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Visual Processing of Hand Motions and Gestures for Computing Input

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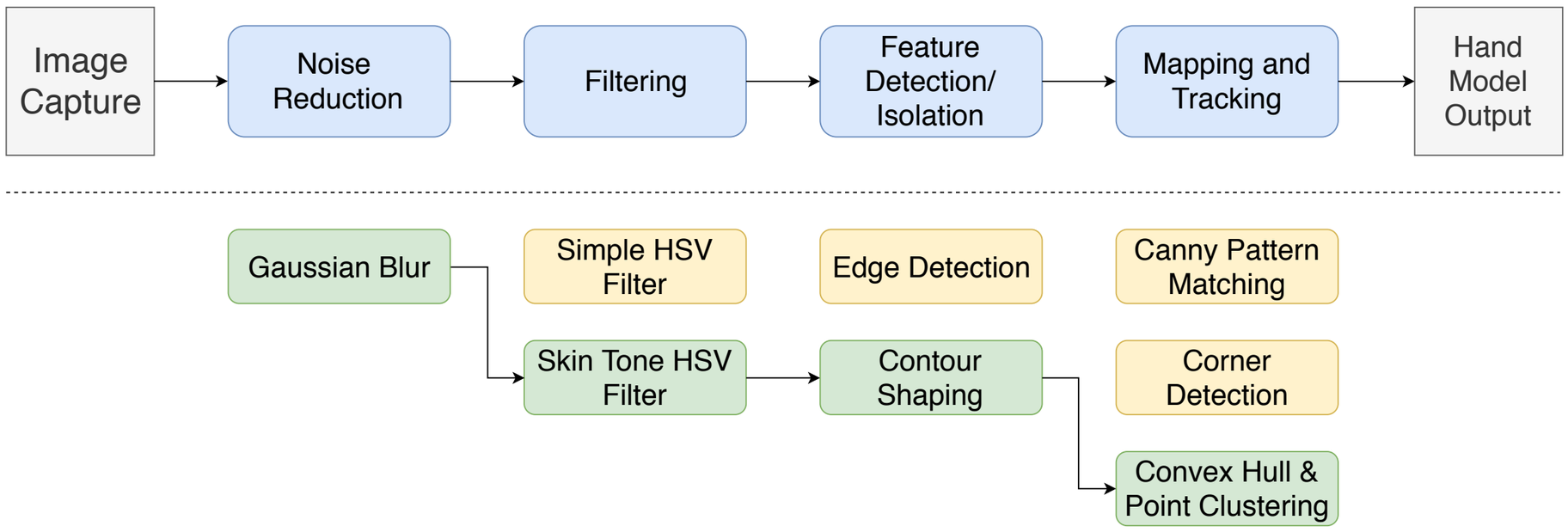


Introduction

Human computer interface technologies are generally limited in their approach to direct physical interaction. When a user needs to specify high precision movement in physical space, they need to learn how to use a joystick [1] or often counter intuitive input devices such as a mouse or trackball [2]. This can be overcome using a glove-based interface however these technologies can be prohibitively expensive [3]. This approach is proposed such that the user's hand is used as an input device through computer vision and image processing techniques, this will provide a reduction in humant training requirements at a low cost.

Objectives

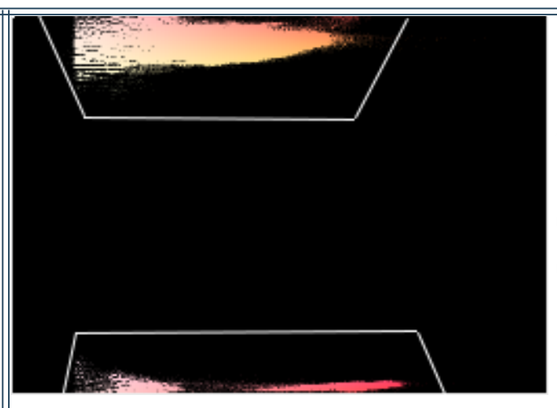
- Produce initial algorithms for noise reduction, filtering, basic feature detection and mapping
- Produce a solution for tracking on a variety of backgrounds in 2D space
- Produce solutions that increase accuracy of the system in a variety of lighting situations
- Optimise the system such that it can be run on a lower power system

Results

Positive accuracy: 100.0%
2663 total frames

Negative accuracy: 14%
1560 total frames

i9-9900K System (Desktop Workstation)	
Stage	**Time (ms)**
Noise Reduction	0.000
Filtering	3.008
Feature Detection/Isolation	0.074
Mapping and Tracking	0.394
Total System	**3.476**
i7-3820QM System (MacBook Pro 2012)	
Stage	**Time (ms)**
Noise Reduction	0.000
Filtering	7.946
Feature Detection/Isolation	0.092
Mapping and Tracking	0.807
Total System	**8.845**



Filtering

A library of hands was processed and the common colourspace determined for the HSV multi-stage filter.

Allowing for:

- Robust filtering in a variety of lighting conditions
- Various skin tones to be processed

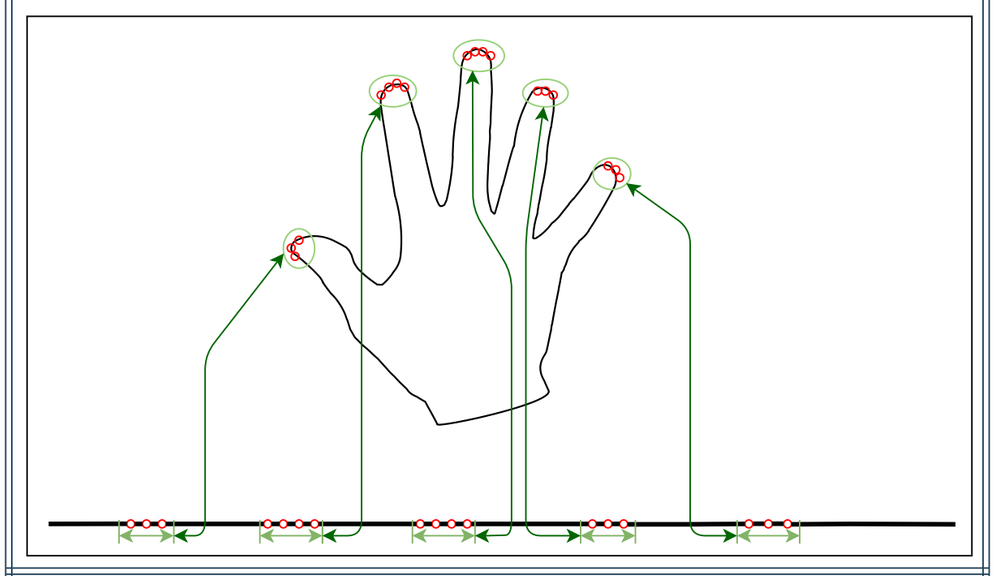
Feature Detection/Isolation

Using the masked image from the filtering a contour outline is produced. The minimum sized box is then fitted to this outline and this is considered the identified hand.

Mapping and Tracking

The contour outline is used to produce a convex hull (white line with yellow points). This represents the extremities of the hand with clusters of points.

The point clusters are then grouped based on their location on the hand outline and these final points provide consistent tracking markers.



References

[1] Pierre Allemann, "Joystick Interfaces Are Not Suitable for Robotized Endoscope Applied to NOTES," Surgical Innovation, vol. 16, no. 2, pp. 111-116, 2009.
[2] Bernd Fröhlich, "On 3D Input Devices," IEEE Computer Graphics and Applications, vol. 06, pp. 15-19, 2006.
[3] "Your hand as an input device," [Online]. Available: http://www.doc.ic.ac.uk/~nd/surprise_97/journal/vol1/ncp/