



# Neven Vision

## Mobile Visual Search

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# Why Visual Search for Mobile Phones?

## Camera Phones are an Enormous Market

- More cameras are bundled with mobile phones than sold standalone or bundled with any other device
- 365 million units shipped in 2005; 903 million units forecast to ship in 2010
- 87 percent of all handsets shipped in 2010 will be camera phones
- By 2010 camera phone users will have captured a total of 228 billion images





# Neven Vision

## Visual Search Market Activities



### i-Scout™

From Mobile Marketing to Visual Search



### Mobile Identifier™

In-Field Multi-Biometric Identification



### Application Development

Photo Sorting, Visual Effects, etc.



# i-Scout™

## Visual Mobile Search



# i-Scout

## Visual Mobile Search

1. Snap a photo with a camera phone

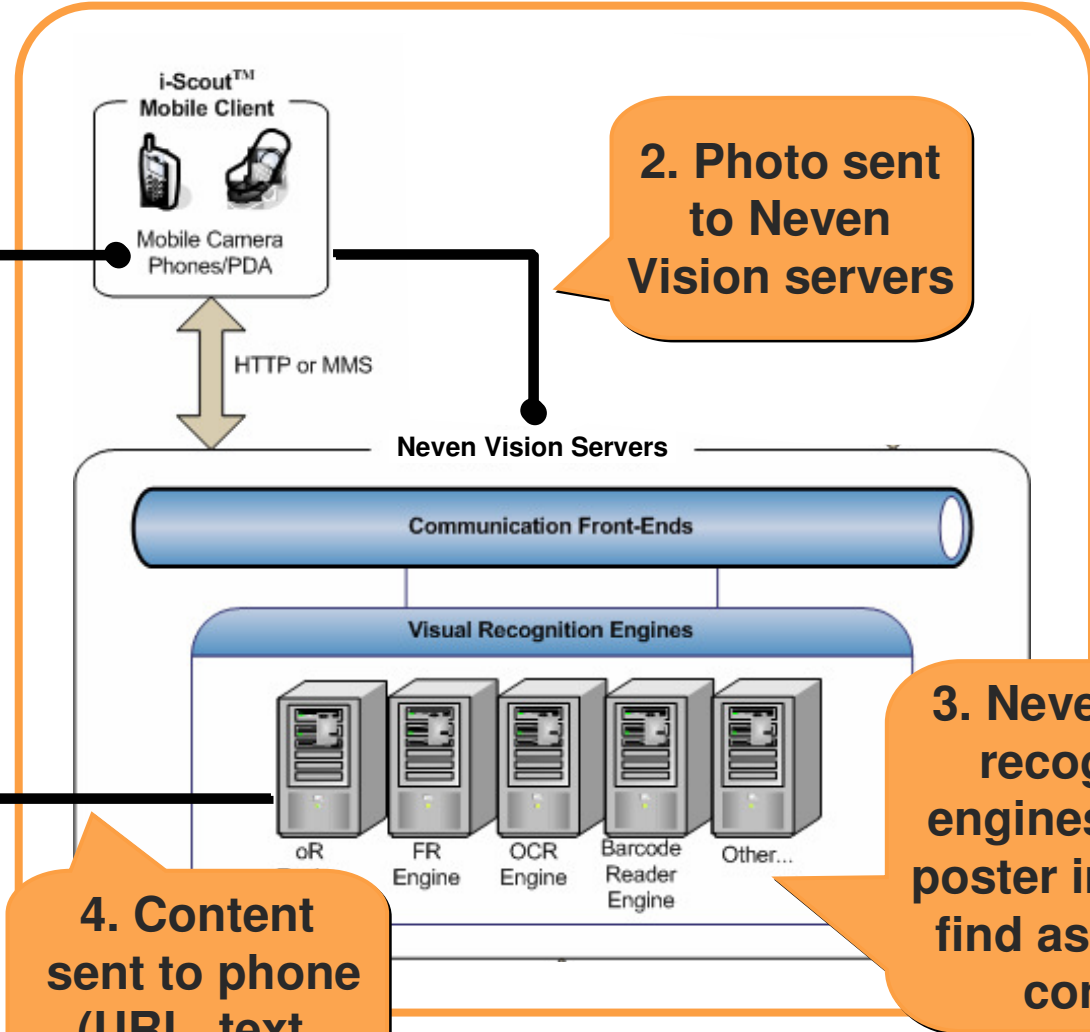
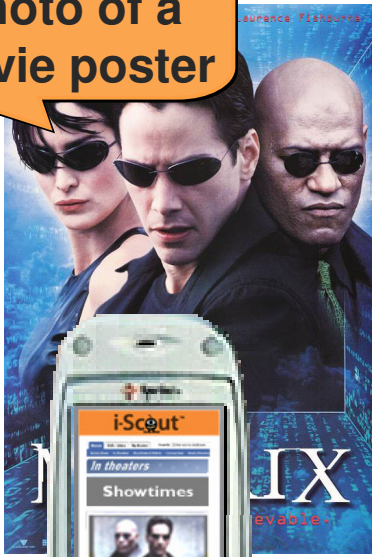
2. Receive relevant content to your phone





# i-Scout Retrieving Mobile Content

1. Snap photo of a movie poster



2. Photo sent to Neven Vision servers

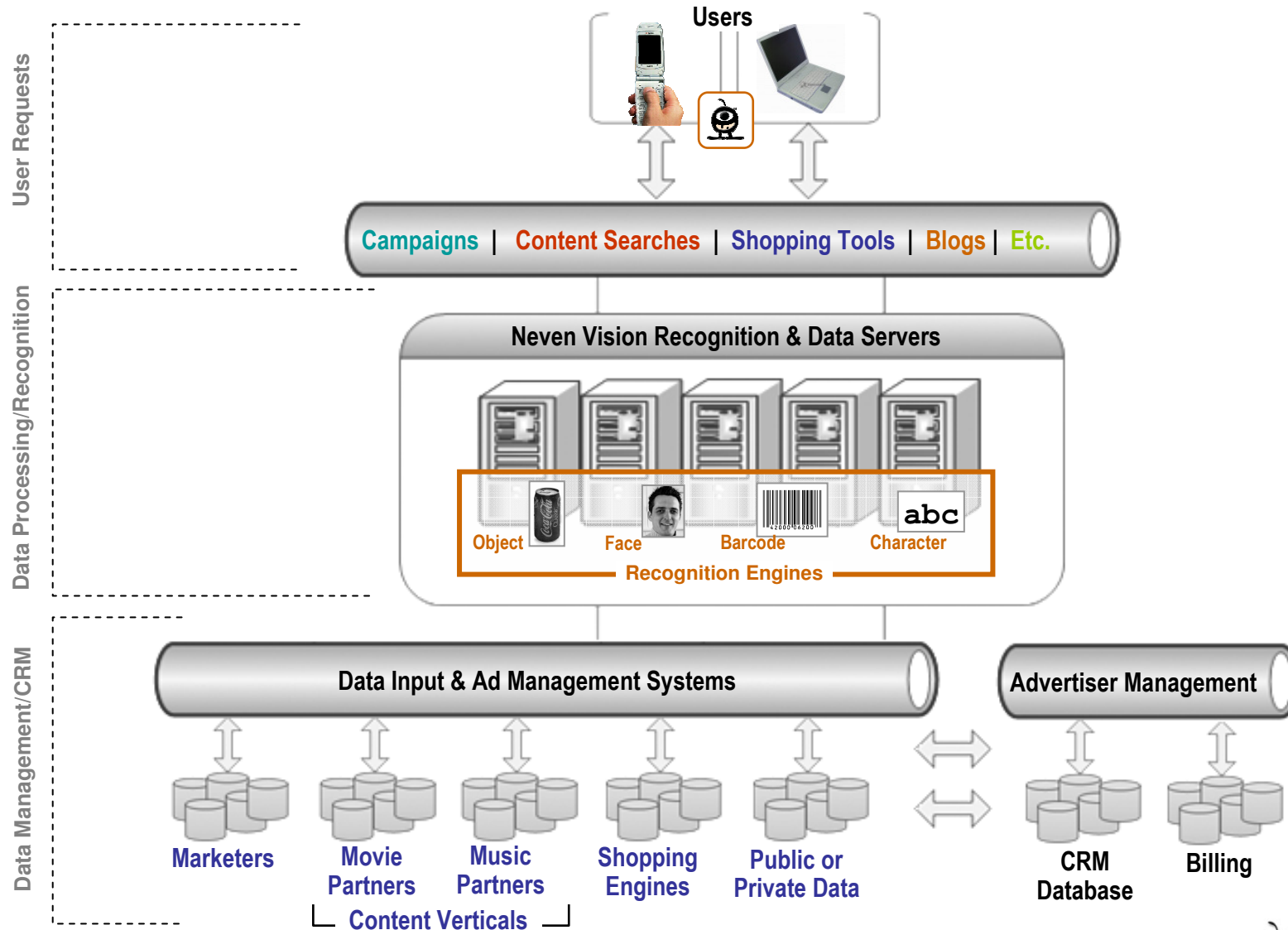
3. Neven Vision recognition engines identify poster image and find associated content

4. Content sent to phone (URL, text, sound, etc.)





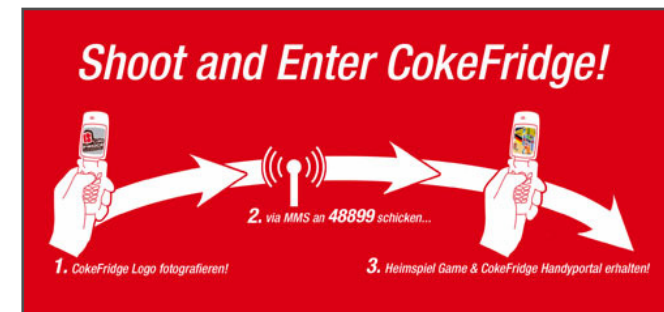
# Building a Visual Search System





# i-Scout Value Proposition for Mobile Marketing

- Branding and direct marketing with performance feedback
  - Connect to customer at moment of interest and create lasting connection
  - Rich, multi-channel, highly interactive, repeated/reinforcing impressions
  - Customer action to initiate
  - Get tracking data, marketing feedback
- Fun, active, and highly convenient experience for consumers
- Higher click rates than in comparable SMS campaigns







# Image-Based Search: Mobile Advertising

## Instantaneous and Interactive





# Mobile Companion: Travel Guide

1



Picture of a place of interest

2



- Read history of the site
- Find admission prices & tour times
- Schedule a tour



# Image-Based Search: Product Inquiry

Catering to the Mobile Lifestyle

1



Picture  
of Car

2



Receive product information  
Customize your options  
Get a price quote  
Receive purchase rewards /  
feature upgrades



# Mobile Companions: Movies, Music and Games

1



Picture of  
movie poster

2



- Read reviews
- See showtimes and purchase tickets
- Watch the trailer
- Download ringtones



# Mobile Identifier™

## In-Field Multi-Biometric Identification



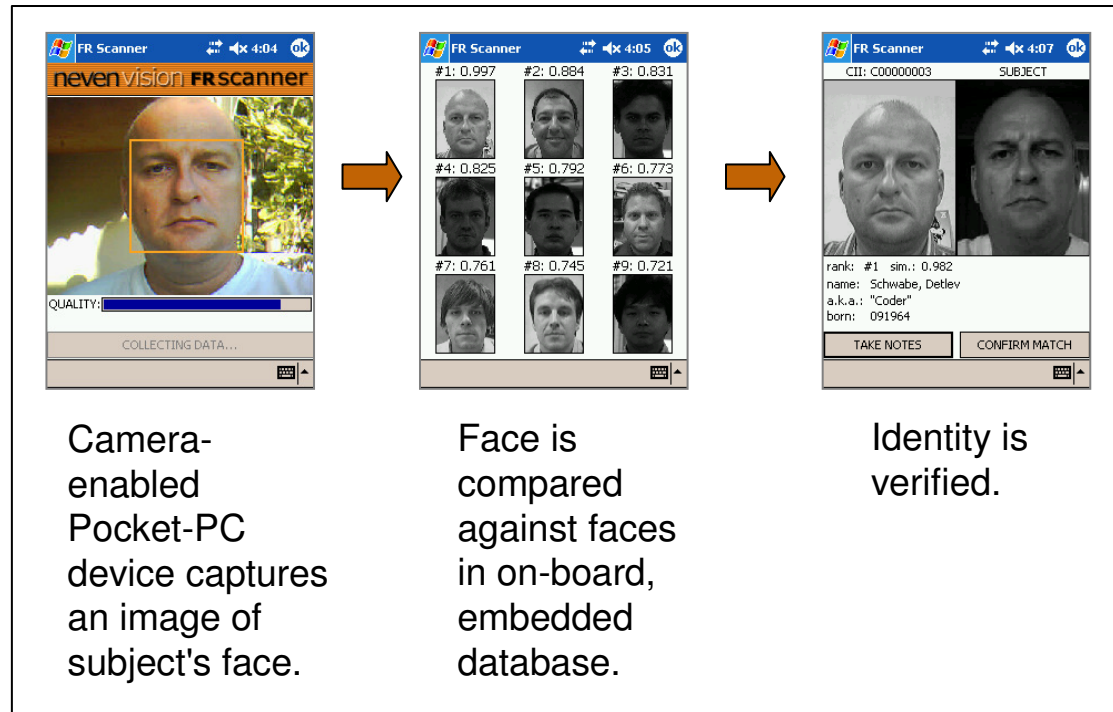


# Mobile Identifier™

## Security Product Fully Developed and Field Tested

*"The Mobile Identifier platform is providing our officers with critical identity information at their fingertips... Every police officer needs to have one on his belt."*

*Commander Charlie Beck  
Los Angeles Police Department*

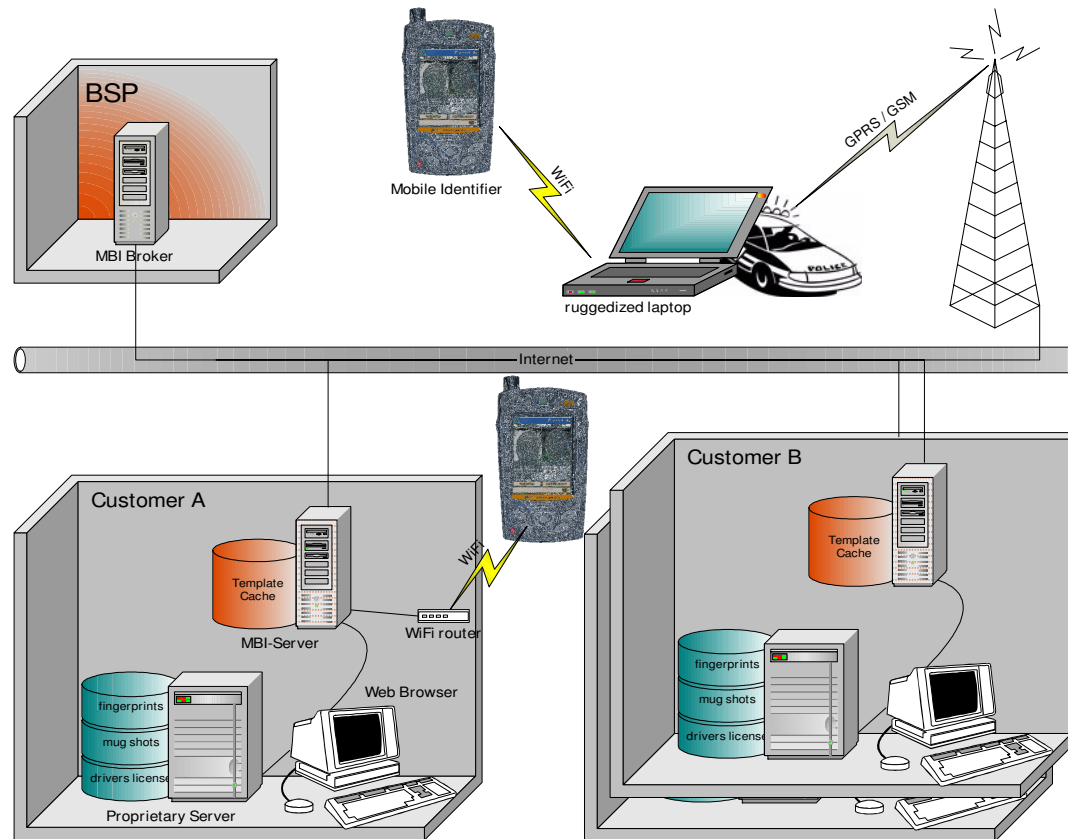






# Mobile Identifier™

## In-Field Identification with Multi-Biometrics

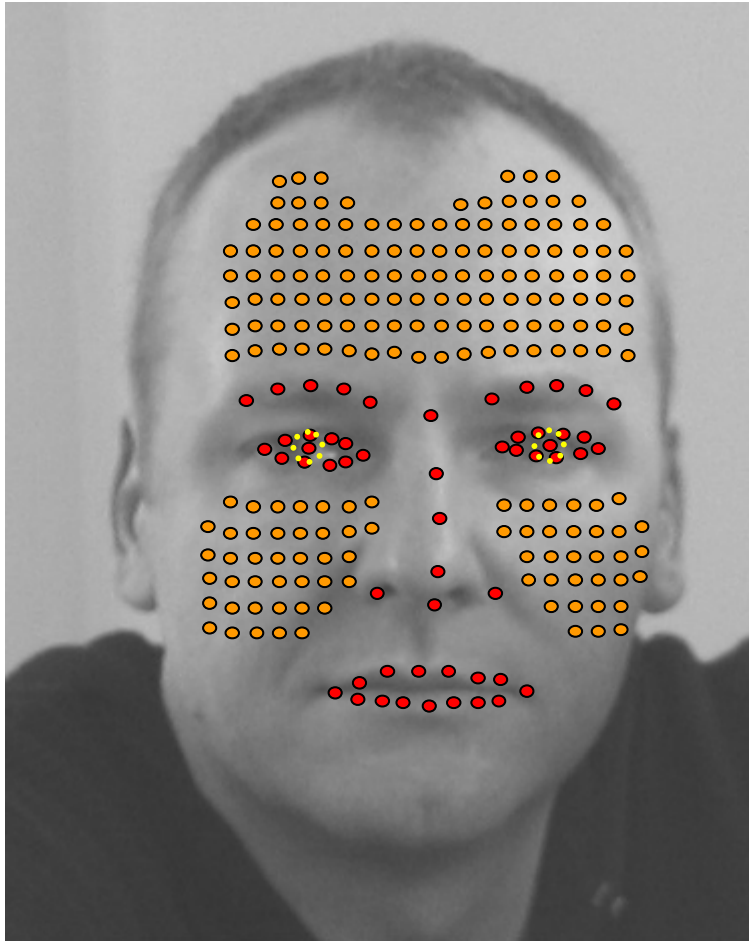


- Mobile device for in-field identification using multi-biometrics
- Face and finger biometrics
- Version 2.0 integrates skin and iris recognition (SIMBA)
- Device holds up to 200,000 records locally
- Allows for wireless WAN connectivity
- Successfully field tested with numerous organizations
- High demand for Mobile Identifier in the law enforcement, military and corporate security markets.
- Acts as force multiplier



# Secret Sauce: SIMBA™

## Single-Image Multiple Biometric Analysis



- 2D high resolution images allow the seamless integration of **Facial Feature, Skin Texture** and **Iris** Analysis into a single recognition engine
- Required resolution in pixels between the eyes:
  - Facial feature >25\*
  - Skin texture >100\*
  - Iris >600\*(6 Megapixel Camera)
- Neven Vision's Facial Feature Tracking is the necessary base technology for SIMBA.

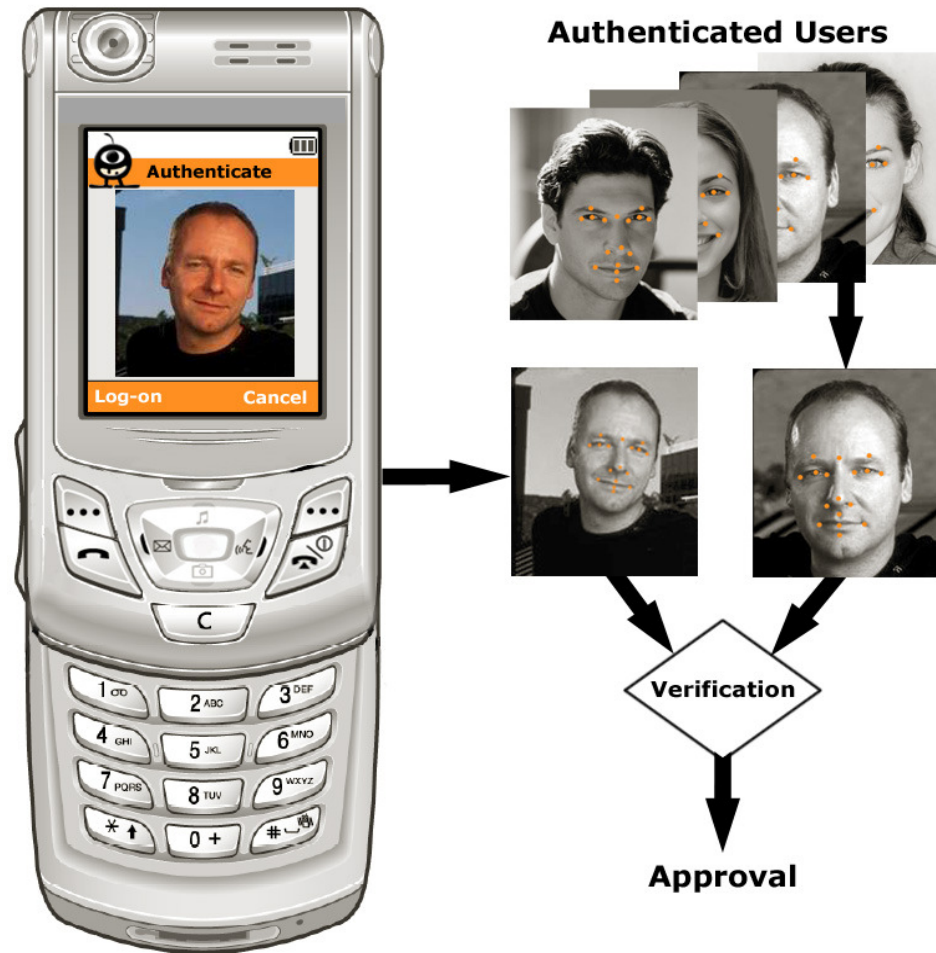
\*Numbers assume a sharp image.



# Mobile-i Face Recognition

## User Authentication

DoCoMo winter models 2005 are equipped with facial biometrics.



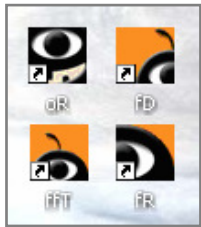


# Neven Vision Technology Overview



# Neven Vision Core Technology

## A Broad Set of Integrated Recognition Modules



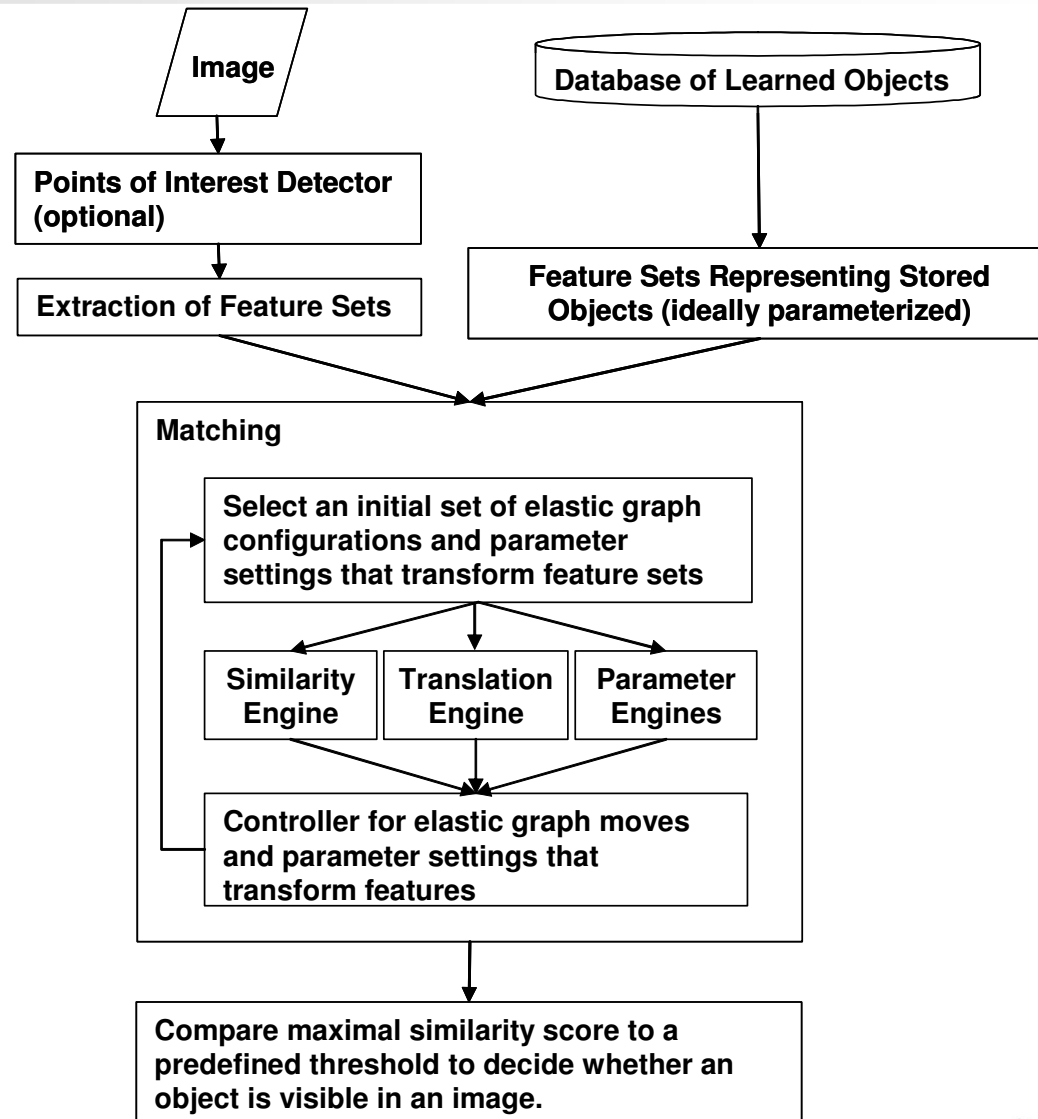
Neven Vision

Module	Technology	Applications
<b>fD</b>	Face Detection	photo sorting, automatic camera control: focus, zoom
<b>ffD</b>	Facial Feature Detection	facial gesture recognition, selection of optimal picture, redevye elimination,
<b>ffT</b>	Facial Feature Tracking	video special effects, character animation, video games, gaze tracking and drowsiness detection
<b>fR</b>	Face Recognition	physical and logical access control, surveillance systems, identity verification, photo sorting
<b>oR</b>	Object recognition	visual mobile search, security applications include tattoo, stolen artwork and driver license recognition
<b>BCR</b>	Bar Code Recognition	visual mobile search, contains licensed technology
<b>OCR</b>	Character Recognition	visual mobile search, contains licensed technology





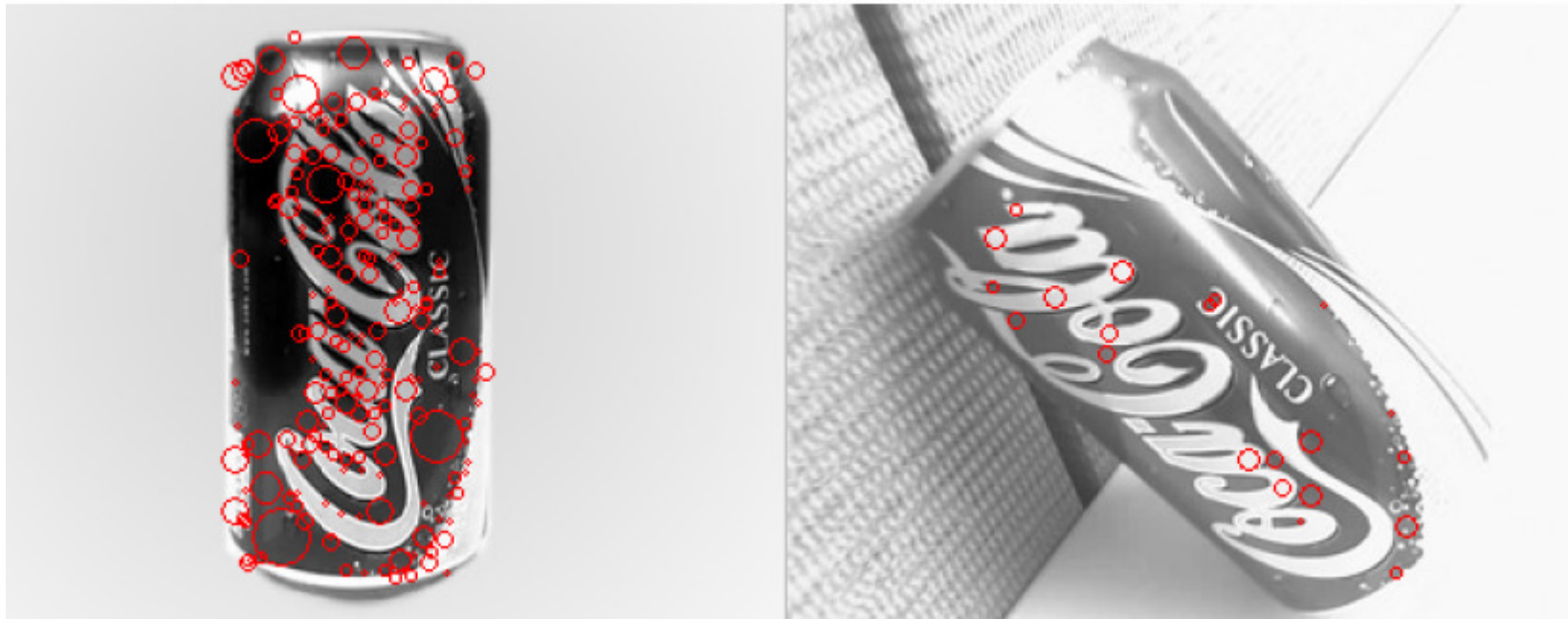
# Overview of Recognition Engine







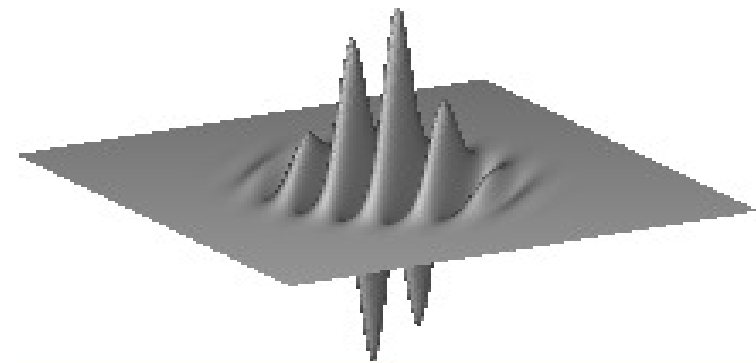
# Interest Point Detection





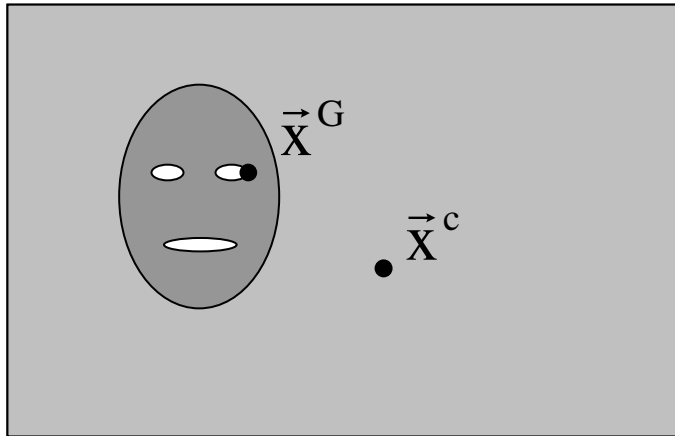
# Choice of Features

- Multiple feature types are employed concurrently
- A corner stone feature are Gabor Wavelets
- Motivation for the use of Gabor Wavelets
  - Good experimental results
  - Favorable signal theoretic properties
    - Optimal localization in space and frequency domain
    - Amplitude is invariant under small translations
    - Phase information for precise localization
  - Biologically plausible





# Finding of Corresponding Points

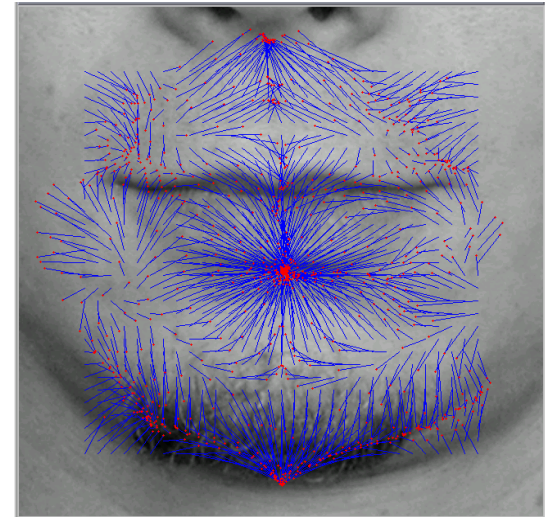
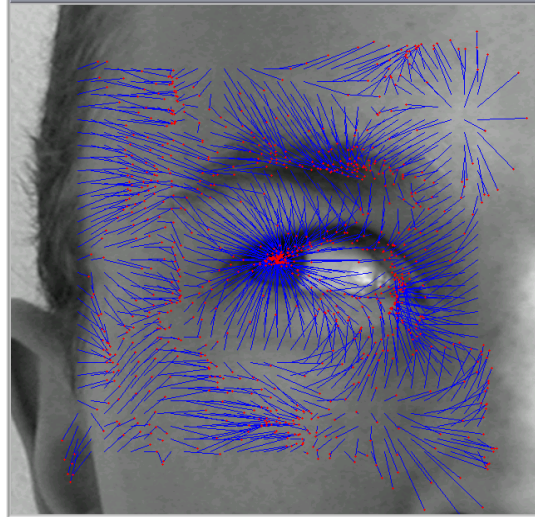
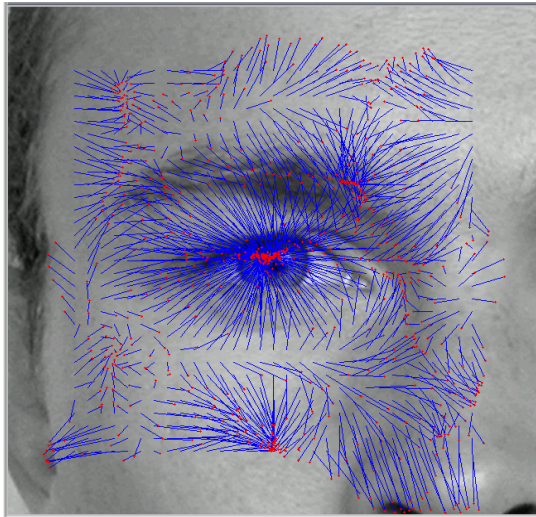


1. How similar is the feature  $\vec{f}(\vec{x}^c)$  extracted at  $\vec{x}^c$  to a set of sample features  $\{\vec{f}^G(\vec{p}_i)\}$ ?
2. How different is  $\vec{x}^G$  and  $\vec{x}^c$ ?
3. Which parameters  $\vec{p}$  characterize  $\vec{f}(\vec{x}^c) = \vec{f}(\vec{x}^c, \vec{p})$ ?

Only Neven Vision employs dedicated engines to address questions 2) and 3).



# Translation Engine



A neural network based translation engine proved superior over phase based translation engine but is less general.



# Experimental Setup to Study Feature Manifolds



Light Stage 2.0  
by Paul Debevec

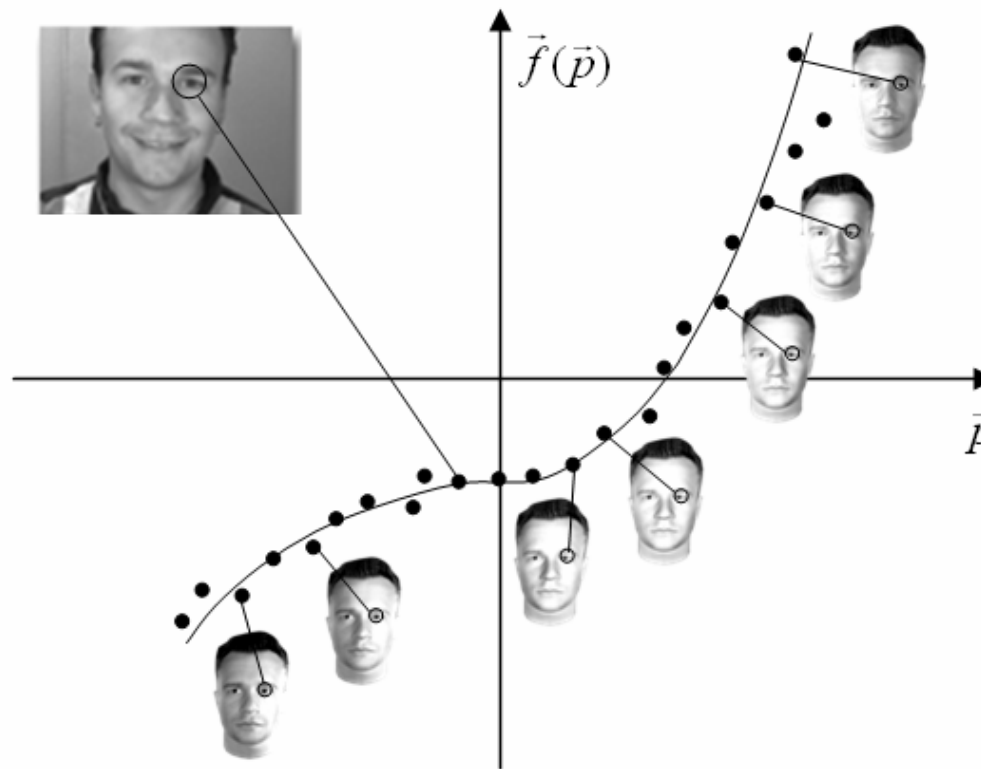


3 Dof Robotic Arm  
by Benahm Salemi



# Parameter Engine

Using parameterized feature sets is key to achieving illumination and pose invariance.







# Mobile Machine Vision

## Conclusions

- Camera phones constitute a large and fast growing market.
- Image recognition forms the basis of new services that will become pervasive.
- Machine vision enables broad range of services: from identity management via visual search to entertainment applications