Research in Document Analysis

Center of Computer Vision & Pattern Recognition
Bahria University

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Bahria University

Center of Computer Vision & Pattern Recognition

Key Research Themes

- Medical Image Analysis
- Natural Language Processing
- Surveillance Applications
- Signal Processing
- Document Analysis & Recognition

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(Urdu) OCR Research in Pakistan

- UET-Lahore – 2010
- DFKI (Adnan-ul-Hassan)
- NUST
- Bahria University
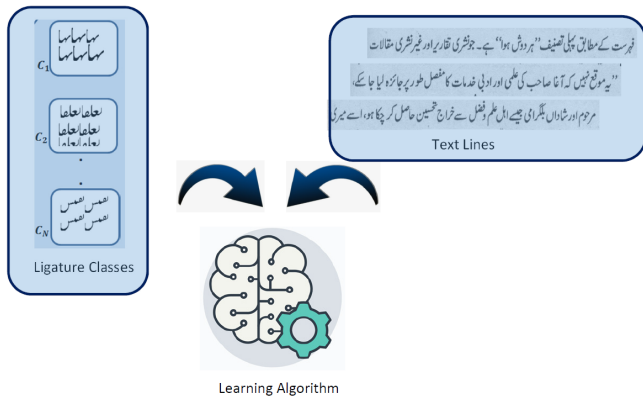- Institute of Space Technology
- . . .

Best Student Paper Award

[0]Sheikh Faisal Rashid, Faisal Shafait, T Breuel. Scanning Neural Network for Text Line Recognition, 10th IAPR Workshop on Document Analysis Systems, DAS'12. Gold Coast, Australia, Mar. 2012.

Holistic vs. Analytical

Unit of Recognition?

Ligature Classes

Text Lines

Learning Algorithm

Holistic vs. Analytical

- Analytical[a]: Large labeled training data – Capture all character combinations etc.
- Holistic: Number of Unique Classes – Too high
- Common Tricks in Holistic Approaches:
  - Use only high frequency ligatures
  - Separate recognition of main body and dots [b]

$$ تّ نّ نّ نّ یّ نّ ⟶ حّ ٜ $$

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[a]Saeeda Naz et al., Urdu Nastaliq recognition using convolutionalrecursive deep learning. Neurocomputing, 2017 (243).

[b]Din et al., Segmentation-free optical character recognition for printed Urdu text. Journal on Image and Video Processing, 2017(1)

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Handwriting Recognition

- Dataset of 6000 handwritten text lines – 600 writers
- CNN–LSTM: 84% Character Recognition rate

Optical Character Recognition
HW Recognition
HW:Diagnostic Tool
Retrieval Applications
Forensic Applications
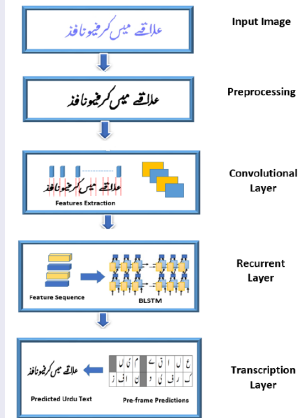
HW & Neurological Disorders
Neuro-psychological Assessments

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Handwriting and Brain

Generation of Handwriting

Handwriting is a complex fine motor
skill produced by manipulating a writing
instrument that is precisely coordinated
by a timing system under a neural
control of movements of the arm, the
hand, and the fingers

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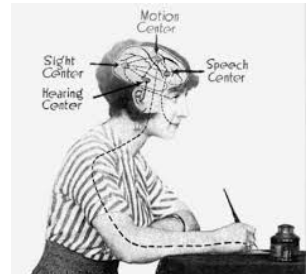
Handwriting & Brain

Writing vs. Typing

- Pens and keyboards bring into play very different cognitive processes
- Strong linkage between handwriting and intellectual development and innovation [1]
- Drawing each letter by hand substantially improves subsequent recognition

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[1] James, K., and Laura E., The effects of handwriting experience on functional brain development in pre-literate children,Trends in Neuroscience and Education, 2012

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Handwriting and Neurological Disorders

Neurological Disorders Refelected in Handwriting [2]

- **Dysgraphia:**
  - Mixed upper & lower case letters
  - Poor legibility & unfinished letters
  - Inconsistent form and size of letters
- **Alzhiemer's Disease:**
  - Handwriting deteriorates and slows down
- **Schizophrenia:**
  - Slant varies very frequently within the same line
- **Parkinson's Disease**
  - Cramped & Jerky handwriting

[2] The information related to health should not be used for self-diagnosis

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Parkinson's Disease (PD)

- Disorder of the central nervous system
- Affects the motor system (Part of brain concerned with movement)
- Motor Symptoms: Shaking, Rigidity, Slowness, Difficulty in walking
- Later Stages: Dementia, Depression
- Changes in handwriting - Much before motor symptoms[3]

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[3]Rosenblum et al.,Handwriting as an objective tool for Parkinson's disease diagnosis.Journal of Neurology, 2013

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Handwriting and Parkinson

Micrographia

- Abnormally small, cramped handwriting
- Progression to continually smaller handwriting
- Decrease in size of letters: over time/lines of same page

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Handwriting and Parkinson

Pressure

- Pen pressure on paper or electronic tablet
- Finger pressure on pen

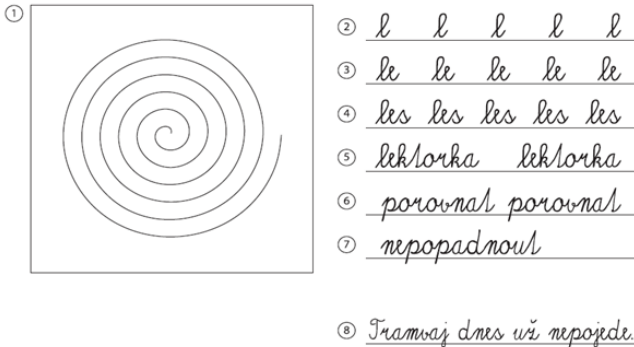## Writing Time

- Parkinson patients – More time to write
- Slow movement of hand
- Pen in air for longer times – Slow cognitive processing

Optical Character Recognition
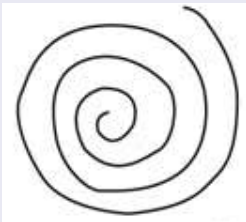HW Recognition
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HW Acquisition Template

- Typically comprises a spiral and characters with loops [4]

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[4] Peter, et al.Evaluation of handwriting kinematics and pressure for differential diagnosis of Parkinson's disease,Artificial Intelligence in Medicine,2016
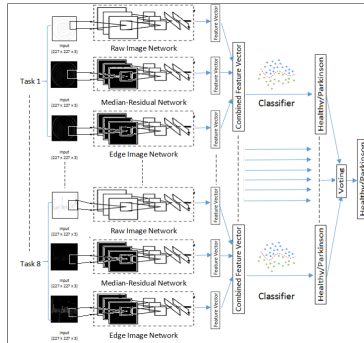
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Handwriting and Parkinson

Control Subject

PD Patient [5]

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Visual Features for PD

- Online data converted to offline images
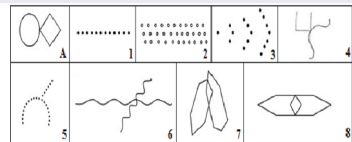- Multiple data representations [6]

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[6]Moetesum, M., Siddiqi, I., Vincent, N., & Cloppet, F. (2019). Assessing visual attributes of handwriting for prediction of neurological disordersA case study on Parkinsons disease. Pattern Recognition Letters, 121, 19-27.

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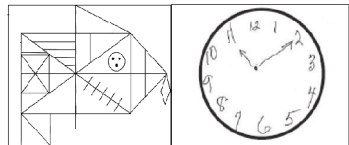# Neuropsychological Assessments

Analysis of Errors

- Missing details, collision or overlapping
- Inability to accurately complete shapes like circles or squares
- Disproportionate sizes and angles
- Wrong placement of objects (digits for instance)

Example Tests
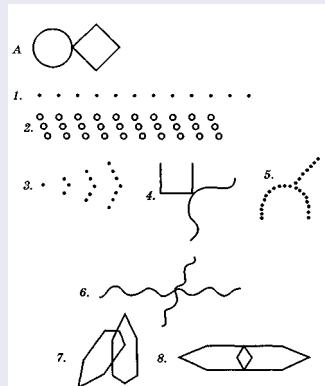

(a) Bender Gestalt Visual Motor Test

(b) Rey Osterrieth Complex Figure Test   (c) Clock Draw Test

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Bender Visual-Motor Gestalt Test

- Evaluates the visual-motor maturity and perceptual distortions associated with various neurological disorders
- A set of nine different drawings
- Subjects reproduce drawings on a sheet of blank paper
- Presence or absence of properties: Rotation, Retrogression, Angulation, Simplification and Closure Difficulty etc.
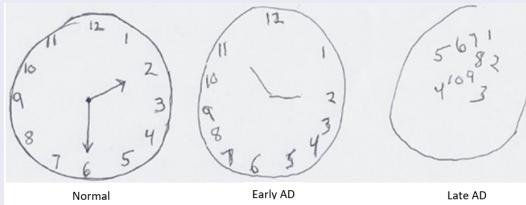- Lack's Scoring System

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BGT Samples by Subjects [7]

[6]Moetesum, M., Siddiqi, I.& Vincent, N., Deformation Classification of Drawings for Assessment of Visual-Motor Perceptual Maturity, To Appear in ICDAR 2019

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Clock-Drawing Test

- Screening test for Alzheimer's and other dementias
- Test Administration
    - A piece of paper (often) with a pre-drawn circle on it
    - Subject draws numbers on the clock
    - Subject draws hands to show a specific time [8]

Normal   Early AD   Late AD

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[8]Image: Mark P. Mattson – Frontiers in Neuroscience

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Draw-a-Person Test

DAP (HFD)

- Projective Personality / Cognitive Test

- Quantitative Scoring Systems - Measurement of Intelligence (IQ) & Cognitive Development

- Goodenoough: Analysis of various aspects of drawing – Body parts, clothing, presence or absence of details, proportions etc.

Sample Drawing

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Historical Documents
Video Retrieval

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Historical Documents
Video Retrieval

Historical Manuscript Retrieval

French ANR Project: Graphem

- Computerized Tool for Palaeographers
- Retrieval of Medieval Documents

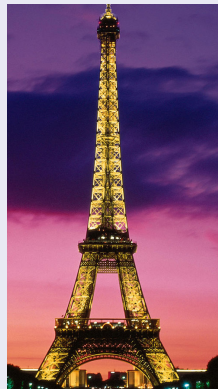Optical Character Recognition
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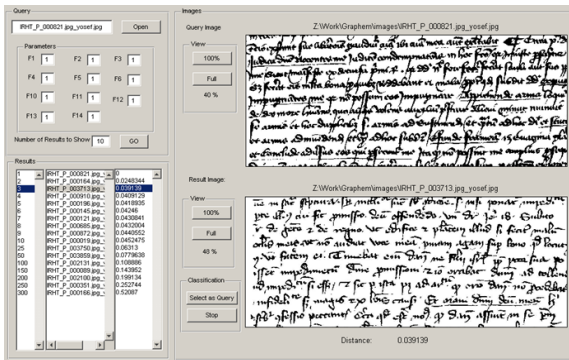
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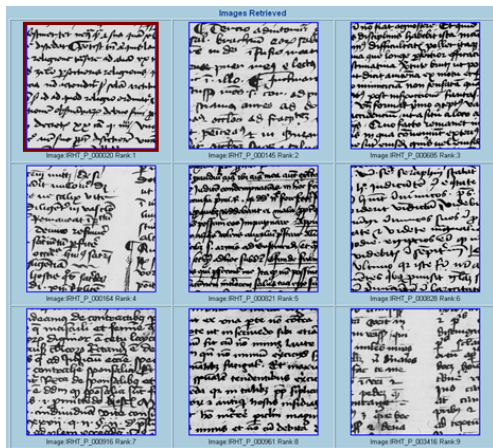
Query by Content

Search by Content

- Content: Visual, Audio, Textual
- Find all videos containing a given object (Building, Person, Scene...)
- Find all videos where a given word has been spoken
- Find all videos where a news on 'ISPR' has been flashed

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Text Detection

Detection Results

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Text Recognition

Synthetic Text Lines

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Text Recognition

Recognition Results

Original Images

Recognized Text (Developed System)

Recognized Text (Google API)

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Applications

Indexing and Retrieval

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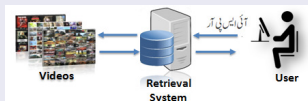
Applications

User Alerts on Specified Keywords
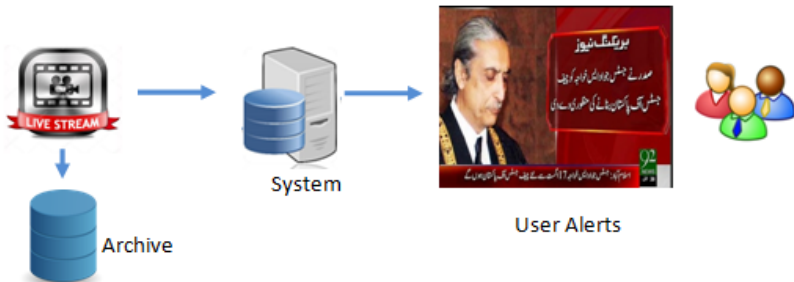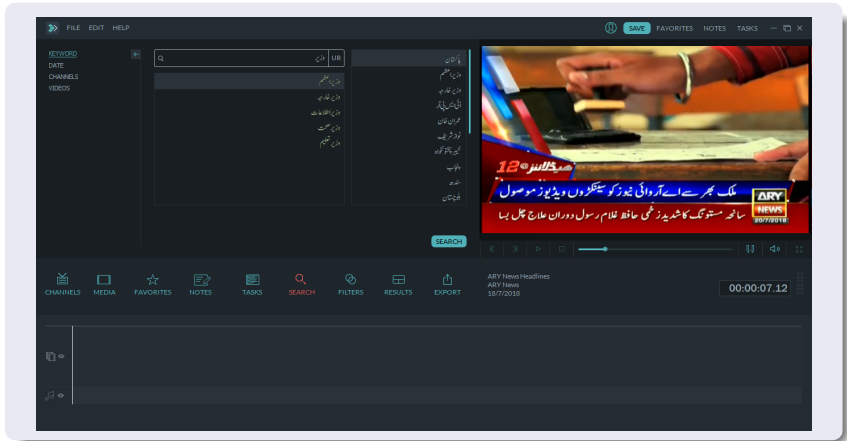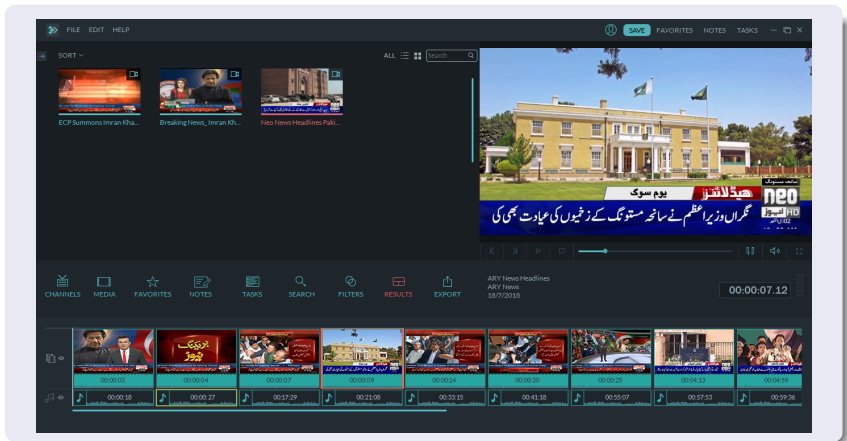
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Retrieval System

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Demo

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Forgery Detection

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Individuality of Handwriting

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Who is the Writer?

In the evening, when Michelle and the girls have gone to bed,
I sometimes walk down the hall to a room Abraham Lincoln used
as his office. It contains an original copy of the Gettysburg
Address, written in Lincoln's own hand.

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Who is the Writer?

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Can we compare writings in different scripts?

L'internet est un système mondi
de réseaux informatiques, utilisant
de protocoles de transfert de don
réseau de réseaux, sans centre néne
de réseaux aussi bien publics, pri
commerciaux et gouvernementaux.
longue spectre d'information et pe
d'applications et de services vari
électronique, la messagerie in

لعت الإنترنت والشبكة العالمية
الشيئ ذاته . لكن في العقيقة
هو مجموعة من شبكات الحواسيب
، وكابلات ألياف بصرية وتوصيلات
ذلك ، الوب هو مجموعة من الوثائق
بعضها البعض عن طريق روابط
نرى الشبكة العالمية واحدة من الخدمات
نرنت ، مثلها مثل البريد الإلكتروني
ج الذي يمكنها الدخول إلى مصادر الوب

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What can you tell about gender of these writers?

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What can you tell about gender of these writers?

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Forgery Detection

Applications

- Signature Verification
- Document Authentication
- Printer Source Identification
- Crime Scene Shoe Print Identification