Human Augmented Cognition based on Human and Environment Understanding

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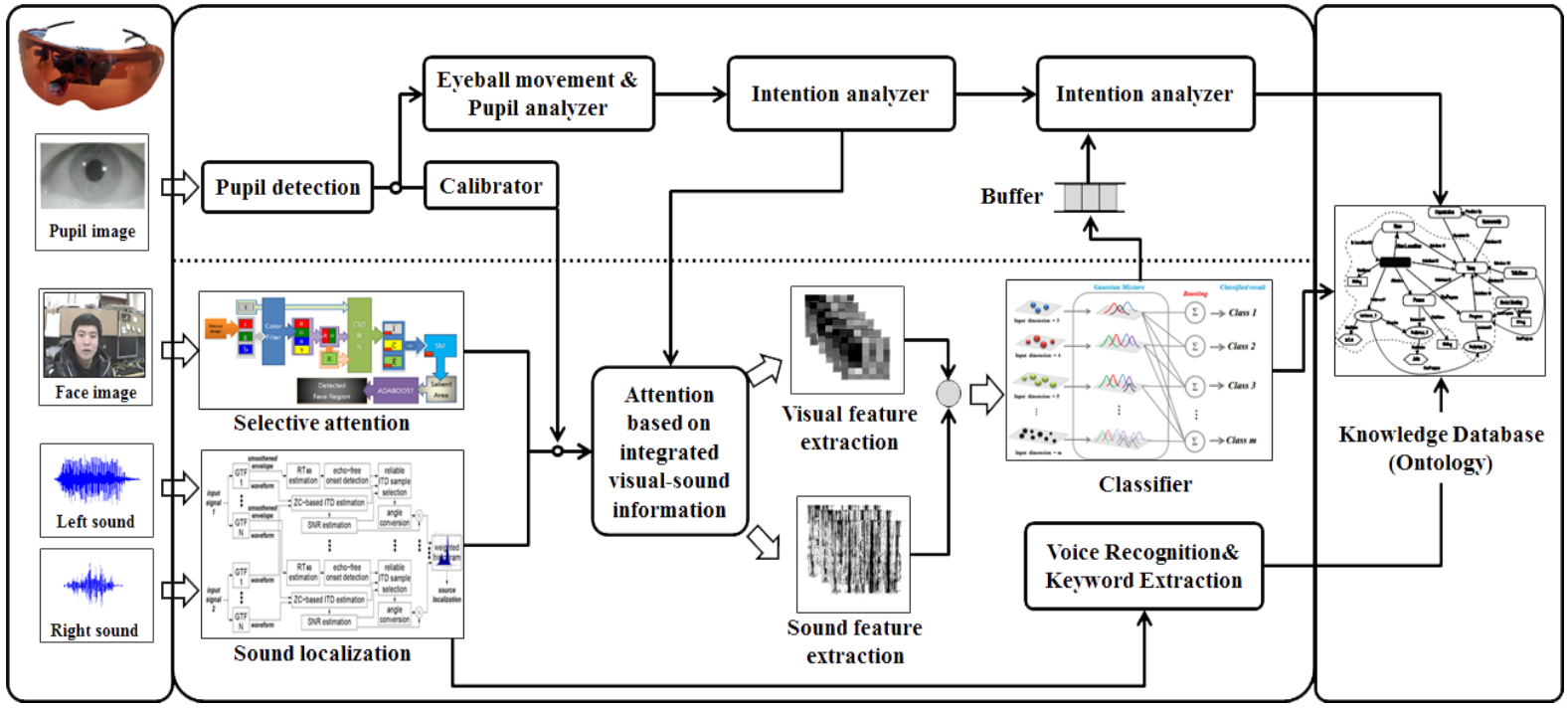
Proposed model of augmented cognition system

- Development of human augmented cognition system aims to actively provide appropriate information to normal and abnormal people.

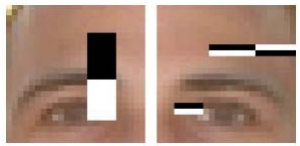
- Basically, this system has 3 purposes memory capacity expansion, decision support and inattention blindness compensation, for the cognition augmentation.



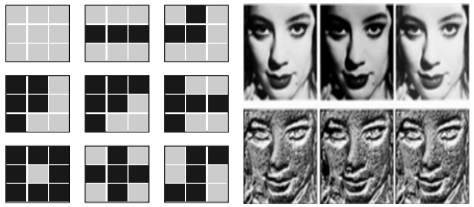
[Overall system block diagram]

Environment understanding : Visual feature extraction

- Architecture of cascade classifier based on the MCT



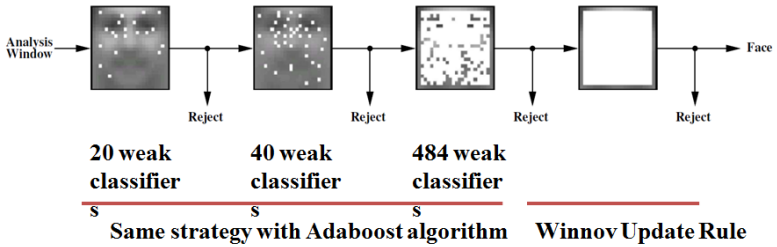
[Haar Feature]

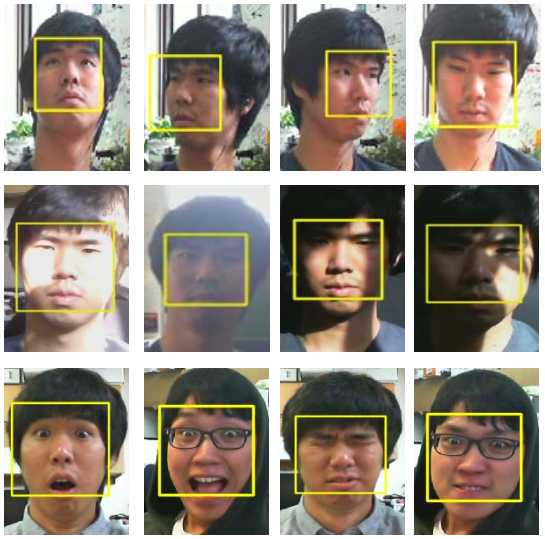


[MCT Feature]

Gray images

MCT images



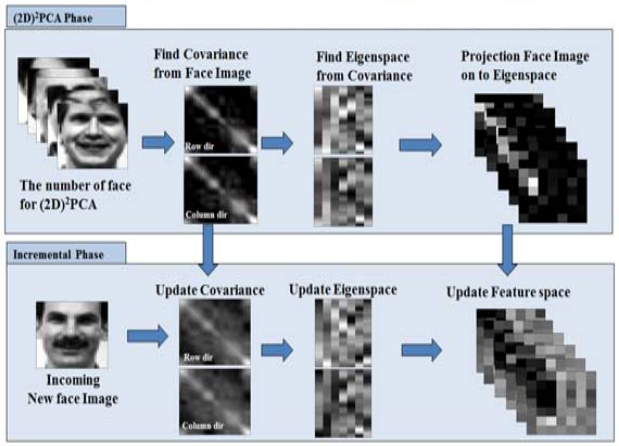


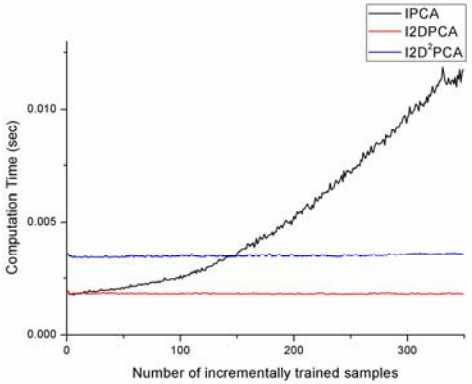
Change of pose

Change of illumination

Change of face expression

- Incremental two dimension and direction principal component analysis



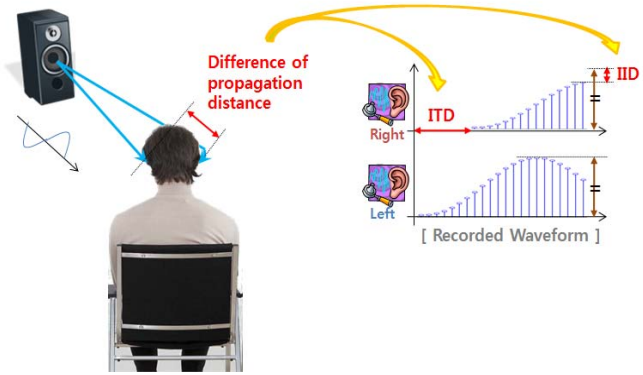


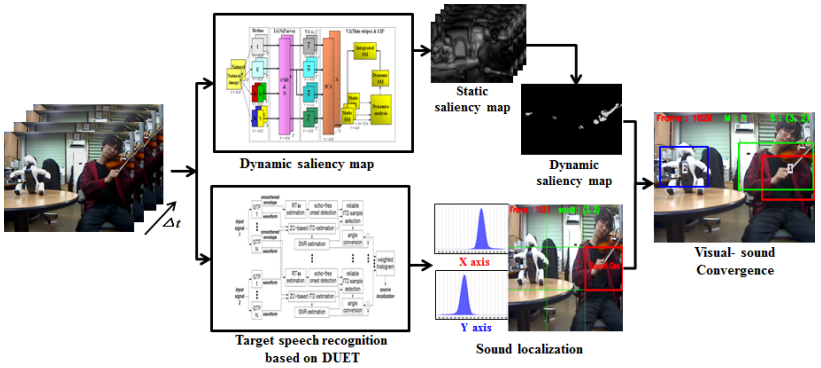
[Performance comparison using ORL DB]

Method	Accuracy (%)	Dimension
IPCA	79.8	185
I(2D)PCA	81.6	512
I(2D)^{2}PCA	82.4	234

Environment understanding : Auditory feature extraction

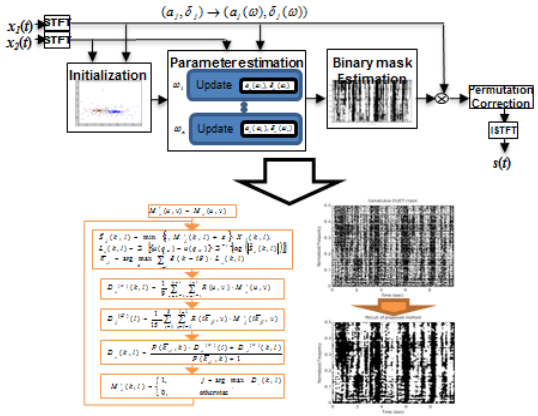
- Localization of sound sources





- The selective attention model based on the convergence of visual and auditory information

- Improved performance of speech recognition

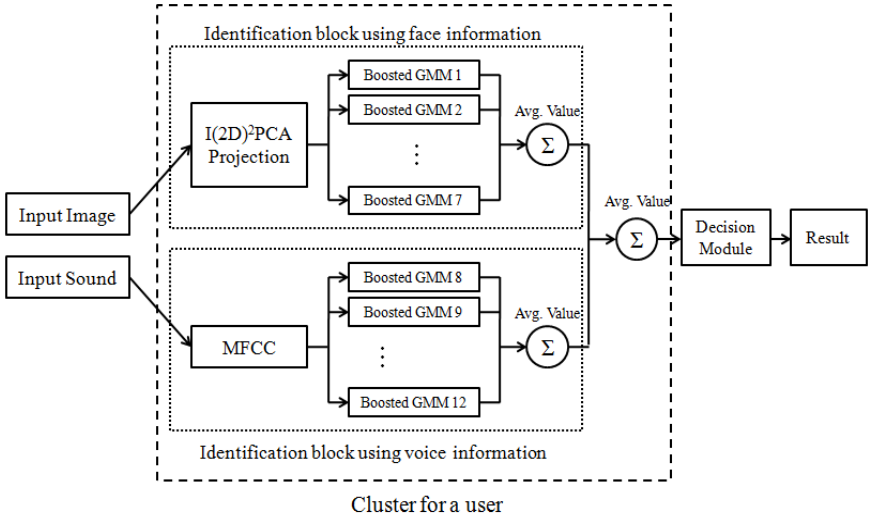


[DUET algorism]

[Improved speech recognition performance]

Performances (%) of word					
SNR	Clean	20dB	15dB	10dB	5dB
Before processing	90.32	88.17	68.82	31.18	13.98
After processing		90.32	87.10	64.52	20.43

Environment understanding : Personal authentication

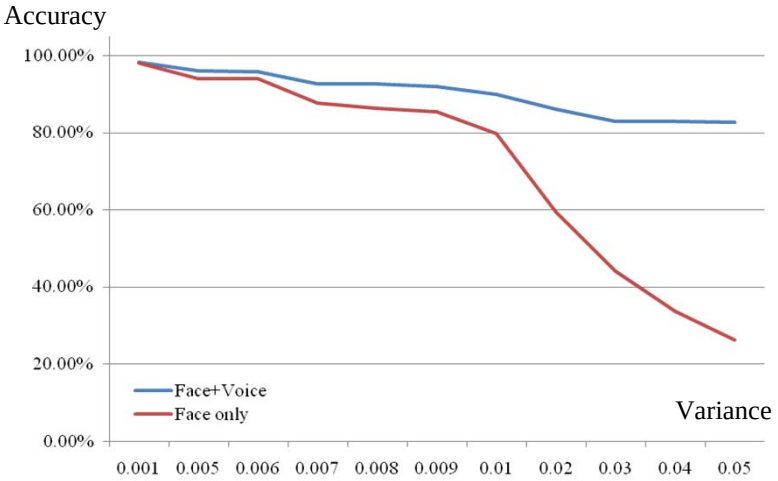


Integrated feature data: Face + Voice signal (100 people)

Num.	5	10	20	30	40	50
Face only	0.05	0.099	0.198	0.294	0.391	0.486
Face+Voice	0.05	0.099	0.198	0.295	0.395	0.489

Num.	60	70	80	90	100
Face only	0.576	0.673	0.759	0.853	0.937
Face+Voice	0.586	0.685	0.778	0.873	0.962

- Performance with respect to the noise of face images



• Add Gaussian random noise to face images
  - Set mean zero and change variance
• Trained with 30 people (30 classes)

• Examples of noisy images (variance)

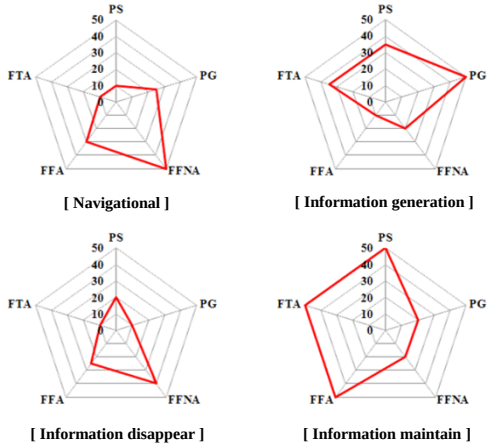
Original 0.001 0.01 0.05

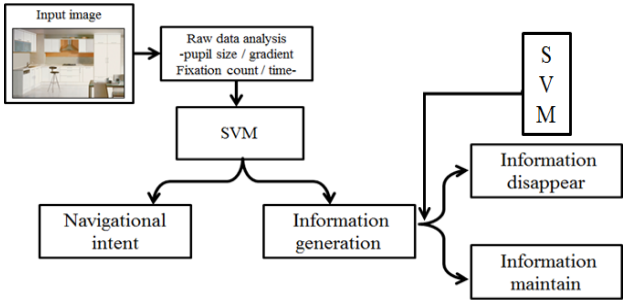
Human understanding : Human intent recognition

- Improved performance of speech recognition

Navigational intent

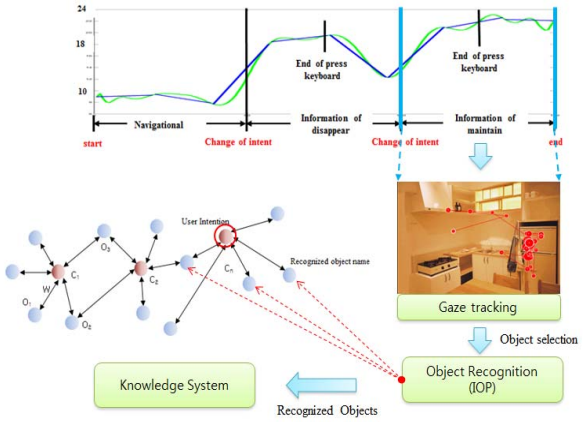
Informational intent





	Navigational to informational	Maintain to disappear
Train per(%)	96.89 ±0.29 (%)	98.71 ±0.19 (%)
Test per(%)	90.02 ±0.48 (%)	90.36 ±0.59 (%)

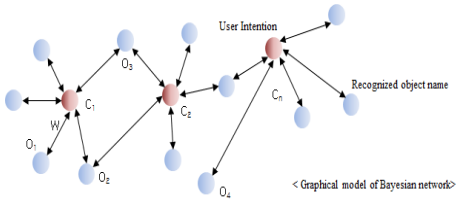
- Human intent probing

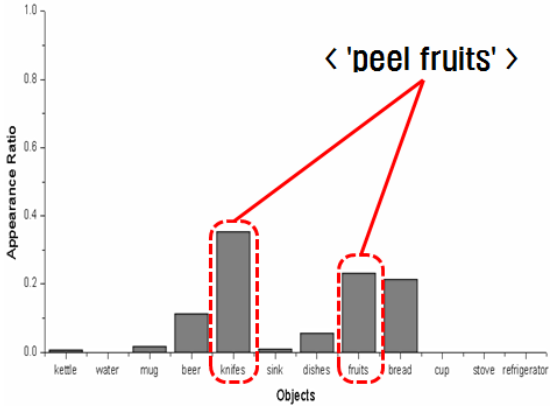


Probabilistic approach : Naïve Bayes

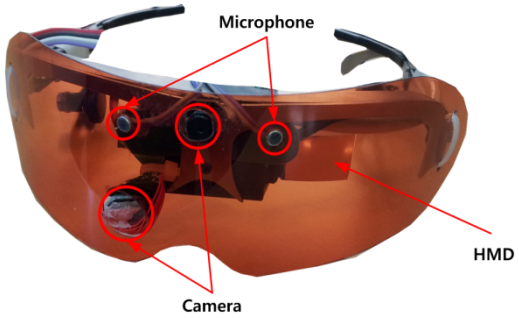
$$P(C \mid O_1, \ldots O_n) = \frac{1}{Z} P(C) \prod_{i=1}^{n} P(O_i \mid C)$$

Measurement of semantic relatedness by (LSA) of the probabilistic weights

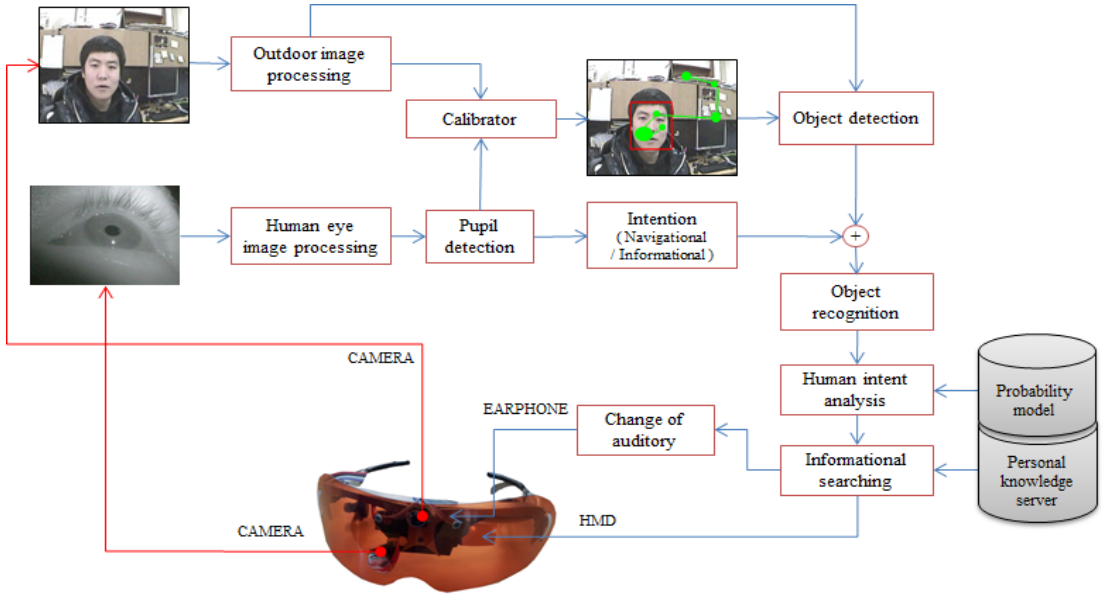


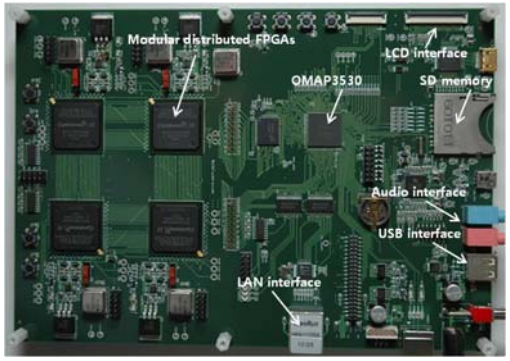


Human augmented cognition of embedded prototype system

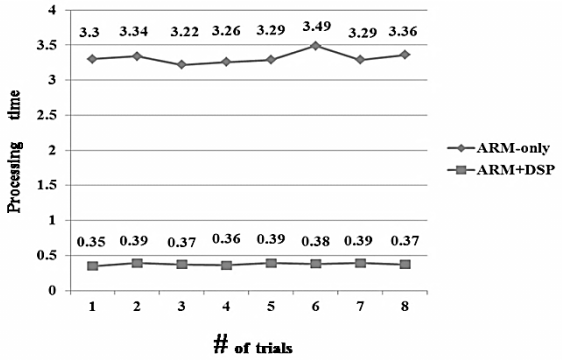


[Prototype platform of human augmented cognition system]





[OMAP3530 Platform]



[Face detection processing time of ARM & ARM+DSP]

[Average processing time for each of functions]

Functions	Processing time average (ms)
Saliency Map	77.29
Face Detection	61.02
Face Recognition	13.02
Information Retrieval	220.58
Total(Whole Process)	Min : 272.17 / Max : 574.69

Conclusion & further works

- A system designed for augmented cognition should account for human cognitive limitations and user conditions in order to retrieve information appropriately from the external repository

- This probabilistic approach can make normative predictions about how humans implicit intention combines prior knowledge (object's functions) with sensory reaction (gaze).

- We measured the performance of the proposed system to assist human cognitive capability, especially, memory capacity expansion, memory retrieval and attention span.

- Currently, we concentrate on developing a large scale knowledge system which can automatically construct knowledge from user's experience and structured general knowledge for human augmented cognition system.

Acknowledgement

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