Fall 2025 CSCI 576 Multimedia Project

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Demonstration Date: Wed Dec 10th, Thu Dec 11th, Fri Dec 12th, 2025

The course project is meant to give you an in-depth understanding of some of the areas in multimedia technology. Since this is a broad field, there can be a variety of interesting projects that can be done depending on your interests which can also extend to related and complementary topics that are taught in class.

Also, larger projects can be successfully accomplished via collaboration with multiple students working in a group. Additionally, working together to design and integrate code can be a rewarding exercise and you will frequently need to work in teams when you graduate and work in the industry. *Accordingly, please form groups of **at least two**, but **at most three** students.* If you need help forming groups, please use Piazza discussions, where you may post your preferred language of implementation, hours of availability etc. Once your group is decided, please send the TAs an email so we with the organization around the project and project grading. Remote DEN students may form groups with in-class students. If you are having trouble finding a partner, please send an email to the TAs and we will try to facilitate group formation. *The demonstrations will be done online over zoom where all members must be present and on camera for Q&A*. You will be asked to submit code in certain cases for further evaluation.

This semester, we are proposing a project that makes use of images, search, graphical transformations and animations. Details are explained on the following pages. For this project, we are placing no restrictions around the language of use or libraries to use. You are welcome to use external libraries, environments of your choice – as long as you can fulfil the objective of the project evaluation.

Computational Image Puzzle Solver

In this project, you will design and implement a program that can automatically solve an image puzzle. The input consists of a set of square or rectangular image fragments each representing a portion of a larger image that are scattered randomly on a virtual board. The system's task is to determine how these pieces fit together to reconstruct the original image and then to produce an animation showing the process of the puzzle being solved.

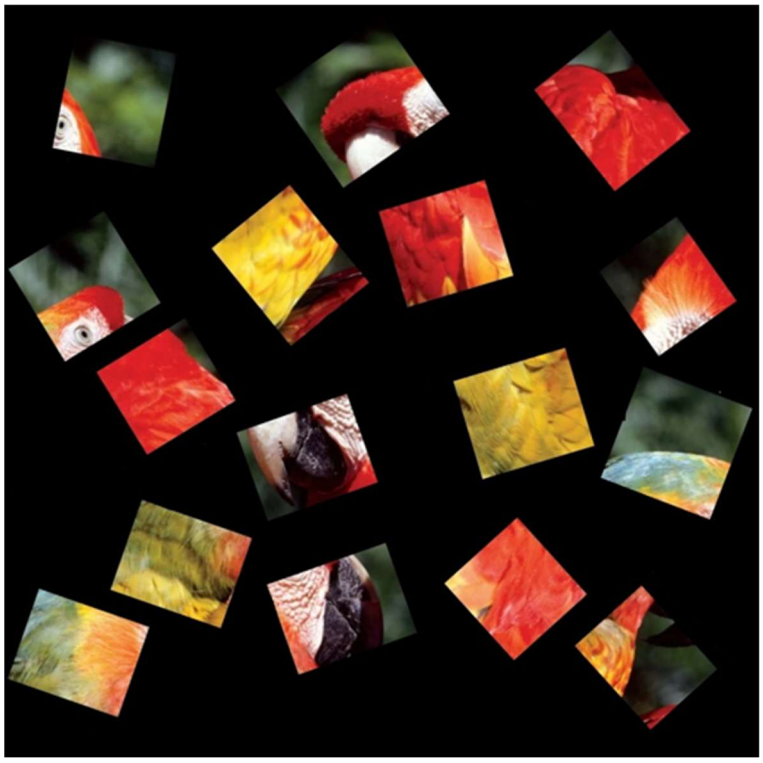
This project integrates elements that we have learned in multimedia processing and animation, providing a hands-on exploration of how computational techniques can analyze visual information and generate engaging visual results.

Inputs, Assumptions and Goals:

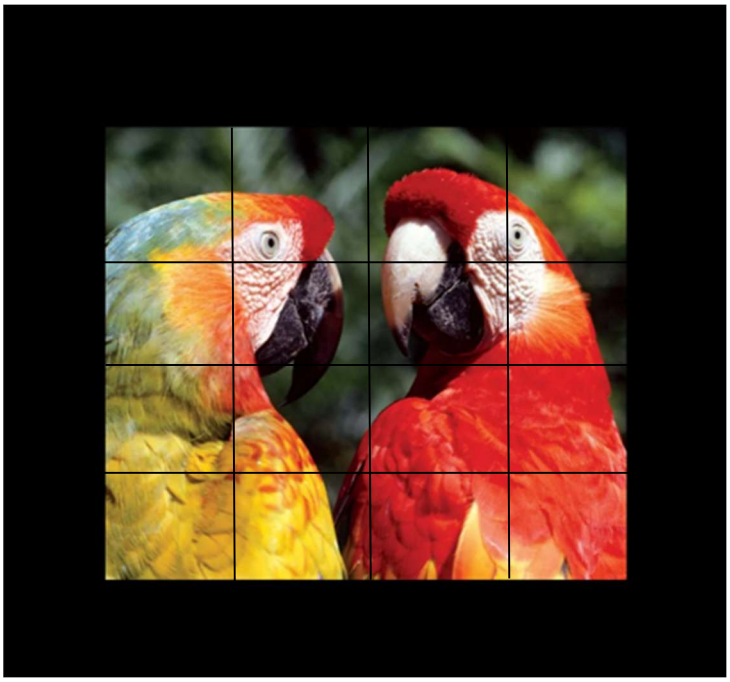
- *Input*: N rectangular pieces which have been laid out on a larger canvas. For the initial examples given N = 16, but this can vary, and you may have this as input to your program if you want. Some of the examples have square pieces all the same size, some examples may have rectangular pieces or a mix of the two – and for this project your input will consist of only four sided pieces.
- *Assumptions*: Each piece has undergone a transformation or movement from its original location. The transformations are all rigid transformations and involve a translation or translation + rotation.
- *Goal*: Place each piece on a discrete grid to reconstruct the original image; Your final outputs should be an animated solution.

Here are good examples of input images. You will be given one large image which contains multiples image pieces at various random orientations. The orientation models necessarily include only rigid transformations with translation and rotation. Some examples are illustrated below

Example 1: Image pieces have a translational model towards a solution



Example 2: Image pieces have a translational + rotational model towards a solution



Final Solution

Implementation Ideas:
Explained below are some ideas that may help you, you will need to think of how to approach your data structure(s). While you are free to research and design a solution that best works for you, here are some suggestions around goals of the project

- *Image Analysis & Preprocessing:*
  Develop algorithms to identify whole areas that are square or rectangular puzzle pieces from the canvas. Normalize the size and orientation of puzzle pieces if needed. Also extract visual features from each puzzle piece such as color distribution, texture, and edge patterns.
- *Piece Matching:*
  Once you have detected the N pieces, devise a computational method to match them edge by edge by evaluating how well they match based on pixel similarity, gradient continuity, or statistical measures like mean squared error. You may use edge histograms, color histograms for each edge which are well within the teachings of this class, and you are also welcome to experiment with other key point descriptors (e.g., SIFT, ORB) if you want. Overall, the matching process may be posed as a search problem. To match pieces, compare all pairs of edges and compute a compatibility score. The best compatibility score will give you a process of how the pieces need to be connected to create a complete picture.
- *Algorithm to Assemble the puzzle:*
  Implement an algorithm that arranges the pieces in positions that minimize mismatches between adjacent edges. After you know how pieces logically fit together, you will need to compute transformations for pieces to align. For ease of processing, we have given you

examples that have only rigid *translational* movements as well a more complex setup with *translational* + *rotational* movements/

- *Visualization and Animation:*
  Create an animation that visually demonstrates how the puzzle is solved step-by-step from scattered pieces to the completed image. You can get creative with animations eg have each piece animate one at a time, have all pieces animate at the same time etc.

Expectations and Evaluations:
We do expect that you will analyze the problem space and produce a solution. The answers here are not subjective since there will always be an exact match of pieces that results in a full image puzzle solution. The evaluation of your project will include:

- The correctness of your match and output, we need to see a final image with pieces aligned properly
- Ability to show a good, animated solution that animates pieces towards the correct solution.
- The time your algorithm takes to find a correct match.
- Oral Q&A about your algorithms and process.