Image Stitching

CMPUT 206 Winter 2025

Steps

1. Feature detection and extraction
2. Feature matching
3. Homography estimation using RANSAC
4. Image warping and stitching

Step 1: Feature Detection

- Detect distinctive points (features) in the images that can be matched across different images.
- To find key points that are easily identifiable in both images, we use feature detectors like **ORB, SIFT, SURF, or BRIEF.**
  - **Key Points**: These are points in the image that have unique patterns, such as corners, edges, or textured areas. Detecting these points is important for matching them later.
  - **Descriptors**: Once key points are identified, each key point is described by a descriptor, which is a vector that encodes the local image features around that point. This allows us to compare key points in different images, even under changes in rotation, scale, or lighting.
- Good feature extraction ensures we find points that are robust (stable across images), enabling accurate matching.

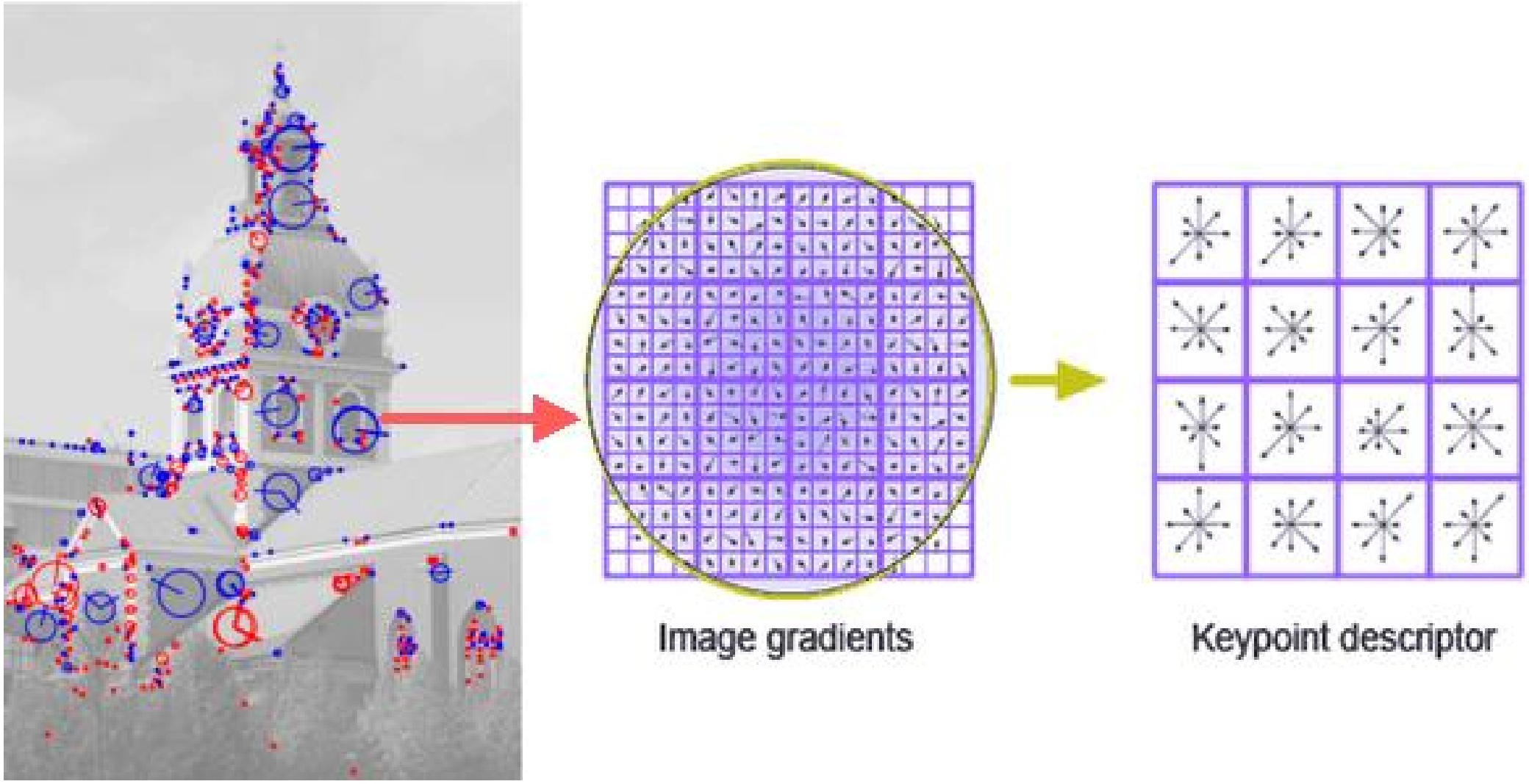
Image gradients
Keypoint descriptor

Step 2: Feature Matching

- To match the features, calculate the **descriptors** of key points and compare them using a **nearest neighbor search**.
- **Matching Criteria**: A feature descriptor from one image is compared to all descriptors from the other image, and the one with the closest similarity (usually based on distance metrics like Euclidean distance) is chosen as the match.
- **Cross-Checking**: To ensure that matches are consistent, use **cross-checking**, which means that for a match to be valid, both features should match each other (i.e., if A matches B, then B must also match A).
- **Filtering**: use a threshold (like **max_distance**) to reject poor matches that are too far apart, reducing the chances of false matches.


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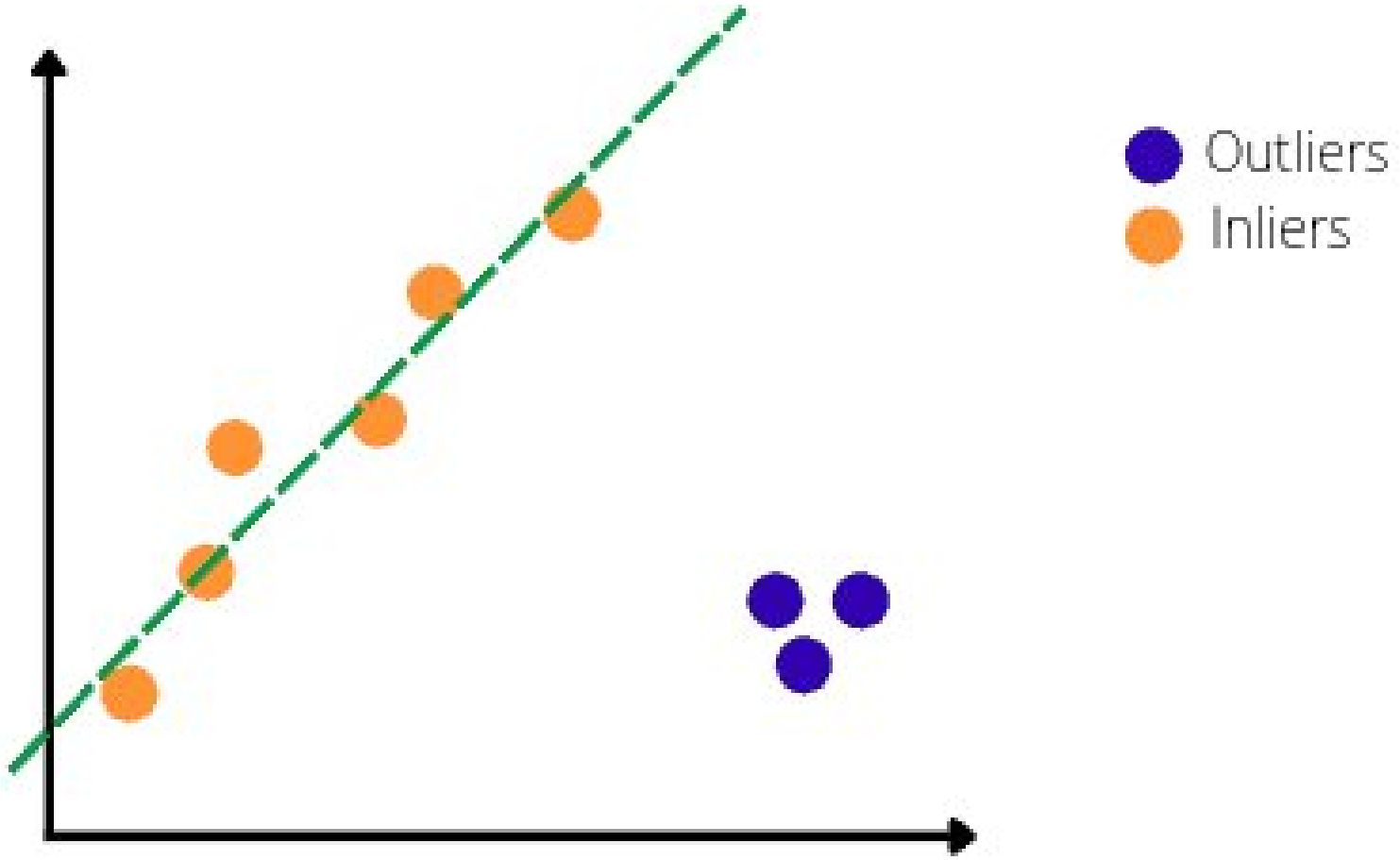
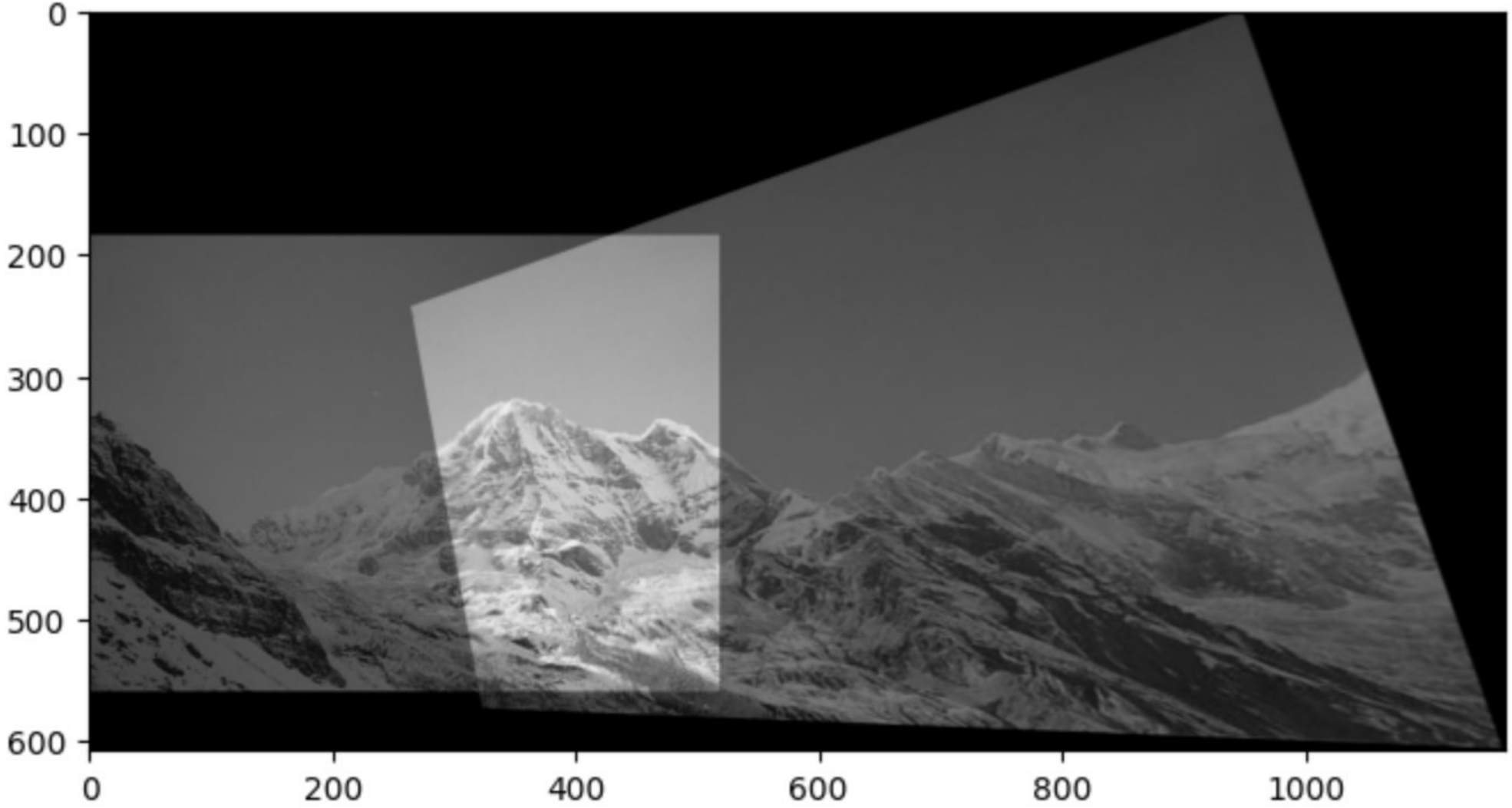
Step 3: Homography Estimation Using RANSAC

- Compute a transformation (homography) that aligns the two images based on their matched key points.
- The homography is a 3×3 transformation matrix that maps points in one image to their corresponding points in the second image.
- **RANSAC (Random Sample Consensus)**: Randomly selecting a small subset of matches, computing the homography based on those, and then testing how well the model fits the rest of the matches. If the majority of matches fit, they are considered **inliers** and contribute to the final homography estimation.
- **Outlier Rejection**: many feature matching algorithms tend to produce some false matches. RANSAC identifies and excludes these false matches, ensuring the homography is calculated based on only correct correspondences.


Outliers
Inliers

Step 4: Image Warping and Stitching

- Apply the homography to warp (transform) the images and combine them into one final stitched image.
- After computing the homography, apply this transformation to the images so that their corresponding features align. This involves calculating the new positions of the pixels from the first image based on the transformation matrix.
- **Warping**: Each pixel from the first image is mapped to its new position in the second image's coordinate system using the homography matrix.
- **Blending**: Once the images are warped, the resulting images are combined. Use alpha blending.
- **Handling Image Size**: Need to ensure the final image covers all areas from both images.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