστρέφει ως x,y τις συντεταγμένες της πάνω αριστερά γωνίας, το πλάτος w και το ύψος του bounding box. Συνεπώς οι συντεταγμένες της κάτω δεξιά γωνίας θα είναι x+w, y+h. Η “Bounding Rect” ωστόσο δεν μπορεί να διαχειριστεί πολλά labels αλλά μόνο ένα. Συνεπώς δημιουργώ κάθε φορά έναν πίνακα με μηδενικά και ορίζω τις τιμές των pixel της εκάστοτε περιοχής που εξετάζεται με 255. Στην συνέχεια γίνεται κλήση της συνάρτησης “Bounding Rect”. Πριν προχωρήσουμε στο σχεδιασμό γίνεται ένα έλεγχος αν το πλάτος η το ύψος είναι μικρότερα από κάποιον αριθμό εδώ επέλεξα 12 pixels δεδομένου ότι οι υποπεριοχές του εγγράφου είναι μεγαλύτερες από αυτά τα μεγέθη και όταν w ή h είναι μικρότερα από 12 πρόκειται είτε από κάποια τυχαία γραμμή η θόρυβο

που δεν μας ενδιαφέρει. Σε αυτήν την περίπτωση αυξάνεται ο αριθμός περιοχών που αγνοήθηκαν και προχωράμε στην επόμενη επανάληψη χωρίς να σχεδιάσουμε και να κάνουμε μετρήσεις. Σε περίπτωση λοιπόν που δεν w και h μεγαλύτερα του 15, δηλαδή για την περίπτωση που έχουμε μια υποπεριοχή, έχοντας τις συντεταγμένες για το bounding box μέσω της συνάρτησης rectangle σχεδιάζουμε στην αρχική μας εικόνα ένα περιβάλλον κουτί και στην συνέχεια γράφουμε έναν αριθμό μέσω της της συνάρτησης "Put Text". Τώρα για τον υπολογισμό του εμβαδού του bounding box χρειαζόμαστε απλά το πλάτος και το ύψος του. Ο υπολογισμός γίνεται ως εξής. Το εμβαδόν είναι μήκος επί πλάτος. Τα υπόλοιπα στοιχεία που χρειάζεται να υπολογιστούν αναλύθηκαν θεωρητικά και θα αναφερθούν στην ανάλυση κώδικα.

// Περιγραφή Κώδικα: Φόρτωση εικόνων σε Path και ανάγνωσή τους με την OpenCV σε ασπρόμαυρη μορφή.

```
# Re-assigning the files:
filenames_org_1 = 'images/1_original.png'
filenames_org_2 = 'images/2_original.png'
filenames_org_3 = 'images/3_original.png'
filenames_org_4 = 'images/4_original.png'
filenames_org_5 = 'images/5_original.png'

filenames_ns_1 = 'images/1_noise.png'
filenames_ns_2 = 'images/2_noise.png'
filenames_ns_3 = 'images/3_noise.png'
filenames_ns_4 = 'images/4_noise.png'
filenames_ns_5 = 'images/5_noise.png'

img_o_1 = cv2.imread(filenames_org_1, cv2.IMREAD_GRAYSCALE)
img_o_2 = cv2.imread(filenames_org_2, cv2.IMREAD_GRAYSCALE)
img_o_3 = cv2.imread(filenames_org_3, cv2.IMREAD_GRAYSCALE)
img_o_4 = cv2.imread(filenames_org_4, cv2.IMREAD_GRAYSCALE)
img_o_5 = cv2.imread(filenames_org_5, cv2.IMREAD_GRAYSCALE)
img_n_1 = cv2.imread(filenames_ns_1, cv2.IMREAD_GRAYSCALE)
img_n_2 = cv2.imread(filenames_ns_2, cv2.IMREAD_GRAYSCALE)
img_n_3 = cv2.imread(filenames_ns_3, cv2.IMREAD_GRAYSCALE)
img_n_4 = cv2.imread(filenames_ns_4, cv2.IMREAD_GRAYSCALE)
img_n_5 = cv2.imread(filenames_ns_5, cv2.IMREAD_GRAYSCALE)
```

// Περιγραφή Κώδικα: Χρήση της συνάρτησης "Median Filter" που δίνεται από την OpenCV και σύγκριση με το αποτέλεσμα της δημιουργημένης συνάρτησης που υπάρχει στο πρόγραμμα.

```
# using filter mean or median for de-noising grayscale images with opencv:
median = cv2.medianBlur(img_n_1, 3)
# cv2.namedWindow('median with open cv', cv2.WINDOW_NORMAL)
# cv2.imshow('median with open cv', median)
# cv2.waitKey(0)
cv2.imwrite('org_median_denoised.png', median)
```

Τα αποτελέσματα αυτά προβάλλονται παραπάνω δίπλα το ένα στο άλλο. Προς το παρόν θα περιγραφεί η διαδικασία της δημιουργημένης συνάρτησης. Αρχικά φτιάχνουμε ένα αντίγραφο της εικόνας που παίρνουμε ως όρισμα και μετά αποθηκεύουμε τις διαστάσεις της ως προς τον αριθμό των σειρών και των στηλών. Έπειτα ταξινομούμε τις κεντρικές και γειτονικές τιμές που αποθηκεύονται προσωρινά ενός παραθύρου 3 x 3 και κατά αυτόν το τρόπο σαρώνουμε όλη την εικόνα.

```
# using filter mean or median for de-noising grayscale images without opencv:
# firstly we use a function that forms a border around an image and applies the respective padding.
# Then we define our window size and its half.
# Constant value border: Applies a padding of a constant value for the whole border and its color
is chosen randomly.
def median_filter(img_noise):
    # Check if image is loaded fine
    # if img_noise is None:
    #     print('Error opening image!')
    #     return -1

    # Creating a copy of image:
    img_noise_2 = np.copy(img_noise)

    rows = img_noise.shape[0]
    cols = img_noise.shape[1]

    for k in range(rows - 2):
        for j in range(cols - 2):
            temp = [img_noise[k][j], img_noise[k][j + 1], img_noise[k][j + 2], img_noise[k + 1][j],
                    img_noise[k + 1][j + 1], img_noise[k + 1][j + 2],
                    img_noise[k + 2][j], img_noise[k + 2][j + 1], img_noise[k + 2][j + 2]]
            temp.sort()
            img_noise_2[k + 1][j + 1] = temp[4]
    return img_noise_2
```

Προχωρώντας στην δημιουργία της δυαδικής εικόνας, βρίσκεται αυτόματα η "flag" τιμή του αλγορίθμου και εκτυπώνεται στην οθόνη.

```
# Taking the resulting gray image from the de-noising above and transforming it to binary image.
# We use Otsu's Binarization that chooses a value and determines it automatically:
flag_otsu = cv2.THRESH_BINARY_INV + cv2.THRESH_OTSU

thres1, th1 = cv2.threshold(median, 0, 255, flag_otsu)
thres2, th2 = cv2.threshold(img_o_1, 0, 255, flag_otsu)

# Also i save the resulted images and view the threshold binary image with and without noise
cv2.imwrite('org_bin_otsu.png', th1)
cv2.imwrite('ns_bin_otsu.png', th2)
avg_thres = (thres1 + thres2) // 2
print("Automatically chosen average value from Otsu's Binarization: ", avg_thres)
```

```
Automatically chosen average value from Otsu's Binarization:  174.0
```

II. Περιγραφή του κώδικα.

Προβάλουμε τα αποτελέσματα στις δύο εικόνες με θόρυβο και χωρίς αν εφαρμοστεί η μεθοδολογία δημιουργίας δυαδικής εικόνας. Παρατηρούμε ότι το binary αποτέλεσμα της original εικόνας είναι λίγο καλύτερο από αυτής με τον θόρυβο καθώς κατά την αποθορυβοποίηση της τελευταίας υπήρχε μερική αλλοίωση σε κάποια γράμματα.

implications of building viewer or consumer profiles through data mining, within the context of VPM and in light of the reaction it already has prompted [2]. Our intent is not to answer all of the questions here, but rather to outline the issues and to propose a framework within which both academics and practitioners can further explore the issue of privacy. Our analysis centers around three essential issues involving technology and privacy: stakeholder perceptions regarding the fairness of the *process* used by a company for collecting and distributing personal information, including the level of choice provided to the individual regarding whether and to what extent they will provide access to their personal characteristics; stakeholder perceptions regarding the fairness of the *outcomes* of those processes, including the cost-benefit trade-offs inherent in the exchange of personal information for some real or perceived gain; and stakeholder perceptions regarding the *accuracy of inferred personal information*—particularly the differential perceptions of consumers and advertisers regarding the impact of accurate versus inaccurate profiles. The analytic capability of VPM adds a layer of complexity to these issues by increasing the ability of a company to gather personal (viewing) information in an exceptionally unobtrusive manner, and then to use that information to infer individual demographic characteristics.

TiVo was able to determine precisely who watched which commercials during the Super Bowl, the amount of time viewers spent watching commercials, and the number of times a particular viewer might have paused, rewound, and rewatched a particular segment of the game or commercial.

New Threats to Privacy through Viewer Profiling

The new threat to privacy begins with the basic technology of the Personal Video Recorder (PVR), which is able to directly monitor and report the viewing choices of individuals. To some extent, this is a reflection of the increased monitoring of individual behavior through a variety of data-gathering means, including point-of-sale devices, online ordering forms, and product registration requests. It also includes less salient technologies such as spyware, which is conceptually similar to the PVR in its PC-based monitoring and reporting capabilities [10]. As we note later, the main difference between the PVR and spyware is that while PVR companies attempt to communicate their data collection and usage procedures in clearly worded privacy policies, spyware often skirts ethical constraints by installing itself on a user's PC with little or no advance warning.

The other major privacy issue in turn involves treatment of the information after it is collected. TiVo, a leading PVR manufacturer and service provider, is selling the viewing behaviors of its customers to Nielsen Media Research, which in turn will use that information to enhance its own collection and analysis of television viewing [6]. The type of information collected can be exceptionally detailed. TiVo was able to determine precisely who watched which commercials during the Super Bowl, the amount of time viewers spent watching commercials, and the number of times a particular viewer might have paused, rewound, and rewatched a particular segment of the game or commercial. Not surprisingly, this simple ability to collect viewing data, combined with the increasing number of PVRs in homes, has raised concerns from privacy advocates [1, 3].

The monitoring-profiling capabilities of the PVR have a direct impact on each of the stakeholders involved in the creation, distribution, and consumption of television advertising. In the domain of PVR-based targeted advertising, the direct stakeholders include television viewers, PVR providers, service providers (for example, cable and satellite companies), content providers (for example, broadcast and cable networks), and advertisers. The impact on these stakeholders can be explored, in turn, in the context of the three privacy issues raised earlier: procedures used to collect and distribute information, the perceived outcomes of those procedures, and the accuracy of inferred personal information. We discuss each of these issues, in part using TiVo as an example when appropriate, and then summarize the issues within a proposed framework for further investigation.

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Filtered Binary with Otsu's method: noise vs original

Σε αυτό το βήμα επιλέγονται οι μετασχηματισμοί που θα χρησιμοποιήσω αρχικά για τον εντοπισμό των περιοχών και στην συνέχεια για την καταμέτρηση των λέξεων. Για αρχή δημιουργώ τα "structural elements" που θα χρησιμοποιηθούν τα οποία μπορεί να έχουν διαφορετικά σχήματα και μεγέθη, εφαρμόζονται σε όλη την εικόνα και για κάθε pixel δίνεται τιμή ανάλογα με τον μετασχηματισμό που χρησιμοποιώ. Ο κώδικας για τον χωρισμό και εντοπισμό περιοχών βρίσκεται παρακάτω μαζί με τον αντίστοιχο κώδικα για τον χωρισμό λέξεων. Συγκεκριμένα

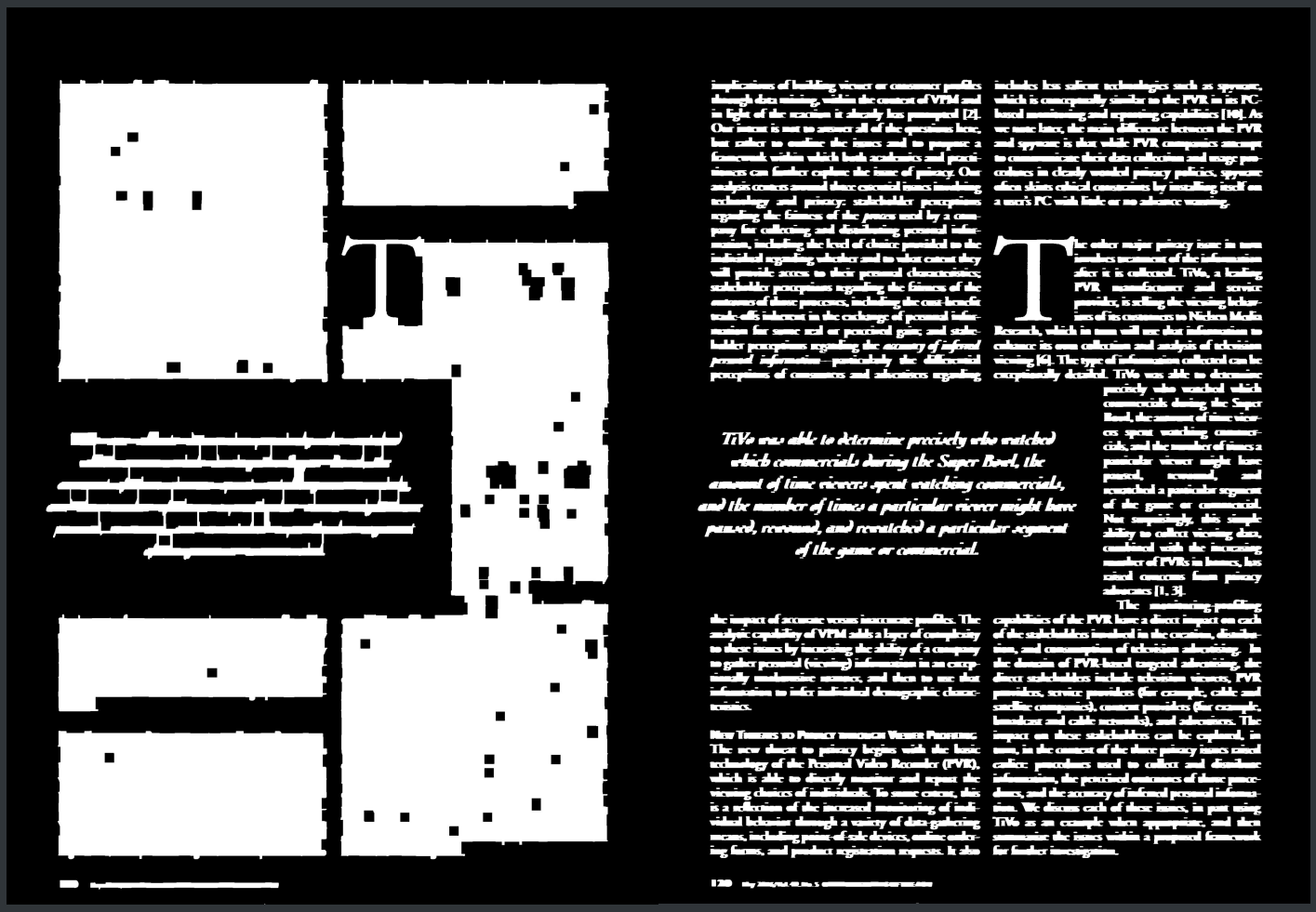
ΙΙ. Περιγραφή του κώδικα.

εφαρμόζουμε "dilation and closing" στις εικόνες ώστε να ενωθούν οι λέξεις και έπειτα να ενωθούν τα κενά στα γράμματα στην κάθετη διεύθυνση. Τα αποτελέσματα φαίνονται παρακάτω στην εικόνα με θόρυβο μόνο καθώς δεν παρουσιάζονται μεγάλες διαφορές από την original.

```
# At this point its time to choose transforms to count words and divide areas of images. A combination of
open and
# close transforms is used to connect the areas and words. Dilate and erosion consist the previews
transformations.
# Structuring elements are being created to connect the areas by dilation, but this action will change the
sizes of
# the areas and results will be wrong. So firstly words are being connected with each other. Also the closing
next is
# used to fill vertically gaps of letters.

sqr_1 = np.ones((3, 3), np.uint8)
sqr_2 = np.ones((5, 5), np.uint8)
rect_1 = np.ones((1, 4), np.uint8)

# For text area dilation and closing:
temp2 = cv2.morphologyEx(th1, cv2.MORPH_DILATE, sqr_1, iterations=1)
texts_bound = cv2.morphologyEx(temp2, cv2.MORPH_CLOSE, sqr_2, iterations=8)
# For text area dilation and closing:
temp2 = cv2.morphologyEx(th1, cv2.MORPH_DILATE, sqr_1, iterations=1)
texts_bound = cv2.morphologyEx(temp2, cv2.MORPH_CLOSE, sqr_2, iterations=8)

# cv2.namedWindow("text_division", cv2.WINDOW_NORMAL)
# cv2.imshow("text_division", texts_bound)
# cv2.waitKey(0)
# For words dilation and closing:
temp = cv2.morphologyEx(th1, cv2.MORPH_DILATE, rect_1, iterations=3)
words_bound = cv2.morphologyEx(temp, cv2.MORPH_CLOSE, rect_1, iterations=1)

# cv2.namedWindow("word_division", cv2.WINDOW_NORMAL)
# cv2.imshow("word_division", words_bound)
# cv2.waitKey(0)

cv2.imwrite('text_division.png', texts_bound)
cv2.imwrite('word_division.png', words_bound)

# The connected components have being formed and the function is used to return the number of the components
found.
num, val_pix = cv2.connectedComponents(texts_bound)

# The bounding boxes and measures to be done will be performed according to the number of components found.
To design
# the bounding boxes a function is used that stores the coordinates of the box. Through an array of zeros
we create a
# mask which later will be helpful to calculate the dimensions of bounding box. An integral image is created
in which
# every pixel is sum of its neighbors to the upper left. Also every pixel of looped area is set to 255. Height
and
# width is checked with a limit - value, before we move on to the next loop because areas often are consisted
by
# higher values than the limit we chose. This check is happening so trash - information will not be considered
# countable region
```

II. Περιγραφή του κώδικα.

Τα αποτελέσματα είναι ικανοποιητικά και στις δύο περιπτώσεις καθώς στην



text_division.png word_division.png

πρώτη κάθε υποπεριοχή έχει σχηματιστεί ένα συνδεδεμένο στοιχείο ενώ στην δεύτερη περίπτωση σχεδόν κάθε λέξη αποτελεί συνδεδεμένο στοιχείο. Στην συνέχεια πάμε σε κάθε περιοχή και σχεδιάζεται ένα περιβάλλον κουτί. Έπειτα δίνεται ένας μοναδικός αύξων αριθμός. Αρχικά, χρησιμοποιήθηκε η συνάρτηση "Connected Components" στην εικόνα η οποία επιστρέφει έναν αριθμό που δηλώνει πόσα διαφορετικά "Connected Components" βρέθηκαν και ένα πίνακα όπου η τιμή των pixel κάθε "Connected Components" έχει ένα συγκεκριμένο αριθμό. Η αρίθμηση ξεκινάει από το 0 που λαμβάνεται ως τιμή από το background. Κατά την επανάληψη ελέγχεται αν κάθε pixel είναι λευκό και με τις διαστάσεις που δίνονται, σχεδιάζεται ένα ορθογώνιο. Για να σχεδιαστεί ένα bounding box χρειαζόμαστε τουλάχιστον τις συντεταγμένες της επάνω αριστερά γωνίας και τις κάτω δεξιά. Την πληροφορία αυτήν για κάθε περιοχή μπορούμε να την λάβουμε μέσω της συνάρτησης "Bounding Rect" η οποία επιστρέφει ως x,y τις συντεταγμένες της

πάνω αριστερά γωνίας, το πλάτος w και το ύψος του bounding box. Για να μη λαμβάνω ψευδή στοιχεία και μετράω θόρυβο ως υποπεριοχή, αποφασίζω να ορίσω ως όριο διαστάσεων το 12 έτσι ώστε να θεωρείται υποπεριοχή ότι είναι μεγαλύτερο από αυτό. Έπειτα χρωματίζεται με κόκκινο χρώμα το κουτί που περικλείει τις υποπεριοχές.

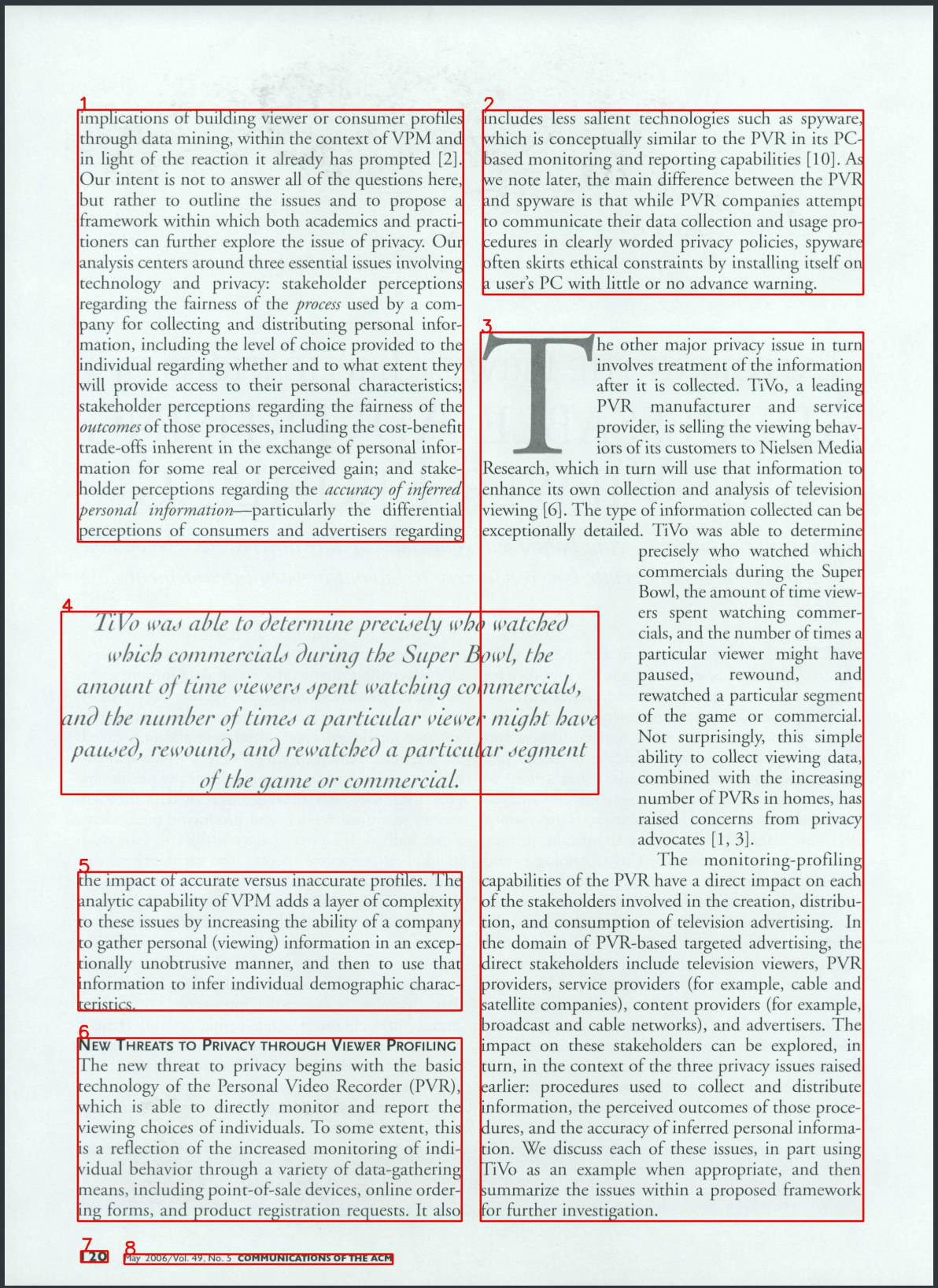
```
img_integral = cv2.integral(median, cv2.CV_32F)

for i in range(1, num):
    counter = 0
    text_regions_msk = np.zeros(th1.shape, dtype=np.uint8)
    text_regions_msk[val_pix == i] = 255
    x, y, w, h = cv2.boundingRect(text_regions_msk)

    # If height and width of bounding rectangles are small enough they are consider regions and we increase
the counter.
    if w < 12 or h < 12:
        counter += 1
        continue
    num_reg = i - counter
    print("----- Region number", str(num_reg), ": -----")

    # Drawing a rectangle with dimensions from above unfilled with red colored line around it.
    # Also a text number is shown on every region.
    color = (0, 0, 255)
    cv2.rectangle(img_colored, (x, y), (x + w, y + h), color, 4)
    cv2.putText(img_colored, str(num_reg), (x, y), cv2.FONT_HERSHEY_SIMPLEX, 1.5, color, 4)

# Calculating the bounding box area with the dimensions of width and height.
box_area = w * h
print("Bounding Box Area (px): ", box_area)
```

// Υπολογισμός αριθμού λέξεων: Με την πολυ-χρησιμοποιημένη συνάρτηση για τα ενωμένα στοιχεία και πλέον με παραμέτρους την εικόνα λέξεων και διαστάσεις από την μια άκρη στην άλλη σχεδιάζεται όμοια ένα μπλε κουτί και αριθμείται το περιεχόμενο.

```
# Calculating the number of words horizontally and vertically: from one point to width and from other
point to
# height. With the parameters of the words' bounding box and the words counting area, the number of
words is
# calculated. Also the possible errors made during the collision of the words earlier can be detected
by giving
# one color at each word, this will not show up in this program. Further down the number of words
displayed must
# be decrease by one cause the background has also a label that is counted in the variable.

num_word, words = cv2.connectedComponents(words_bound[y:y + h, x:x + w])
# For loop below used only for bounding words and with words_bound whole indexes:
# for wrd in range(1, num_word):
#     word_regions_msk = np.zeros(th1.shape, dtype=np.uint8)
#     word_regions_msk[words == wrd] = 255
#     x_w, y_w, w_w, h_w = cv2.boundingRect(word_regions_msk)
#     cv2.rectangle(img_colored, (x_w, y_w), (x_w + w_w, y_w + h_w), (255, 0, 0), 3)

print("Number of Words: ", num_word)
```

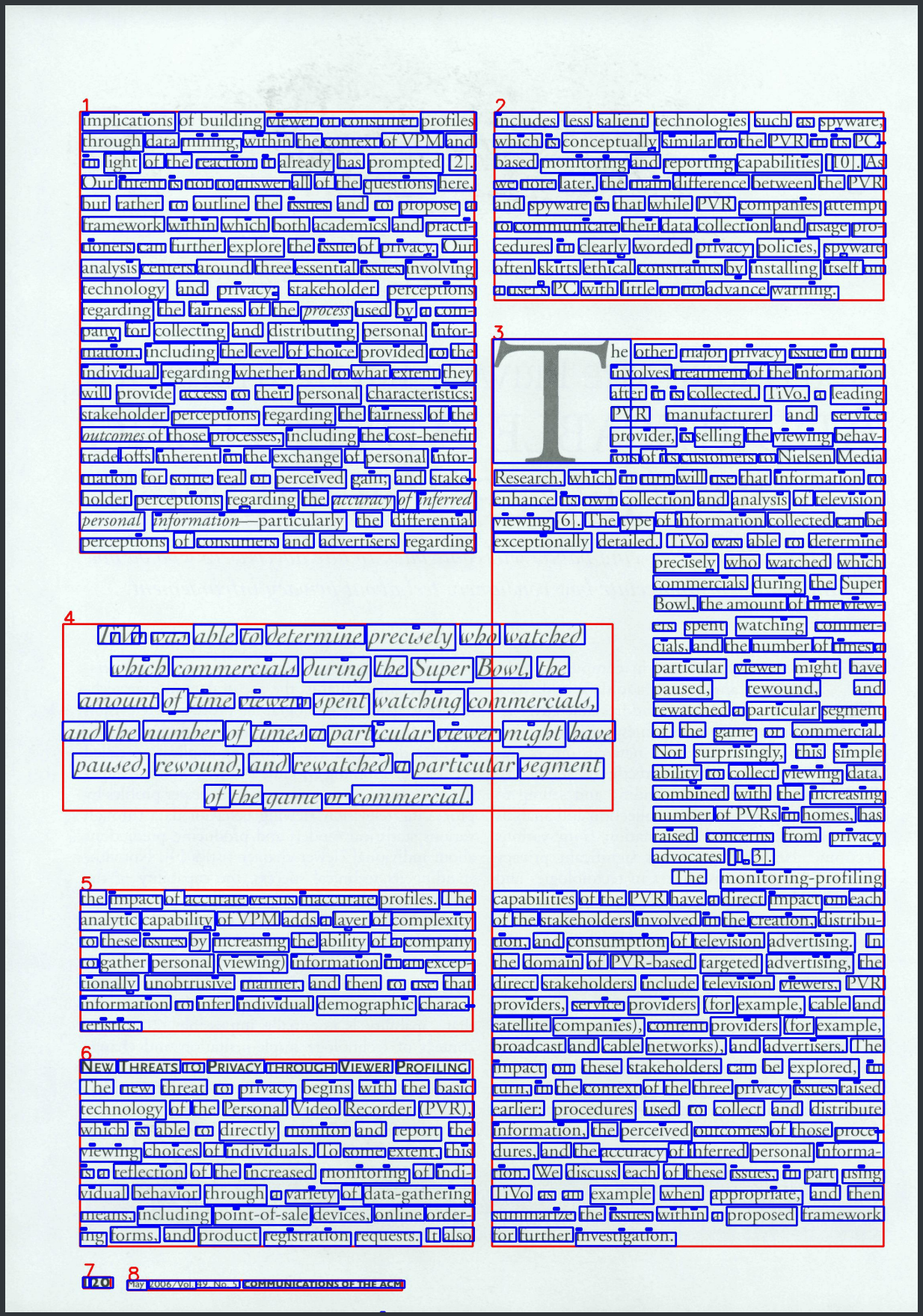
II. Περιγραφή του κώδικα.

// Υπολογισμός εμβαδού: Το εμβαδόν υπολογίζεται από το γινόμενο των διαστάσεων του κουτιού όπως φαίνεται και στον παραπάνω κώδικα.



bounding_box_colored.png

II. Περιγραφή του κώδικα.



bounding_box_colored_words.png

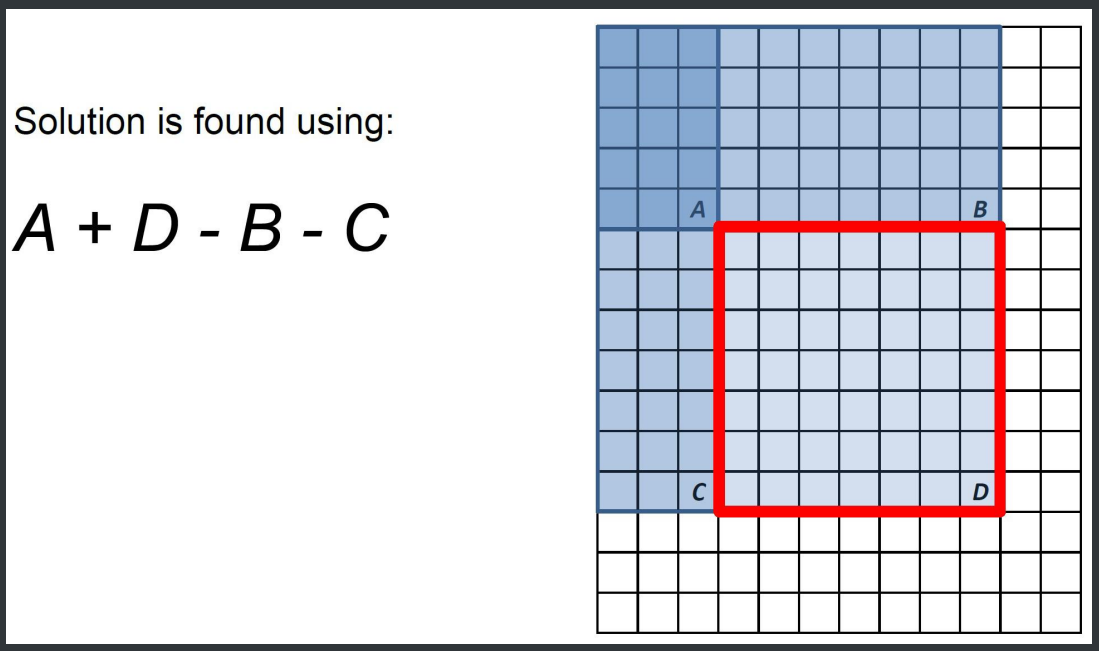
II. Περιγραφή του κώδικα.

// Υπολογισμός περιοχής κειμένου: Με παρόμοια επανάληψη εντοπίζουμε, χρησιμοποιώντας ένα παράθυρο αναζήτησης με διαστάσεις που ερευνούν από το ένα άκρο περιοχής στο άλλο, τα λευκά σημεία και αυξάνουμε τον μετρητή μας κατά ένα.

```
# Calculating text area:
text_area_box = th1[y:y + h, x:x + w]
text_area = 0
for y_i in range(1, text_area_box.shape[0]):
    for x_i in range(1, text_area_box.shape[1]):
        if text_area_box[y_i][x_i] == 255:
            text_area += 1

print("Text Area: ", text_area)
```

// Υπολογισμός μέσης τιμής διαβάθμισης του γκρι: Πρακτικά ο υπολογισμός που ζητείται είναι το άθροισμα των τιμών των pixel σε κάθε υποπεριοχή προς τον αριθμό των pixel του εμβαδού. Εδώ λοιπόν θα χρησιμοποιηθεί το Integral Image της grayscale αποθορυβοποιημένης εικόνας το οποίο μπορεί να υπολογίσει το άθροισμα των τιμών των pixel σε σταθερό χρόνο.

```
# Calculating Mean gray-level value in bounding box:
A = img_integral[y][x]
D = img_integral[y + h][x + w]
B = img_integral[y][x + w]
C = img_integral[y + h][x]
mglv = (A + D - B - C) / (w * h)
print("Mean Gray Value of bounding box: ", mglv)
```



III. Ανάλυση Αποτελεσμάτων.

Συγκεντρωτικά όλα τα αποτελέσματα για εικόνα με θόρυβο είναι:

```
Original Dimensions:  (3245, 2356)
Original Dimensions:  (3245, 2356)
Original Dimensions:  (3118, 2296)
Original Dimensions:  (3118, 2296)
Original Dimensions:  (2483, 2037)
Original Dimensions:  (2483, 2037)
Original Dimensions:  (3228, 2272)
Original Dimensions:  (3228, 2272)
Original Dimensions:  (3239, 2368)
Original Dimensions:  (3239, 2368)
Automatically chosen average value from Otsu's Binarization:  174.0
----- Region number 1 : -----
Bounding Box Area (px):  1070910
Number of Words:  230
Text Area:  136047
Mean Gray Value of bounding box:  222.35267762930593
----- Region number 2 : -----
Bounding Box Area (px):  450655
Number of Words:  111
Text Area:  57038
Mean Gray Value of bounding box:  222.01626965195106
----- Region number 3 : -----
Bounding Box Area (px):  2187663
Number of Words:  387
Text Area:  241884
Mean Gray Value of bounding box:  223.9644972740317
----- Region number 4 : -----
Bounding Box Area (px):  631069
Number of Words:  67
Text Area:  52838
Mean Gray Value of bounding box:  229.9011344242864
----- Region number 5 : -----
Bounding Box Area (px):  341523
Number of Words:  76
Text Area:  40717
Mean Gray Value of bounding box:  222.1697103855377
----- Region number 6 : -----
Bounding Box Area (px):  451936
Number of Words:  100
Text Area:  60671
Mean Gray Value of bounding box:  217.3496070240034
----- Region number 7 : -----
Bounding Box Area (px):  1904
Number of Words:  3
Text Area:  827
Mean Gray Value of bounding box:  167.88970588235293
----- Region number 8 : -----
Bounding Box Area (px):  17025
Number of Words:  5
Text Area:  5129
Mean Gray Value of bounding box:  192.74096916299558

Process finished with exit code 0
```

Η ανάλυση των αποτελεσμάτων έγινε και θεωρητικά και στην περιγραφή του κώδικα.

III. Ανάλυση Αποτελεσμάτων.

Πηγές:

[

- Remove Salt and Pepper noise with Median Filtering | by Prabhavi Jayanetti | Analytics Vidhya | Medium
- Otsu' s Thresholding Technique | LearnOpenCV
- py_morphological_ops
- https://medium.com/hackernoon/an-introduction-to-morphological-operations-for-digital-image-text-classification
- Διαφάνειες Μαθήματος.

]