The UK's European university

University of Kent

INTERACTIVE EVOLUTIONARY GENERATION OF FACIAL COMPOSITES FOR LOCATING SUSPECTS IN CRIMINAL INVESTIGATIONS/

Dr Stuart Gibson (speaker) & Dr Chris Solomon
School of Physical Sciences, University of Kent, UK.
S.J.Gibson@kent.ac.uk

Background

- Facial composite system:
  - Tool for creating a **likeness to a suspect's face** based on an eyewitness' description.
  - Used by the majority of **police** services in the UK and used in most other countries.
  - Sometimes only tool available to **locate** suspect.

Feature based systems

- Likeness to suspect constructed by piecing together individual facial features.

Limitations of feature based systems

- Humans are **poor** at **recall** and description (but **good** at **recognition**)
- Psychological studies show we recognise faces **holistically** not as a sum of individual facial features (Tanaka,1993).
- Feature based approach not well suited to global transformations (e.g. increasing perceived age)
- Artistic skill required to add enhancements.

Features vs whole

- It’s impossible to discern any details in these facial features.
- But recognition is still possible.

Time for a different approach

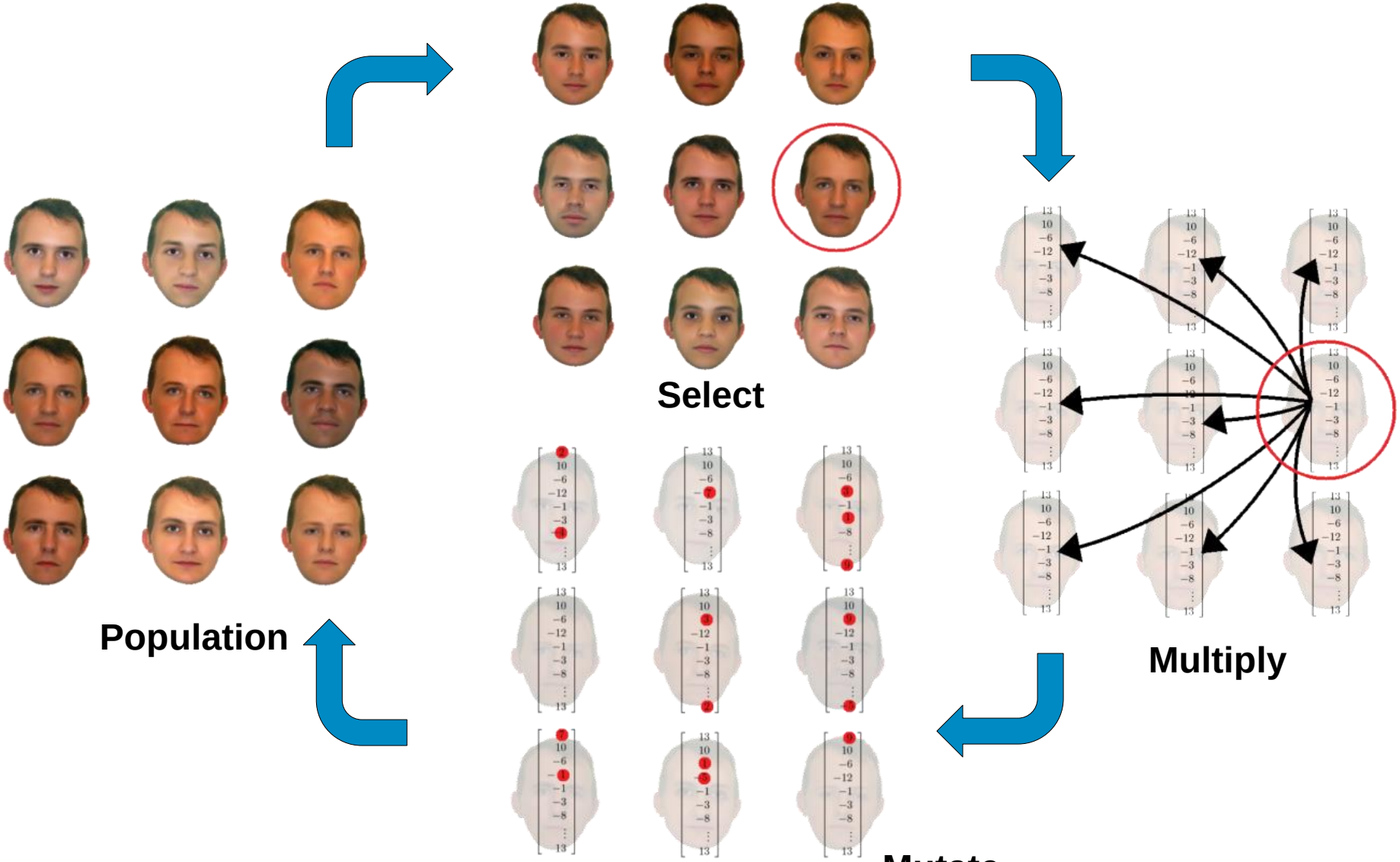
- EFIT-V (EFIT6) is a holistic composite system – used by the majority of UK police and in many other countries.
- Based on whole face recognition not feature recall.

Our method is ‘holistic’ (i.e. whole face)

- Training sample of images – dimension reduction using principle component analysis (PCA).
- Any face can be approximated by a vector of numbers (dimension << number of pixels).
- Iterative search using **evolutionary algorithm** (Gibson, 2003).
- Similar idea to DNA - Vector = **genotype,** face image = **phenotype**.

$$\begin{bmatrix} 4 \\ 1 \\ -6 \\ -5 \\ 4 \\ -9 \\ 7 \\ \vdots \\ -7 \end{bmatrix}$$

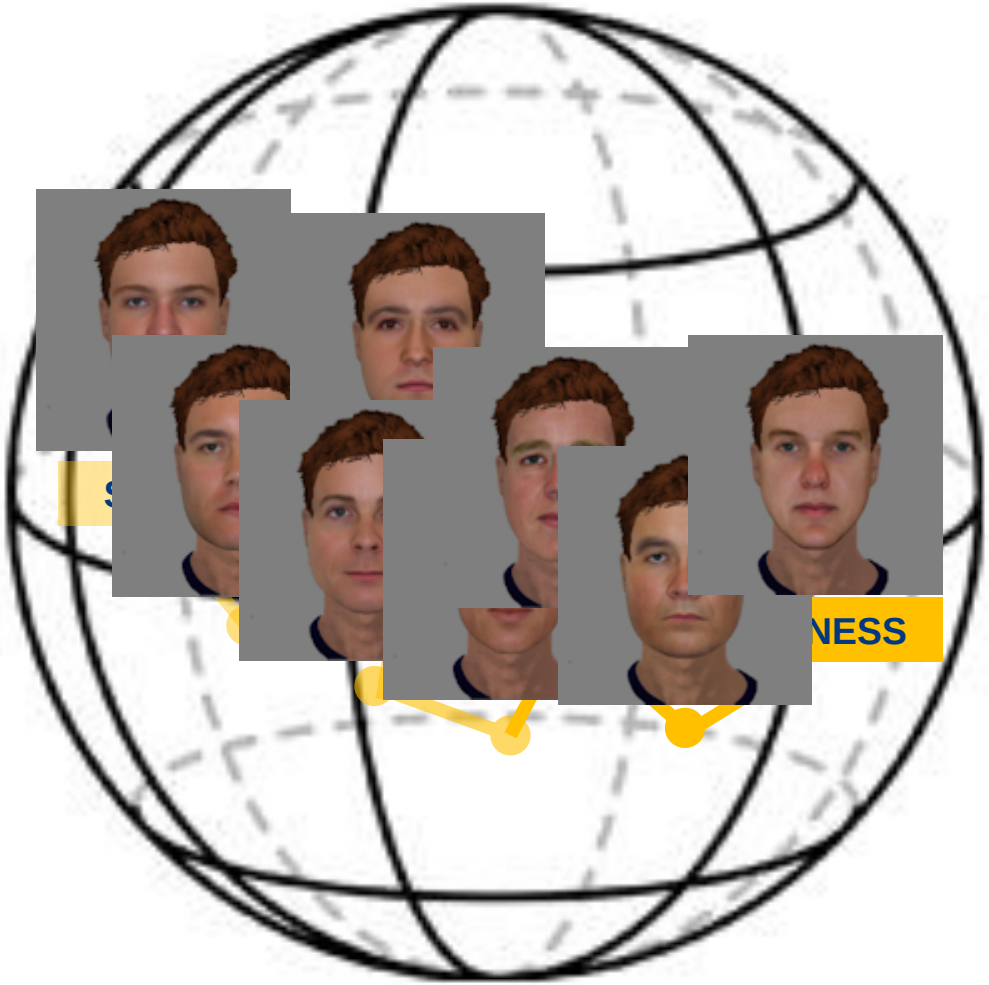
Our method is ‘holistic’ (i.e. whole face)



University of Kent

Face-space search

- Alternatively, can consider the problem of creating a likeness to the suspect as a **multi-dimensional search problem**.



Simplistic search-space representation

EFIT6 Software demo

EFIT-V Upper bound on accuracy

- Target

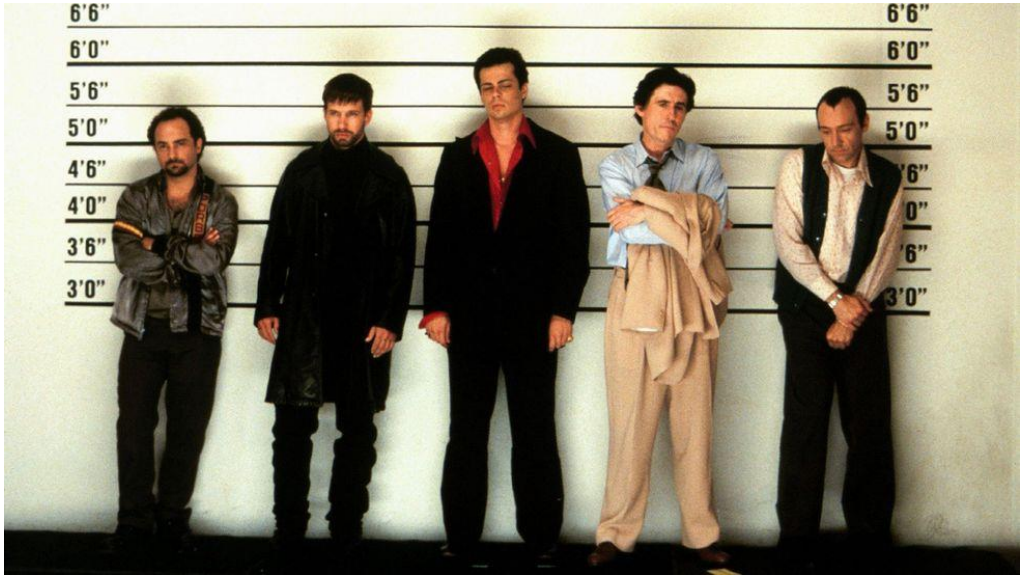
- ‘Portrait’ composite image

2014.12.01_19.57.33_007

EFIT-V Typical accuracy composites

Studies on EFIT-V composite images

- Composite creating participants were found to **1.5x more likely** to correctly identify a target face from a police **line-up** than control participants (Davis, 2014).



- **Morphs** of 4 composites produced by different witnesses (between-witness morphs) were judged better likenesses and were more **frequently named by participants** who were familiar with the target faces than were morphs of 4 composites produced by a single witness (within-witness morphs) (Valentine, 2010).

Current & future work

Improving cyber security using realistic synthetic face generation

- Collaborative project between University of Haifa and University of Kent (UK).
- The work plan comprises a novel programme of research that questions the uniqueness of facial identity and investigates the use of computer generated face imagery in the area of cyber security.
- Investigators
  - Rita Osadchy (Haifa)
  - Orr Dunkleman (Haifa)
  - Julio Hernandez-Castro (Kent)
  - Stuart Gibson (Kent)
  - Chris Solomon (Kent)

Privacy issues relating to individuals in the training set

- Face model generates new instances of faces as linear combinations of training images.
- What are the implications for individuals in the training set?
- Aim to show that the face model entropy is sufficiently high to avoid legalistic issues and wrongful arrest.

Bibliography

- Davis, Josh P., Stuart Gibson, and Chris Solomon. "The Positive Influence of Creating a Holistic Facial Composite on Video Line-up Identification." *Applied Cognitive Psychology* 28, no. 5 (2014): 634-639.
- Mist, Joseph J., Stuart J. Gibson, and Christopher J. Solomon. Comparing Evolutionary Operators, Search Spaces, and Evolutionary Algorithms in the Construction of Facial Composites. *Informatica* 39, no. 2 (2015) 135-145.
- Solomon, Christopher J., Stuart J. Gibson, and Joseph J. Mist. "Interactive evolutionary generation of facial composites for locating suspects in criminal investigations." *Applied Soft Computing* 13, no. 7 (2013): 3298-3306.
- Valentine, Tim, Josh P. Davis, Kate Thorner, Chris Solomon, and Stuart Gibson. "Evolving and combining facial composites: Between-witness and within-witness morphs compared." *Journal of Experimental Psychology: Applied* 16, no. 1 (2010): 72.
- Gibson, Stuart J., Christopher J. Solomon, and Alvaro Pallares Bejarano. "Synthesis of Photographic Quality Facial Composites using Evolutionary Algorithms." In *BMVC*, pp. 1-10. 2003.
- Tanaka, James W., and Martha J. Farah. "Parts and wholes in face recognition." *The Quarterly journal of experimental psychology* 46, no. 2 (1993): 225-245.

ACKNOWLEGEMENTS/

- Engineering and Physical Research Council EPSRC Grant REF EP/M013375/1
- Israel Ministry of Science Technology and Space MOST
- VisionMetric Ltd (developers and distributers of EFIT-V & EFIT6)

- Contact: s.j.gibson@kent.ac.uk

www.kent.ac.uk