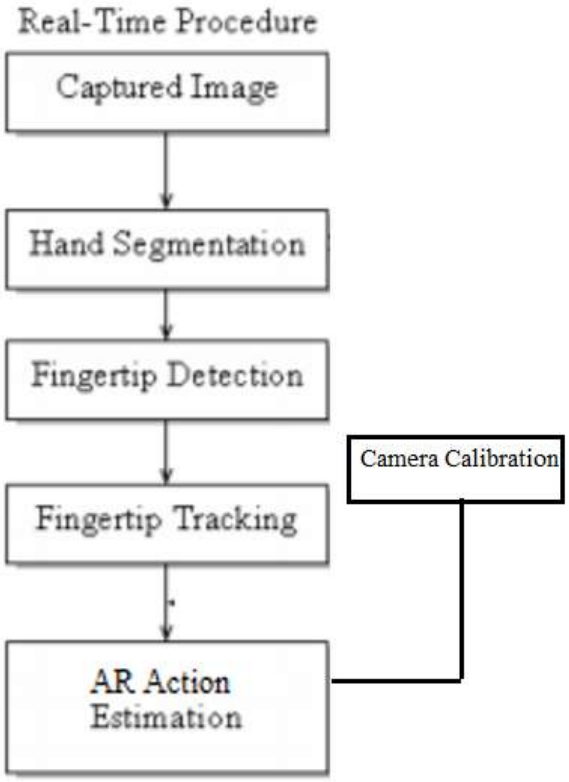
Proposed Solution

We will develop a vision-based user interface that can track the user's outstretched hand robustly and use it as the reference pattern for AR inspection. Here we develop a method for fingertip configuration of a single hand posture, and use it as input to the AR object to perform various action.



Implementation Details

Skin Detection using HSV color space

There are many difficulties when detecting skin pixels. Skin color is affected by ambient light which is unknown in many situations; different cameras produce different colors, even from the same person, under the same illumination conditions; and finally, skin colors change from person to person

This work describes an implementation for skin detection which relies on the H channel to characterize the skin colors range. The openCv library is used for image processing. The program initially converts RGB images to HSV one. The H channel is used to characterize the colors range for skin detection.

Algorithm Steps:

1. Image in RGB was converted to HSV color space(as it is more related to

human color perception) [6]

2. The skin in channel H is characterized by values ranging between 6 and 38 and a mix of morphological and smooth filters. [7]

Original Image

Image in HSV

Illustrates an intermediary image, where all pixels classified as skin (using the range in channel H already established) were set to value 255, and non-skin pixels was fixed to 0.

3. Minimize noise using 5x5 structuring element in morphological filters:
    a. Use the structuring element with a dilatation filter that expands the areas in the skin regions. After that the same structuring element was used to erode the image and reduce all the imperfections that the dilatation

created. These techniques were used, by approximation, to fill all the spaces that were by H channel range supposed that is skin or non-skin

b. Then, a 3x3 median filter was used to soften more the results achieved by the dilatation and erosion, because these techniques adulterated regions in contours
c. Finally, only skin regions are represented as white pixels

Placing a Contour on the hand:

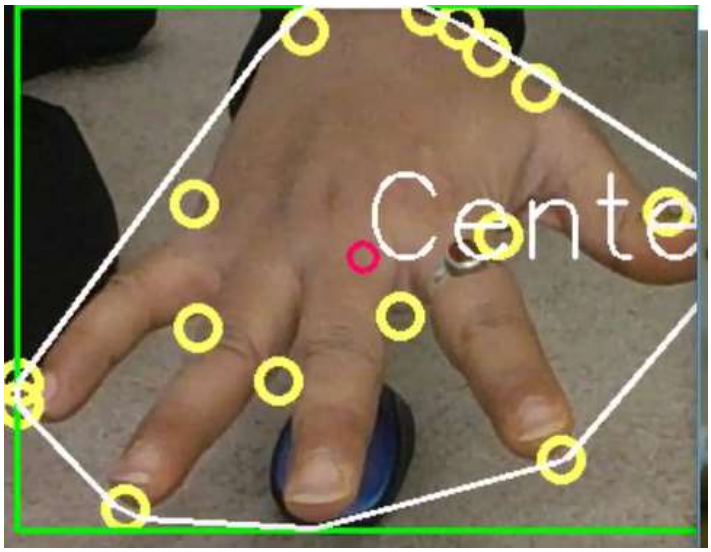


Fig 1 : shows contour on hand

Contours can be explained as a curve joining all the continuous points having same color or intensity which is useful for shape analysis

- Here we are using binary images for better accuracy
- The images are already thresholded in the previous step to have the elements which are having skin color.
- In the image object to be found are in white and the background is black.
- Different contours detected are filtered to obtain the contour with the maximum area (as the hand region is closest seen by the camera it should be having the largest area with the skin color).

Finger Detection:

Steps:

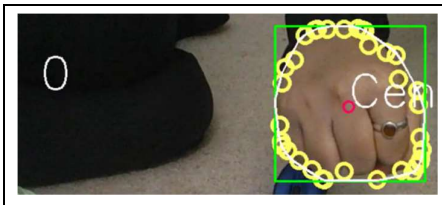
- Form a convex hull.
- Find the center of the contour mass (center of the palm).
- Find defects in the convex hull.
- Distance between defects in the convex hull (representing the curve between the fingers) and the center of the mass is calculated
- The fingers are detected based on the largest value of Y coordinate.
- Calculate the distance between fingertip points and the center of the mass

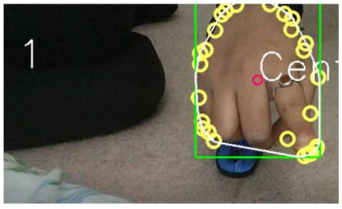
Finger Tip as an Input:

Based on the numbers of fingers seen the input is passed to the AR module

Steps:

- If fingertip distance is from the center is greater than the end point of the curve between two fingers, then that finger is considered to be raised.
- Based on the number of fingers being raised the input is given as shown in figure 2





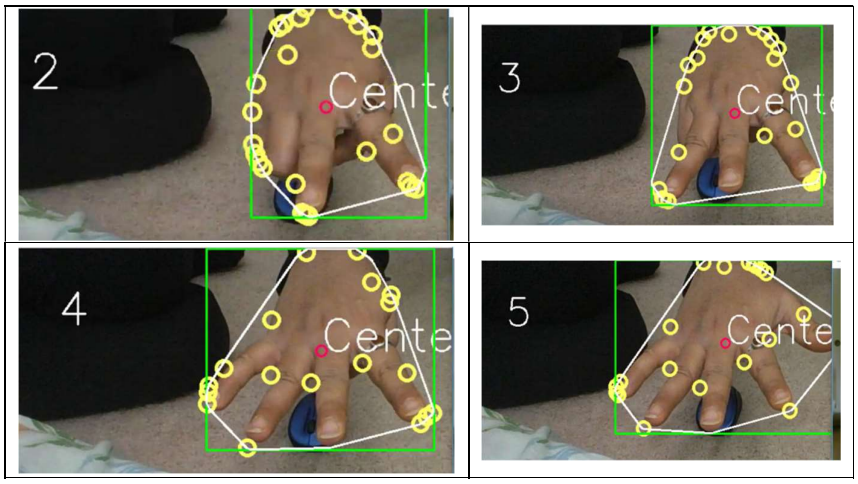


Figure2: Input by counting the number of figures stretched out

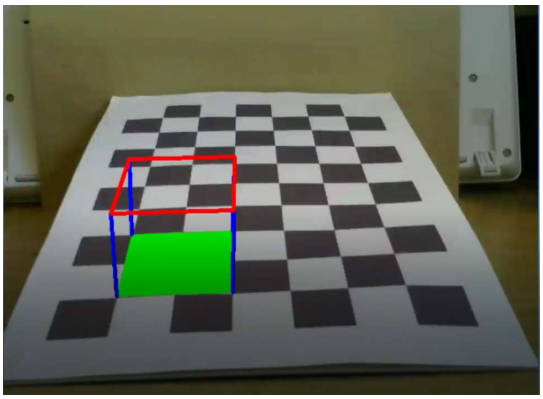
Camera Calibration

Camera calibration parameters obtained by initial calibration provide the necessary intrinsic and extrinsic camera parameters necessary to project 3d world points to image. For this purpose, we have done initial calibration by taking image of a chessboard and calibrated based on its corners.

Augmented reality

Our implementation shows a simple projection of a 3d cube on an image of a chess board.

Augmentation of a 3d cube



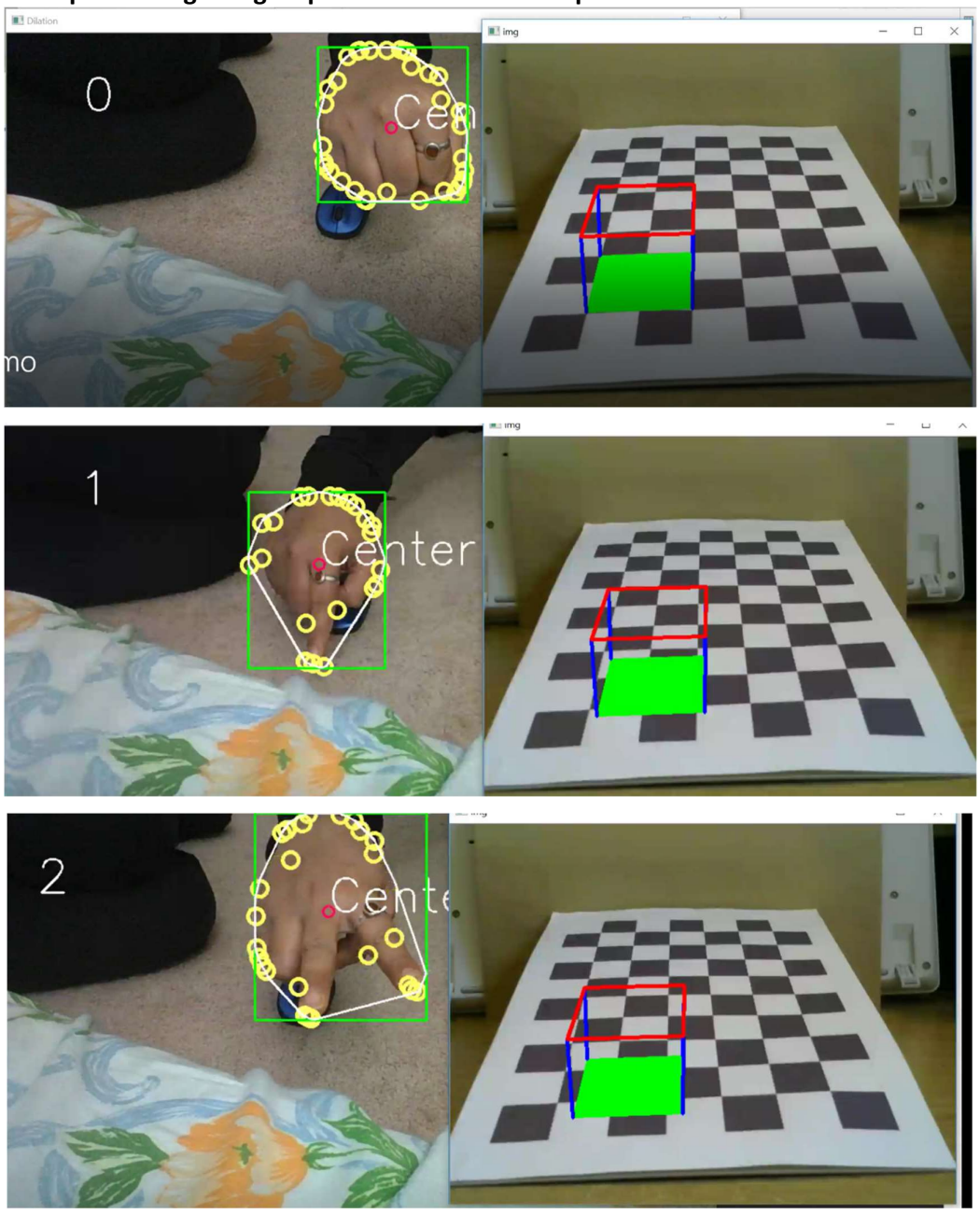
Steps:

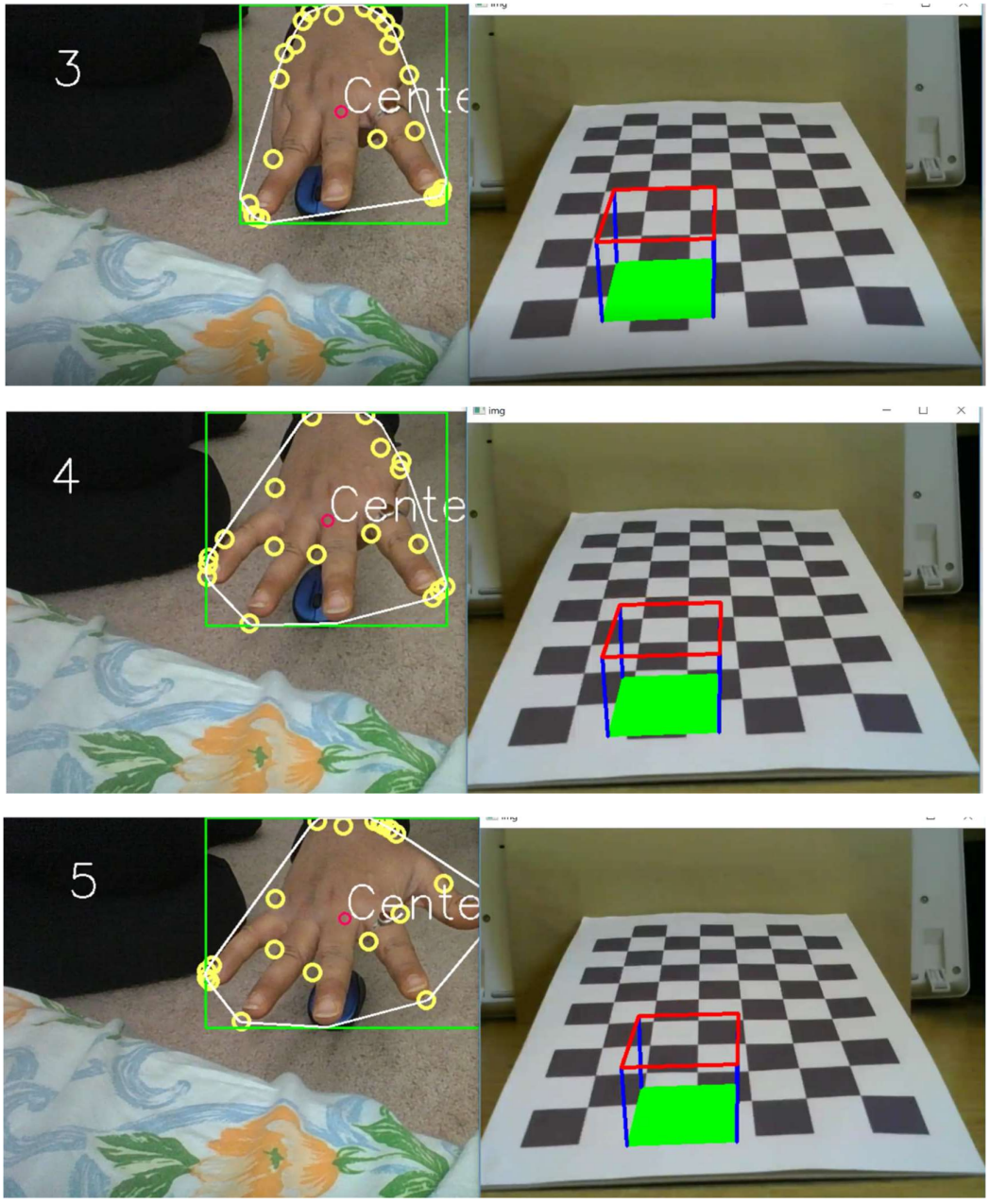
- Initial one-time calibration which gives the camera parameters
- Camera parameters are used to project a 3d digital cube onto the image of the chessboard to obtain its 2d image points
- The image points are used to augment the cube on to the chessboard

Input for augmented cube

- Figure tip count is used in this case to move the cube on the chess board

Input Through Fingertip Count **Represented Movement in the Cube**





Current Implementation:

Currently we have implemented the following:

Hand segmentation:

- Skin Detection using HSV color space
- Placing a Contour on the hand

Finger Detection

- Convex Hull approach

Finger Tip as an Input

- Finger count

Camera Calibration

3D Cube Augmentation on Chessboard

Future Works:

- Augmentation of stabilized 3d world objects on live image capture
- Augmented Object viewing from different angles
- Placing AR object on any flat surface instead of having chessboard
- Better hand segmentation and optical flow using KLT algorithm with analysis to stabilize hand detection and finger tracking
- In addition to finger count, utilization of finger motion itself as an input

References

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[2] R. T. Azuma, Y. Baillot, R. Behringer, S. Feiner, S. Julier, and B. MacIntyre. Recent advances in augmented reality. IEEE Computer Graphics and Applications, 21(6):34–47, Nov./ Dec. 2001.

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