# Report: Template Matching for Number Detection on Pakistani Currency Note

## Computer Vision – Assignment 2

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## Introduction to Template Matching

Template matching is a technique in computer vision used to find parts of an image that match a template image. The template is a small image or pattern you want to find in a larger image. It works by sliding the template over the big image and checking how similar each part is. This method is often used in object detection and image recognition tasks.

## Objective

The purpose of this assignment is to detect the **note identification number** on Pakistani currency notes by using template matching techniques with no OCR or deep learning models are allowed.

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## Problem Overview and Approach Shift

**Original Method (Digit-Based Template Matching):**

- Match each digit (0–9) individually using cv2.matchTemplate.

- Aggregate the matches to get full serial numbers.

- Draw clear boxes around each digit.

- **Limitation:** Can make mistakes, needs many templates, and doesn't work well if digits are spaced differently or the lighting changes.

**Adopted Method (Offset-Based Matching):**

- Choose a **clear and fixed part** of the note (like a logo or watermark) that is always in the same place.

- Find the **anchor location** using template matching.

- From that anchor, jump to where the serial numbers are using **fixed pixel distances**.

- **Benefits:**

  o Works better if all images are scanned the same way.

o   Faster — only one match per image required.

o   Simpler — no need to match each digit separately.

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**Selected Template and Methodology**

1. **Choosing Template**

A small area near the top-right corner of the currency note was manually chosen as the reference point. This region was picked because:

- It has clear contrast and a distinct pattern.

- It appears reliably on all scanned notes, regardless of denomination.

2. **Matching Procedure**

- Each image is first converted to grayscale to simplify processing.

- Template matching is done using cv2.matchTemplate with the method cv2.TM_CCOEFF_NORMED.

- The location with the best match score is found using cv2.minMaxLoc.

- This position is used as the main reference for locating other elements.

3. **Offset Calculation**

- The distances from the reference area to the top-right and bottom-left serial number locations were measured manually.
- These fixed distances (offsets) help determine where to look for the serial numbers on any new note.

4. **Improving Box Accuracy**

- A custom function was written to slightly reduce the size of the bounding boxes to better fit the serial number region.

def adjustBox(boundingBoxCords, shrinkFactor=0.1, imageWidth=None,imageHeight=None):    ...

- This helps remove extra background and focuses the box more tightly around the numbers.

5. **Creating the Output**

- Blue rectangles are drawn around the found regions using cv2.rectangle.

- The corner coordinates of each box are saved in this format:
  image1.jpg x1 y1 x2 y2 x3 y3 x4 y4
- Both annotated images and a CSV file containing the coordinates are saved for later analysis.

## Challenges Encountered & Solutions

| Challenge | Solution |
|---|---|
| **Scale sensitivity**: Notes of different resolutions misaligned the offsets. | All input images were resized to a fixed width before processing. |
| **Variations in rotation or skew** | Minor rotations were ignored, but preprocessing can be enhanced by applying alignment in future versions. |
| **Bounding box size too large** | The adjustBox() function was introduced to shrink boxes using a configurable shrinkFactor. |
| **Template matching false positives** | The matching threshold and distinctiveness of the anchor template were improved to ensure reliable matching. |

## Conclusion

The offset-based template matching approach effectively simplifies the serial number detection task under the constraint of not using OCR or deep learning. By anchoring detection to a fixed region and applying known offsets, we bypass the complexity of character-level detection while achieving reliable localization.

This method is highly efficient for datasets with consistent layouts and demonstrates the power of simple template matching combined with strategic design.