

# Sign Language to English (Slate8)

App Development

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2<sup>nd</sup> EECS Day  
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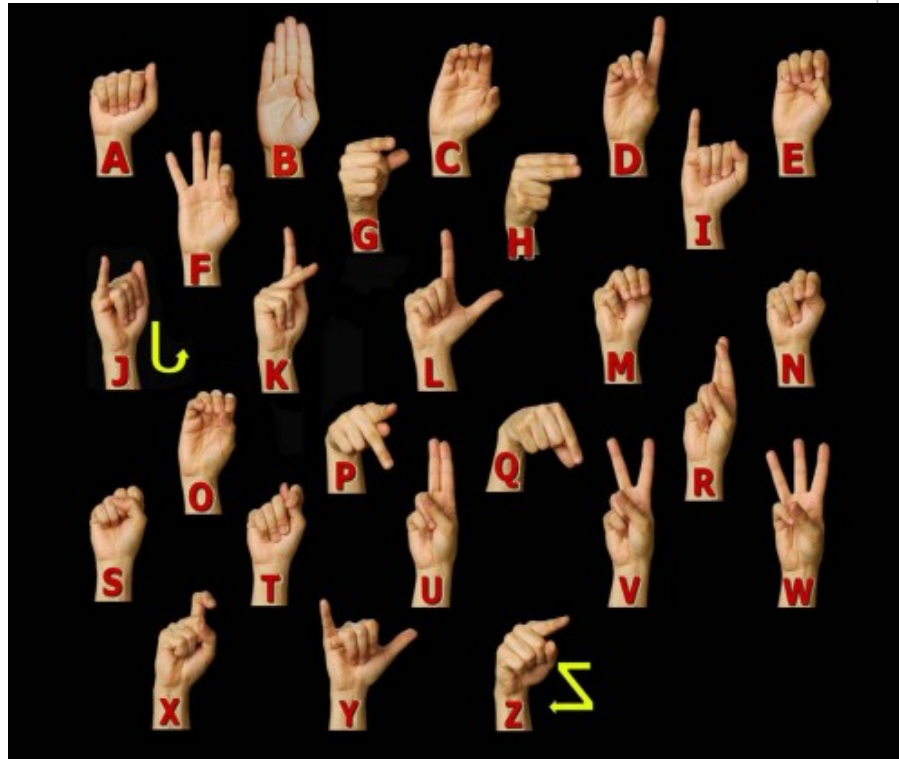
Electrical Engineering and Computer Science (EECS)  
Howard University

# Problem Definition

- ▶ **Project's Long Term Goal**  
A Working Sign Language App
- ▶ **Project's 2017-2018 Academic Year Goal**  
The recognition of American Sign Language (ASL) Symbols
- ▶ **Problem Statement**  
To create a means of communication between the hearing and hearing impaired community.

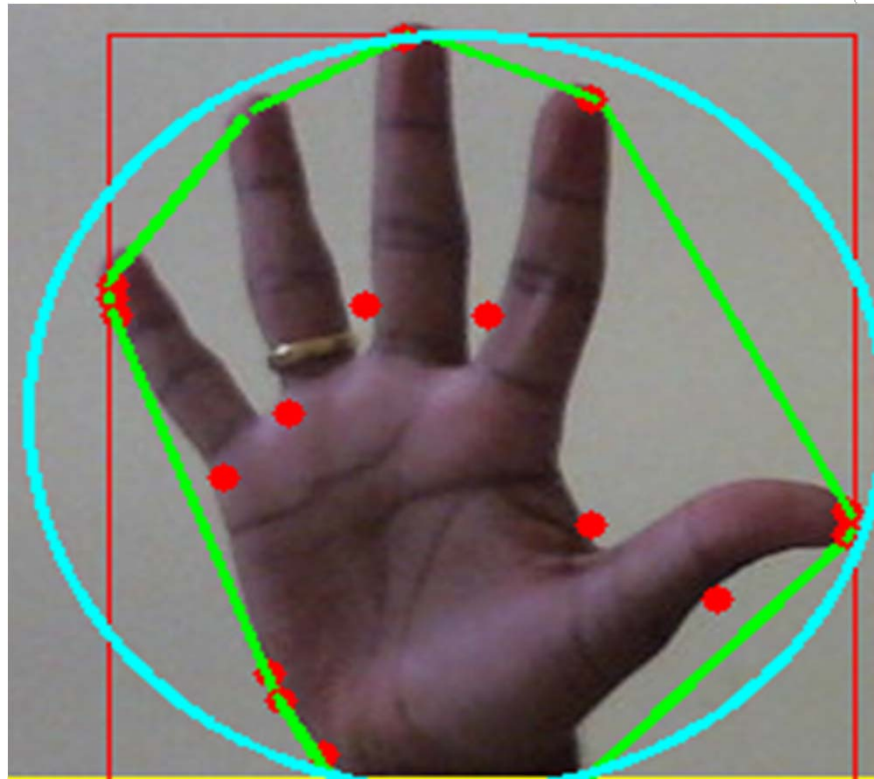
## Design Requirements

The recognition of symbolic letters from the National Institute of the Deaf (NID).



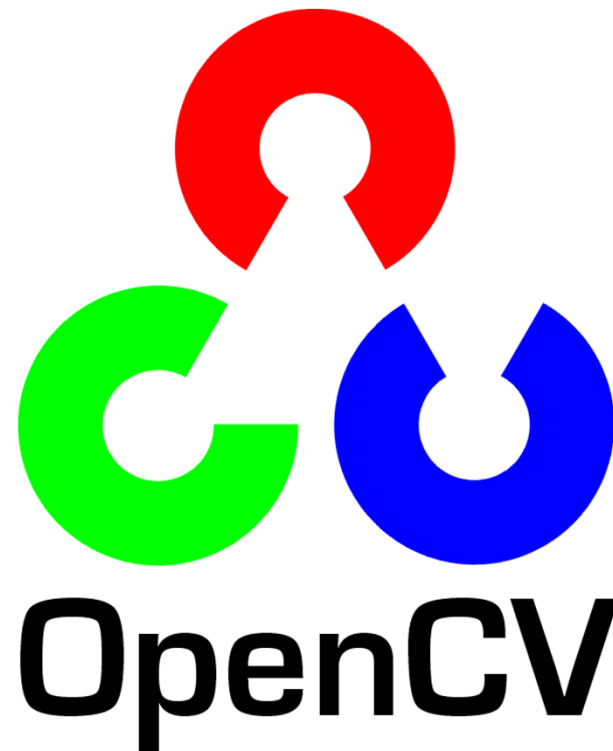
## Design Requirements

- Symbol recognition is done using Contour Analysis and Feature Extraction techniques.
- OpenCV contours algorithm techniques .
- The project is coded in Python



## Design Constraints

- No cost for software OpenCV (Open Source Computer Vision).
- No cost for Python 2.7
- The app will work on any smart phone device.



# Standards and Regulations

ADA Compliant – Adheres to ADA section 508, and WCAG 2.0 – Handicap Accessible

Large screen display and color compliant

Multimedia capabilities

Easy to navigate

Design using Accessibility Frameworks, text – to – speech, haptic (touch), and gesture technologies

Safe for all ages

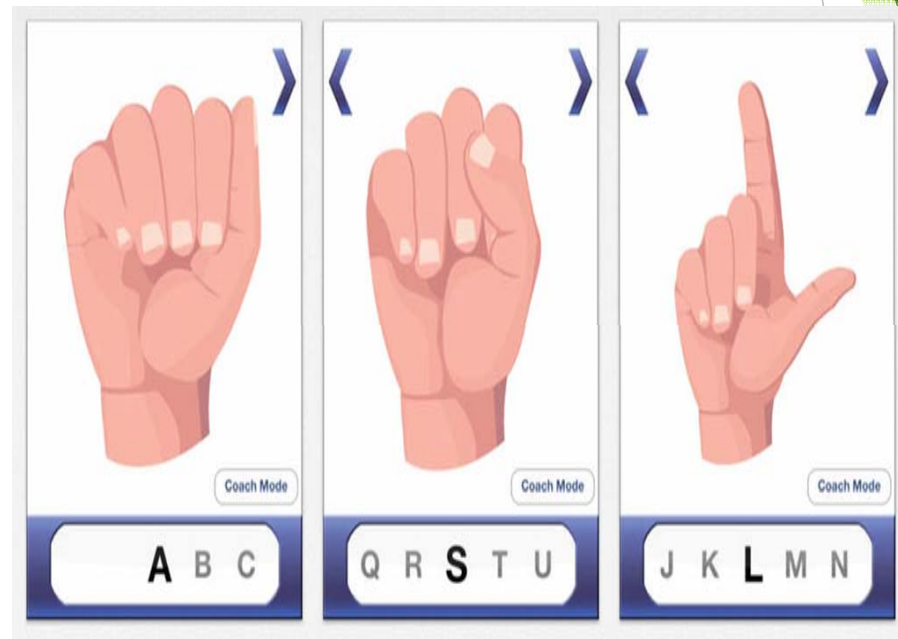
Legal – does not interfere with other apps and hardware.

# ASL Designed Devices

## Current State of Art

- ▶ Teaches Symbol Identification
- ▶ Video record with playback interpretation
- ▶ Early detection and warnings

## American Sign Language App

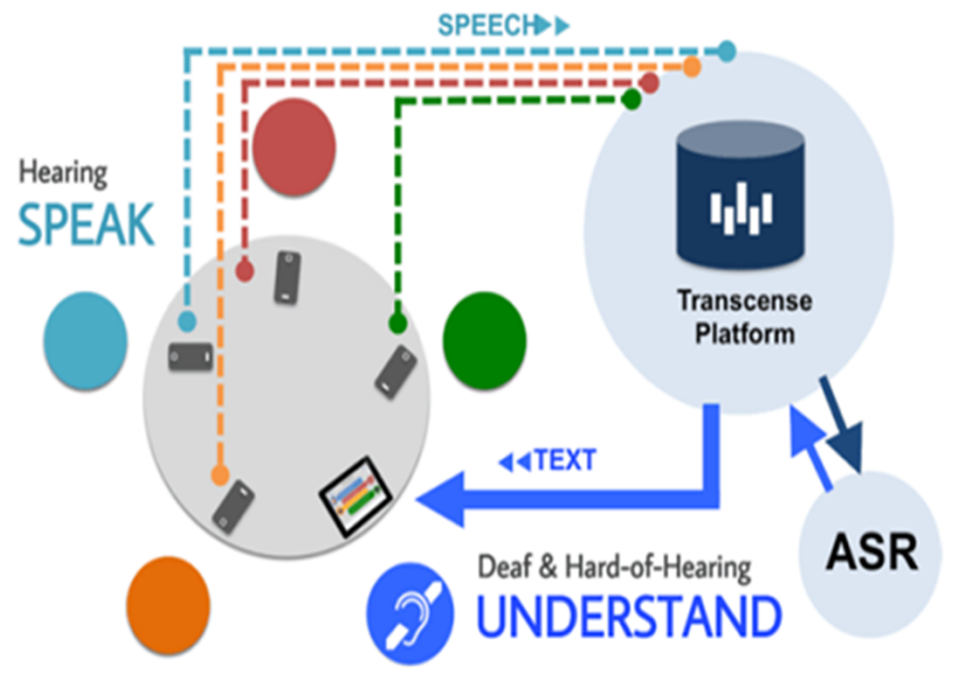


# ASL Designed Devices

## Current State of Art

- ▶ Individual recording devices
- ▶ Base station
- ▶ Automatic Speech Recognition
- ▶ Group Meetings

## American Sign Language System



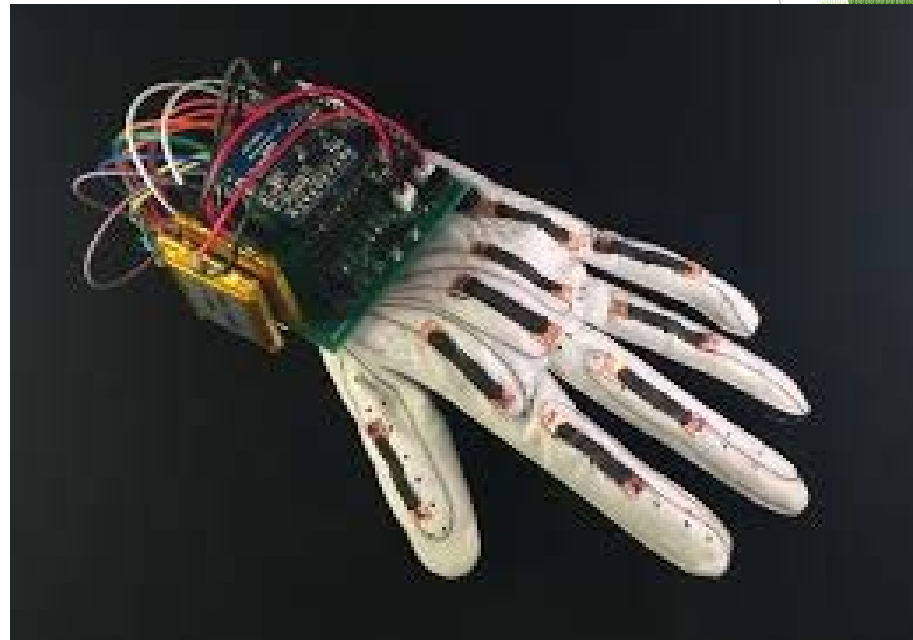


# ASL Designed Devices

## Current State of Art

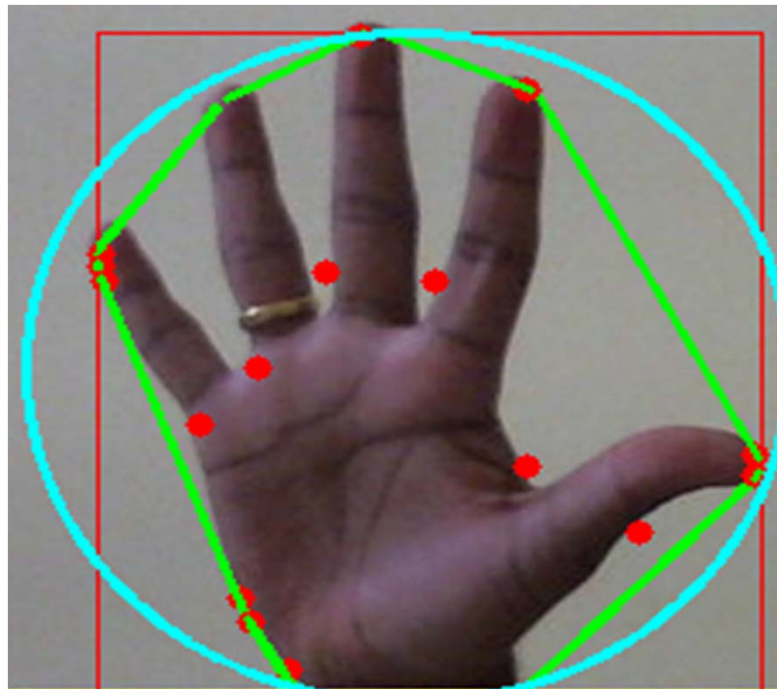
- ▶ Wirelessly translates the American Sign Language alphabet into text
- ▶ Controls a virtual hand to mimic sign language gestures

## American Sign Language Glove



## Solution Design

- The goal of this design is a program that extracts features of the human.
- Convert the images to text and audio.



# Implementation Process

- Use visually based interfaces (cameras).
- The human hand converted to digital representation by camera.
- The digital images are a matrix of scalar or vector values.



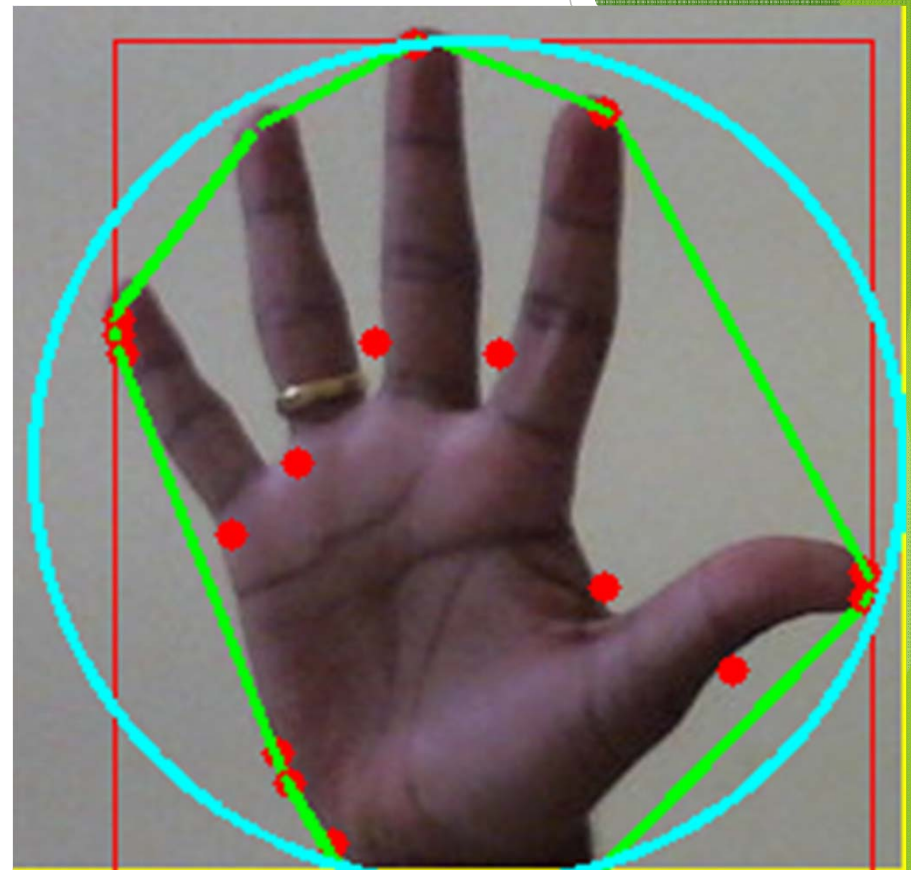
# Implementation Process

- The contour of an object is defined by a set of points.
- The OpenCV library use algorithms to place points around the contour of an object.
- These contours are then extracted.



# Implementation Process

- The points of the contours are enclosed in a n-dimensional polygon, also known as a hull.
- A Hull is a geometrical shape which is a concave or convex polygon.
- If you can draw a line inside to it's border it is concave and contain convexity defects.
- The human hand contain convexity defects between fingers.



Implementation Process cont.

### Threshold Image of The Letter "H"

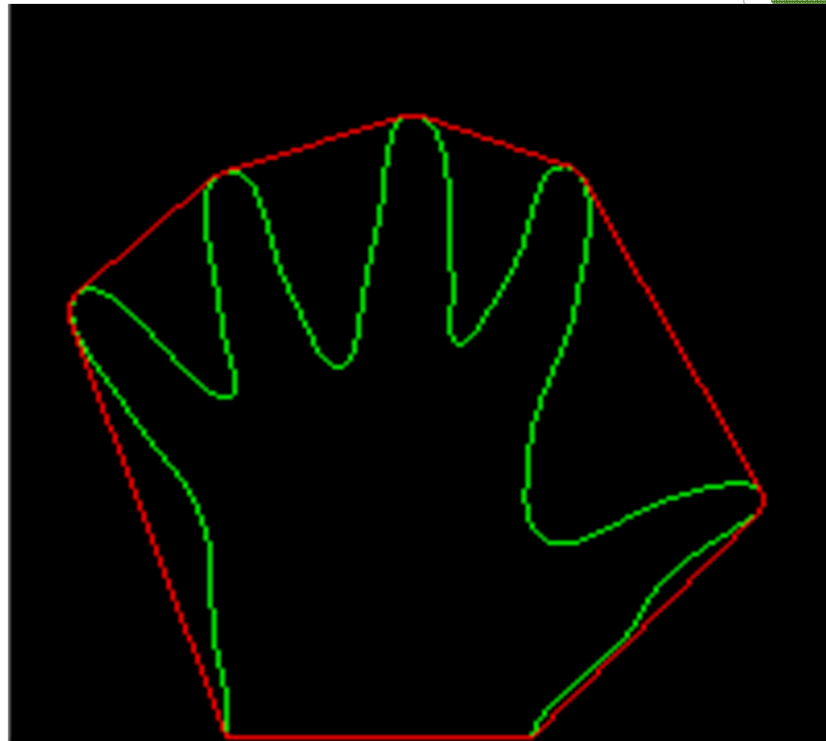
- A threshold image is needed for hand detection.
- The hand is isolated from background to the foreground.



Implementation Process cont.

### *Finding Contours*

- OpenCV contour functions identify the hand.
- An array of co - ordinates of the hand are returned.



Contour of Hand with Convex Hull Identification .

## Implementation Process cont.

### *Convex Hull and Convexity Defects*

- Manipulating the array of co - ordinates show the number of “Convexity Defects” .
- These convexity defects identify how many fingers are present.
- The angle of the hand and number of fingers present represent the symbolic letter.

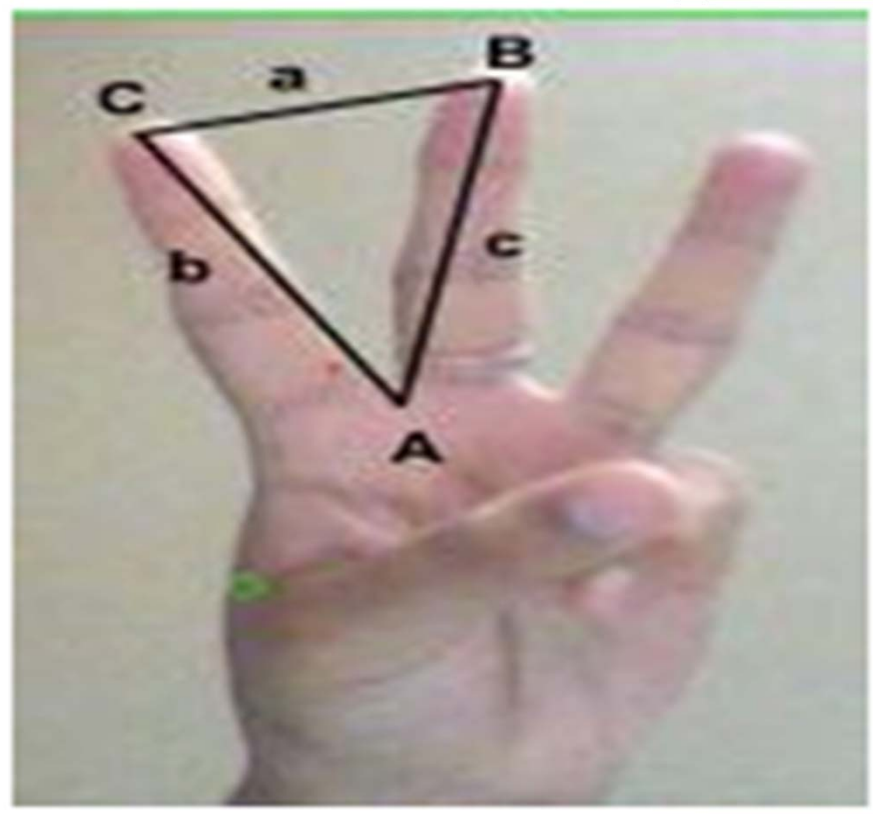


## Implementation Process cont.

### Convex Hull and Convexity Defects Calculations

- Angle 'a' is computed by the following formula.

$$a = \mathit{math.sqrt}((\mathit{end}[0] - \mathit{start}[0])**2 + (\mathit{end}[1] - \mathit{start}[1])**2)$$



## Implementation Process cont.

### Convex Hull and Convexity Defects Calculations

- Angle b and c are calculated in the same way.
- Then the Cosine rule is applied.

$$a^2 = b^2 + c^2 - 2bc \cos A$$

$$b^2 = a^2 + c^2 - 2ac \cos B$$

$$c^2 = a^2 + b^2 - 2ab \cos C$$

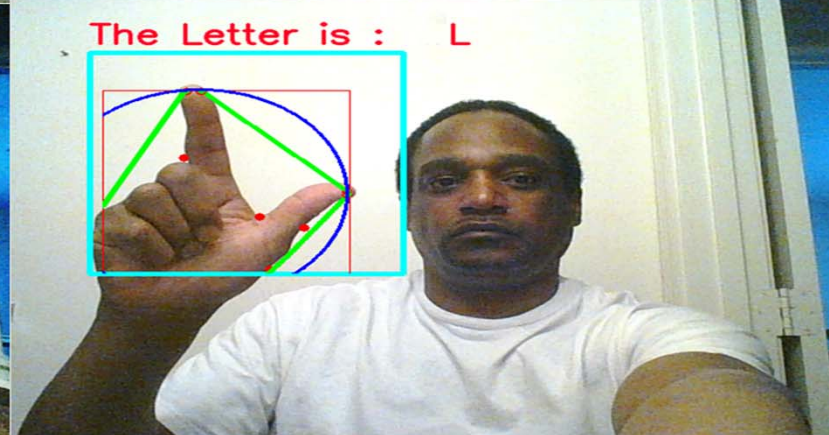
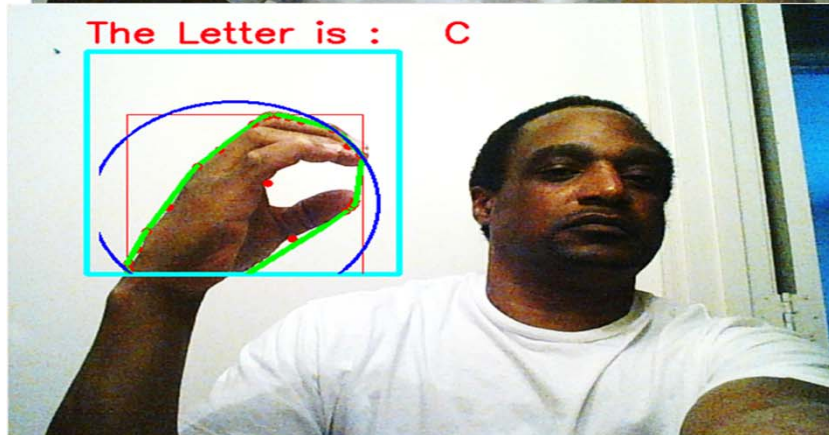
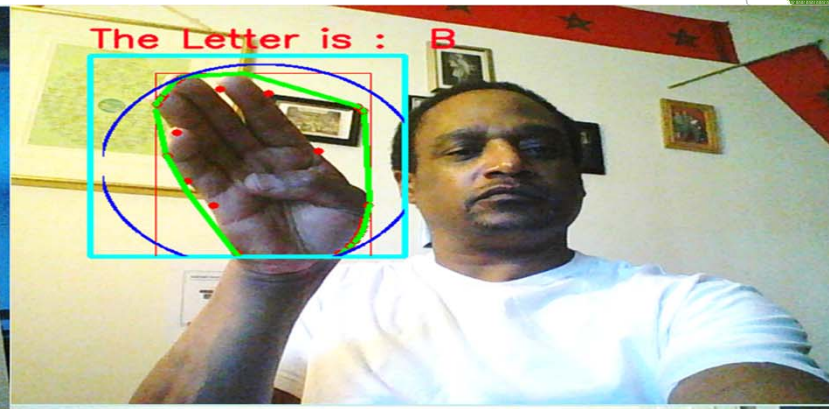
$$\cos A = \frac{b^2 + c^2 - a^2}{2bc}$$

$$\cos B = \frac{a^2 + c^2 - b^2}{2ac}$$

$$\cos C = \frac{a^2 + b^2 - c^2}{2ab}$$

# Implementation Process cont.

## The Identification of Symbolic Letters



## Conclusion

- ▶ The principal goal of this project is the recognition of American Sign Language Symbols.
- ▶ The extraction of features of the human hand.
- ▶ OpenCV and Python software was used.
- ▶ At present thirteen symbolic letters recognised by this technique.

Thank You!  
Questions!