Mimic Recognition and Reproduction in Bilateral Human-Robot Communication
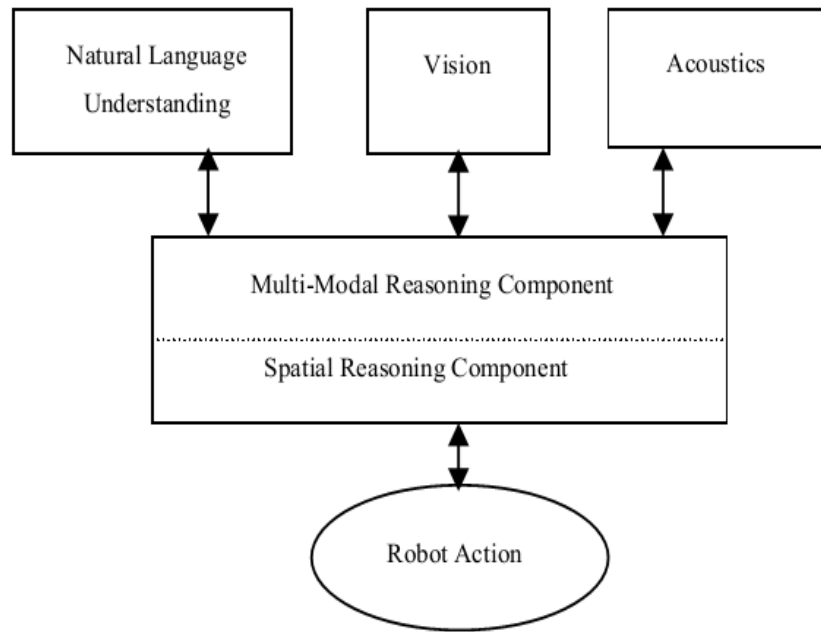
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Content

- Short introduction
- Problem of facial mimic recognition
- Problem of mimic reproduction by robotic system
- Speech dialogue with mimic recognition and reproduction
- Conclusion

Multimodal control is a basic mode for collaborative mobile robots, using Vision, Acoustics and Natural Language

Natural Language Understanding	Vision	Acoustics

Multi-Modal Reasoning Component

Spatial Reasoning Component

Robot Action

OBYS, service mobile robot

**George, a B21r mobile robot**

Flexible Manufacturing System of collaborative type "Baxter"

The task of human-robot communication may be made easier for unprepared user by facial mimic reproduction

- By complementation of the speech dialogue

- By mimic reproduction of "emotional state" of robot itself

- By analyzing of human's emotional state by robotic system

- By dialogue planning in correspondence with the emotional valuation of the real situation

Dialogue control of collaborative robot with "emotional feedback"
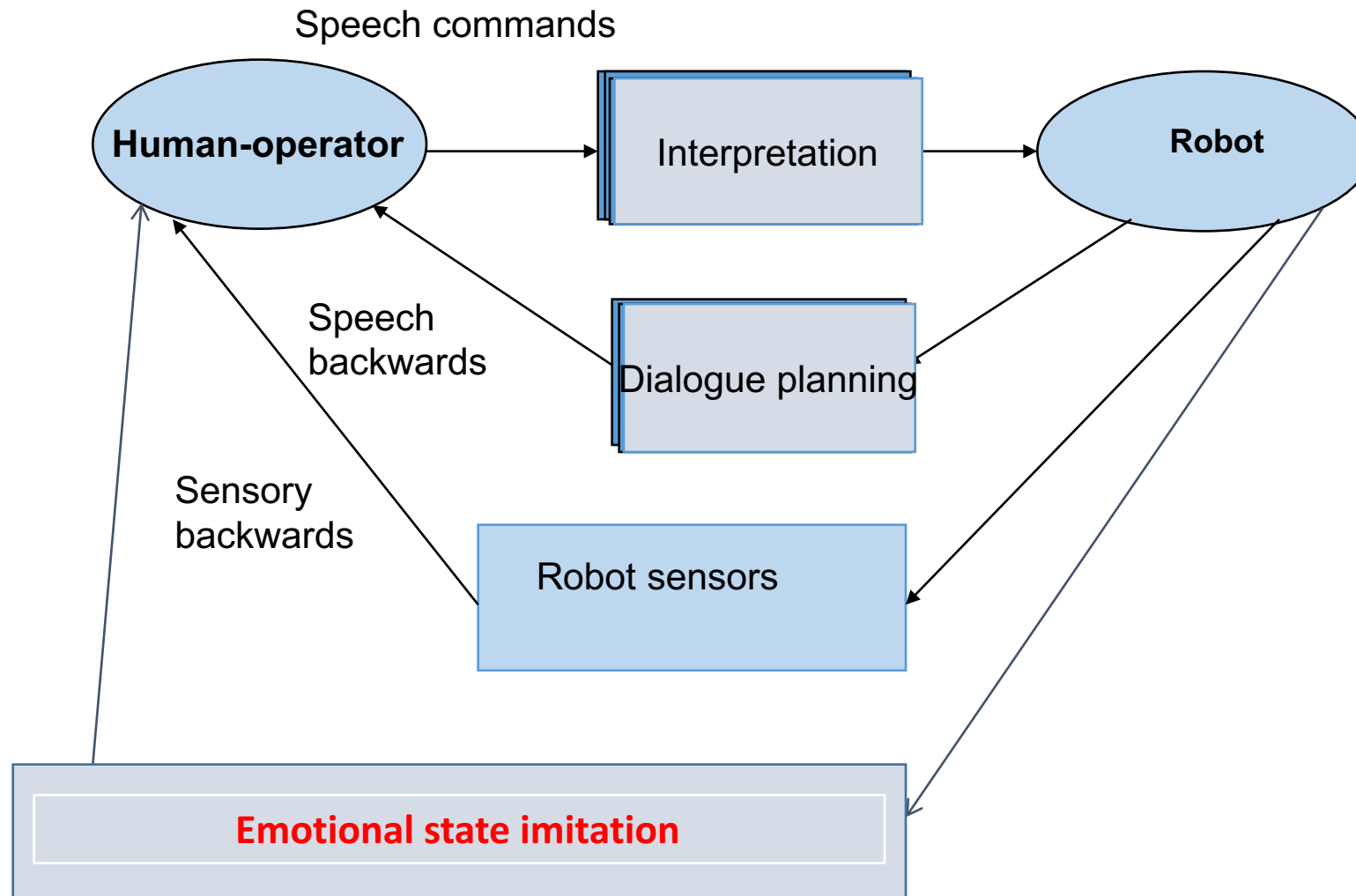
Mimic recognition of human emotions

P.Ekman   Facial expression and emotion (1993)

P.Ekman, W.Friesen, J.Hager   Facial Action Coding System (FACS) (2002)

Basic Emotional States (BES) independent of cultural level and nationality:
- Happiness
- Sadness
- Anger
- Fear
- Surprise
- Disgust

Facial state is a composition of typical action units (AU) i.e. position of distinctive facial points by separate facial muscles

Emotional state recognition with EmoDetect algorithm, based on the BES concept (Neurobotics – Moscow, Zelenograd, 2013)
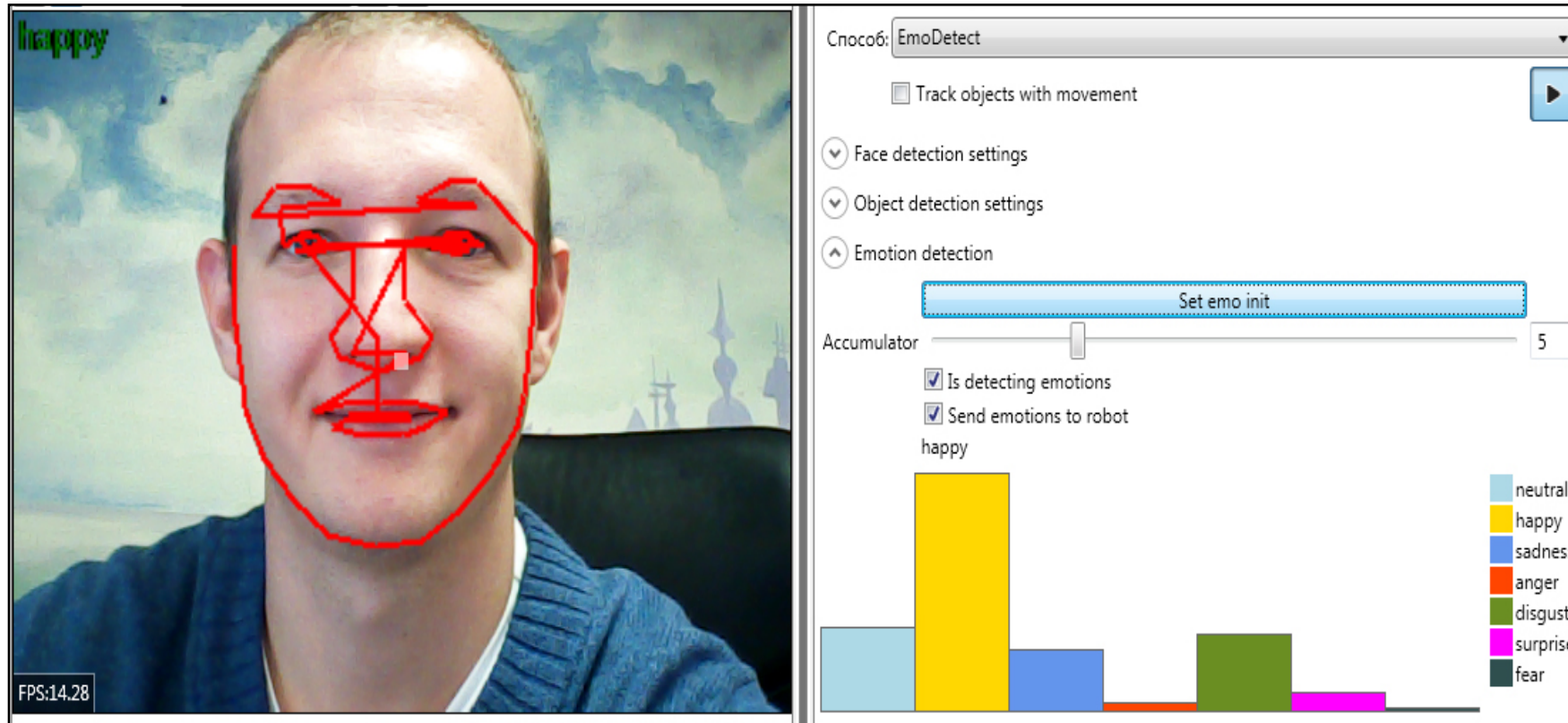
EmoDetect Algorithm is based on the comparison of the real facial state with the BES

Adaptive Neuro-Fuzzy Inference System (ANFIS) for mimic recognition
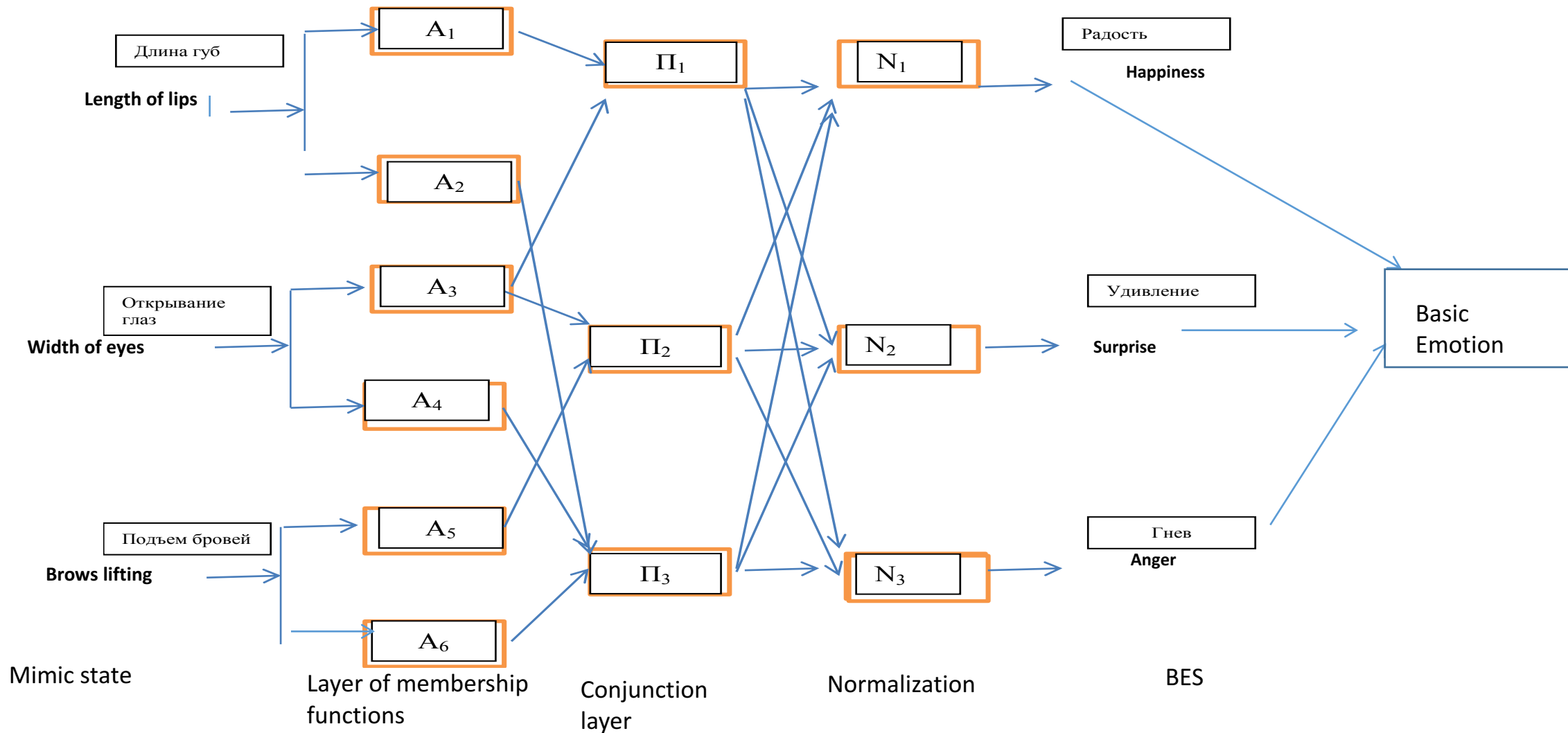
Mimic analysis make it possible to recognize the human operator's emotional state of collaborative robotic system:

- The psychophysiological state of human and his possibility to control the system
- The level of dangerousity of the situation
- The real sense of speech commands of human

Emotion reproduction by robot "face"

- The speech dialogue may be complemented by visualization of mimics of robot-partner.
- The robot's "face" may be shown on screen or realized as a model of a human face.
- The mimic control may be used to present:

    - Robotic system reflection of the contemporary situation (danger, calm, etc.)

    - Robot's reflection of its own condition (robot self-diagnostics)

    - Robot's reflection of the human-partner condition (human state diagnostics by robot)

- The mimic may be complimented by gesticulation.

Some examples of emotion reproduction by facial mimic of human like robots:

- **Hanson Robotics**
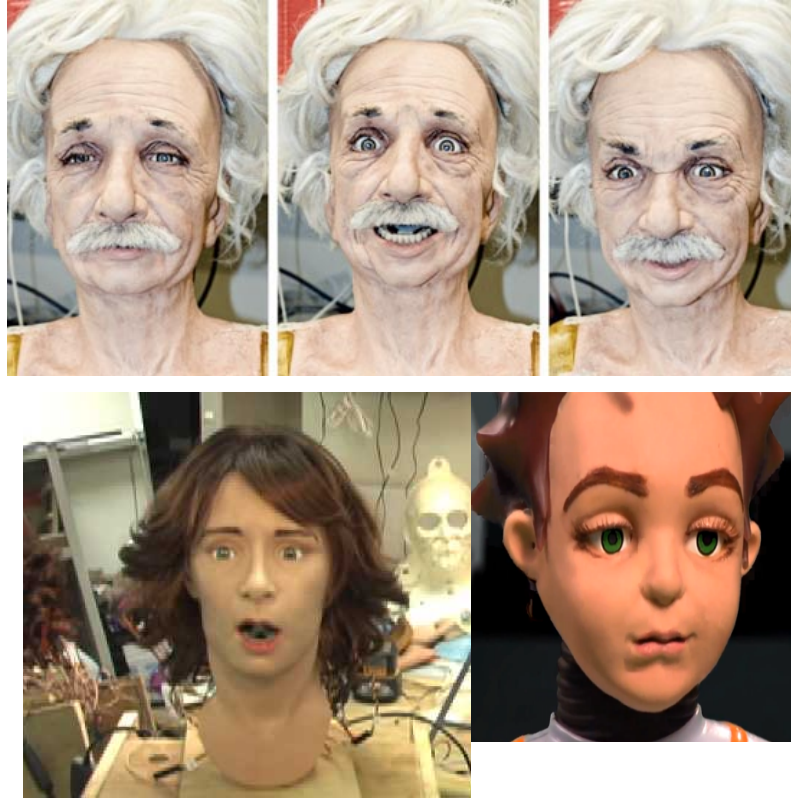
- **Hiroshi Ishiguro**
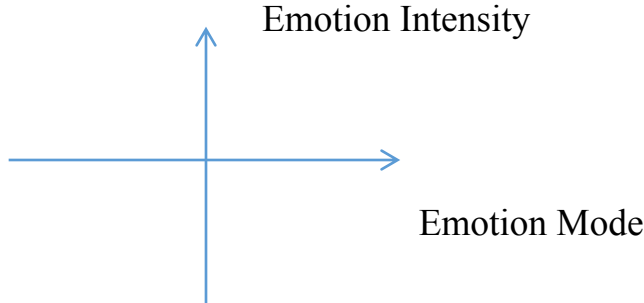

- **Alice – Neurobotics, (Russia)**

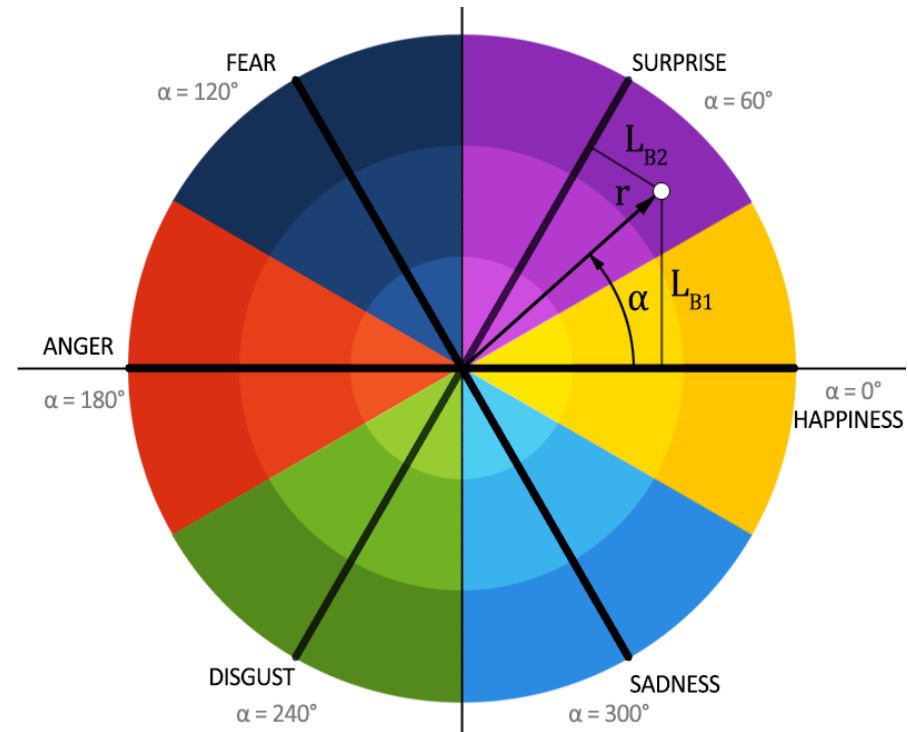# Emotional Cartesian Space with Basic Emotional States (BES) by P. Ekman
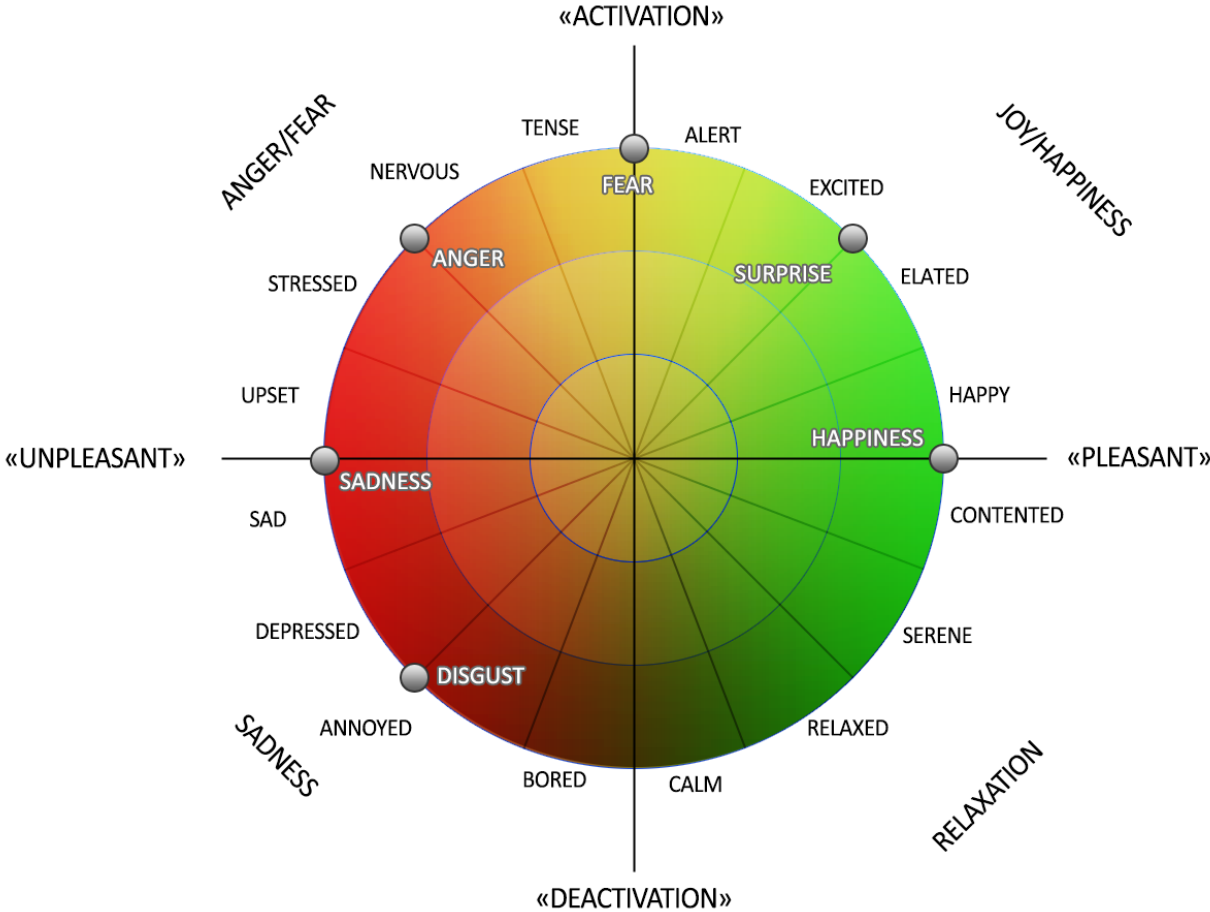
D.Mazzei, N.Lazzeri, D.De Rossi, – HEFES: an Hybrid Engine for Facial Expressions Synthesis to like androids and avatars (2012)

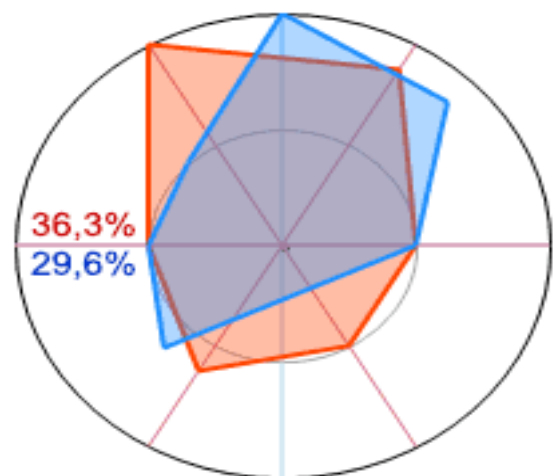C.Breazeal, C.Brooks, - Robot Emotions: A functional Perspective (2013)
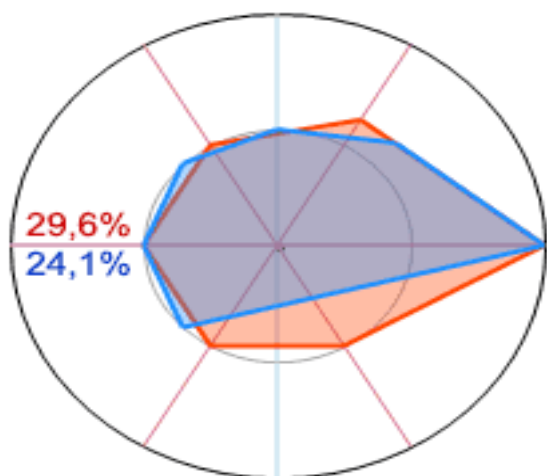
Cartesian Space of Basic Emotional States (CSBES)

Now emotion is formalized as a vector e(r , α)

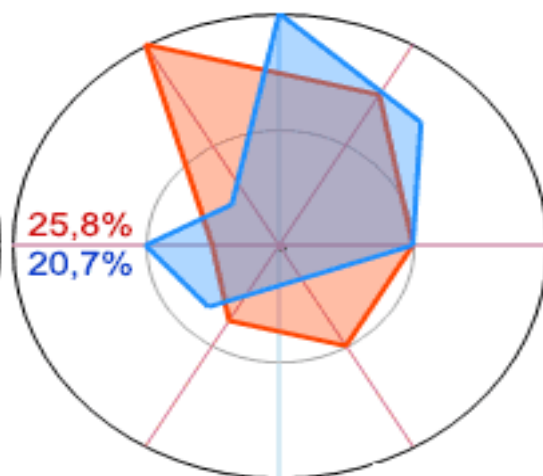CSBES is a version of Emotion Cartesian Space realized the Ekman's BES

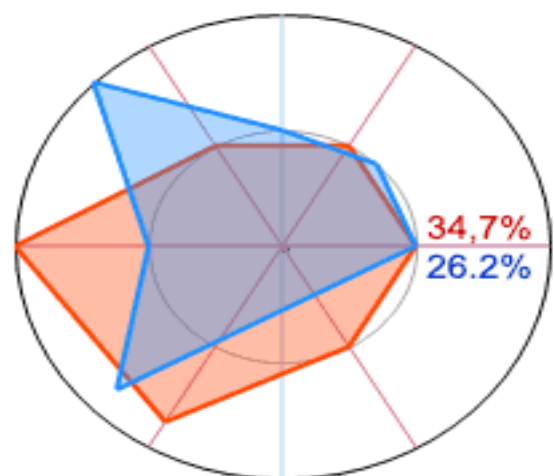Distribution of control impact on different actuators for ● ECS and ● CSBES
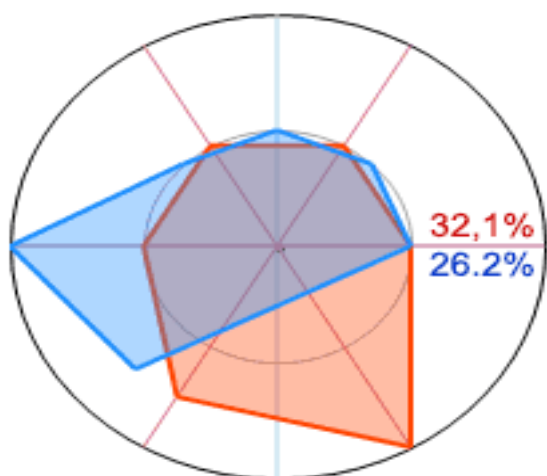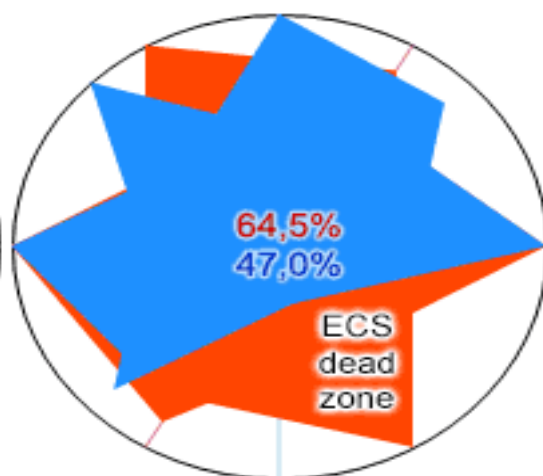
a) Left brow actuator

36,3%
29,6%

b) Left smile actuator

29,6%
24,1%

c) Left eyelid actuator

25,8%
20,7%

d) Evilness actuator

34,7%
26.2%

e) Sadness actuator

32,1%
26.2%

f) Common coverage

64,5%
47,0%

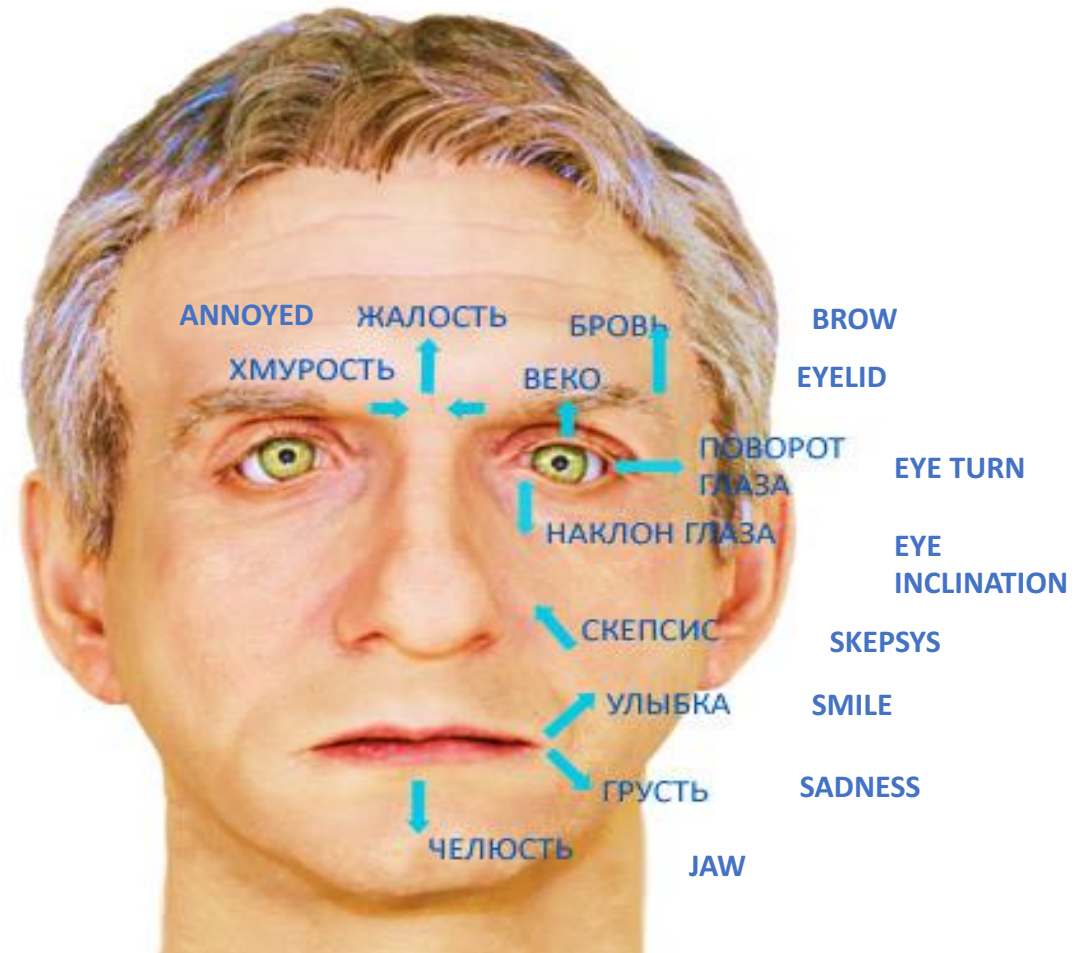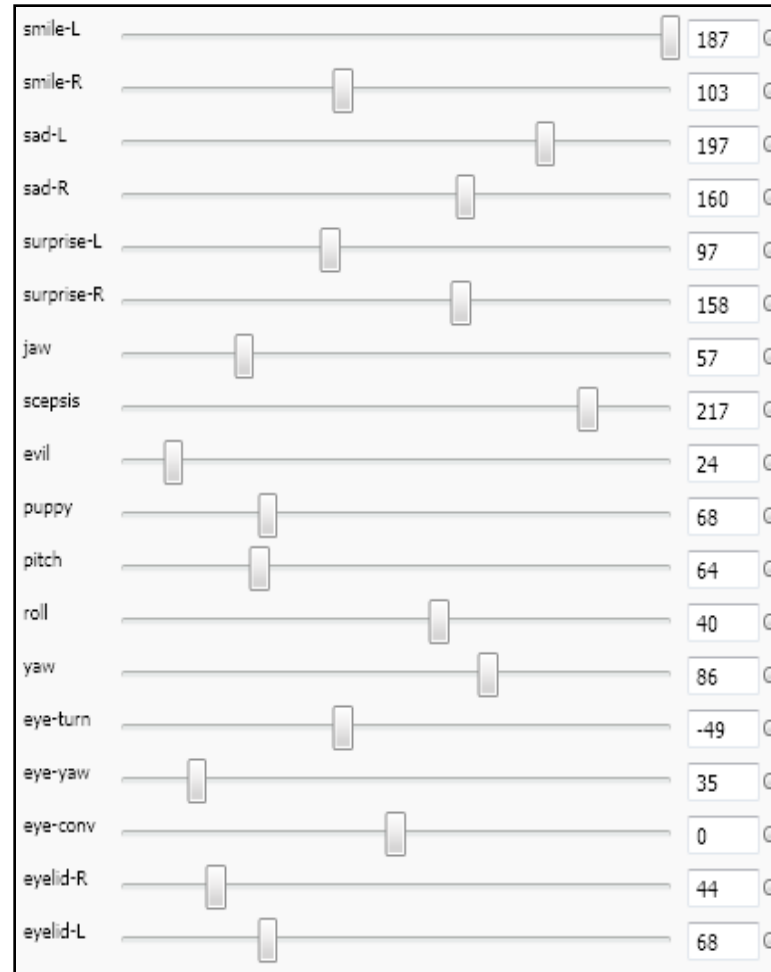ECS dead zone

Emotions reproduction using the Action Units (AU)

Facial actuators (Neurobotics, Russia)

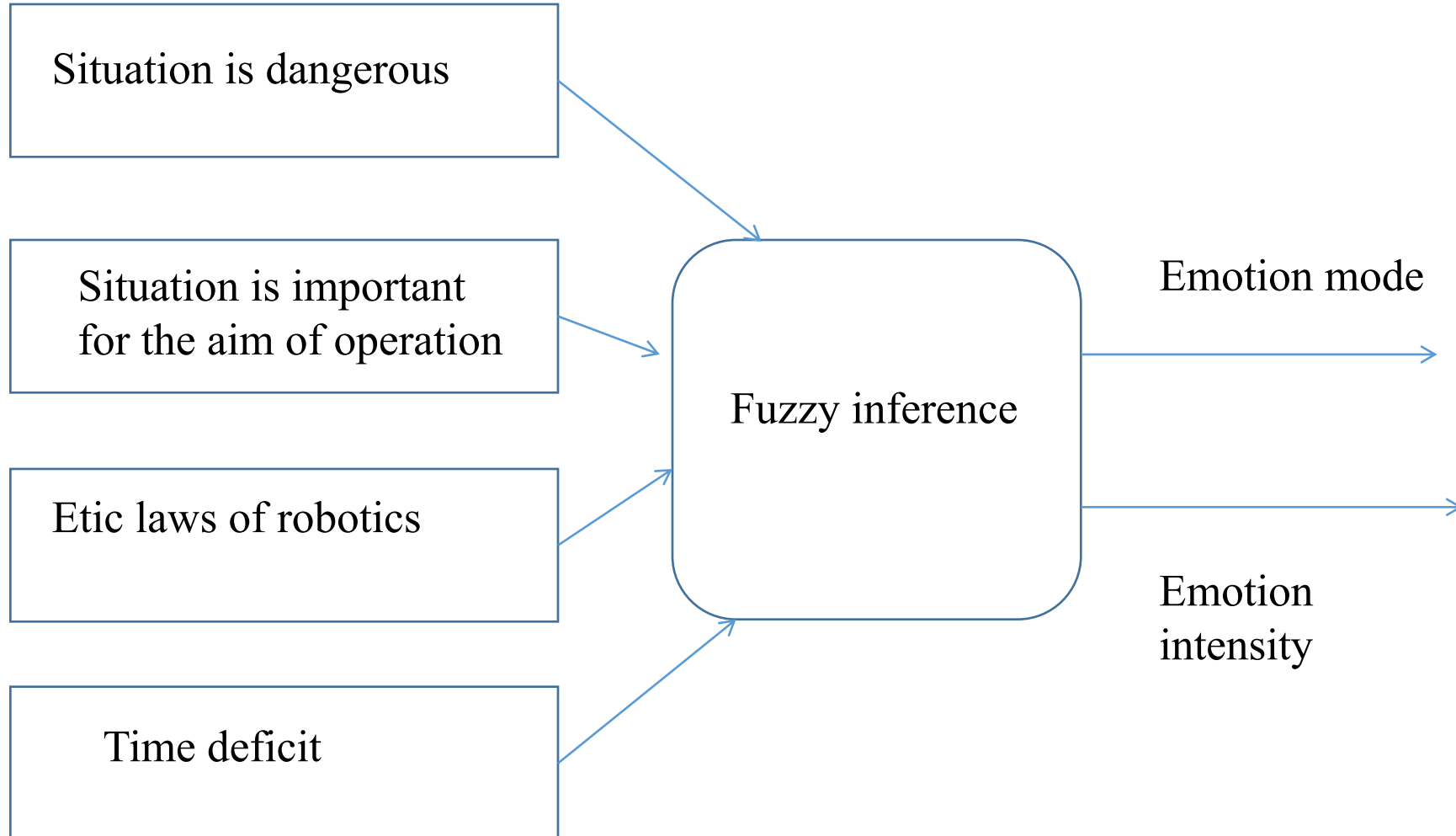# Emotion synthesis of robot Alex (Neurobotics, Russia)

Neutral	Happiness	Surprise	Happy surprise
CSBES: r=0	CSBES: r=1, α=0	CSBES: r=1, α=60°	CSBES: r=1, α=30°

General Concept of fuzzy inference for facial state
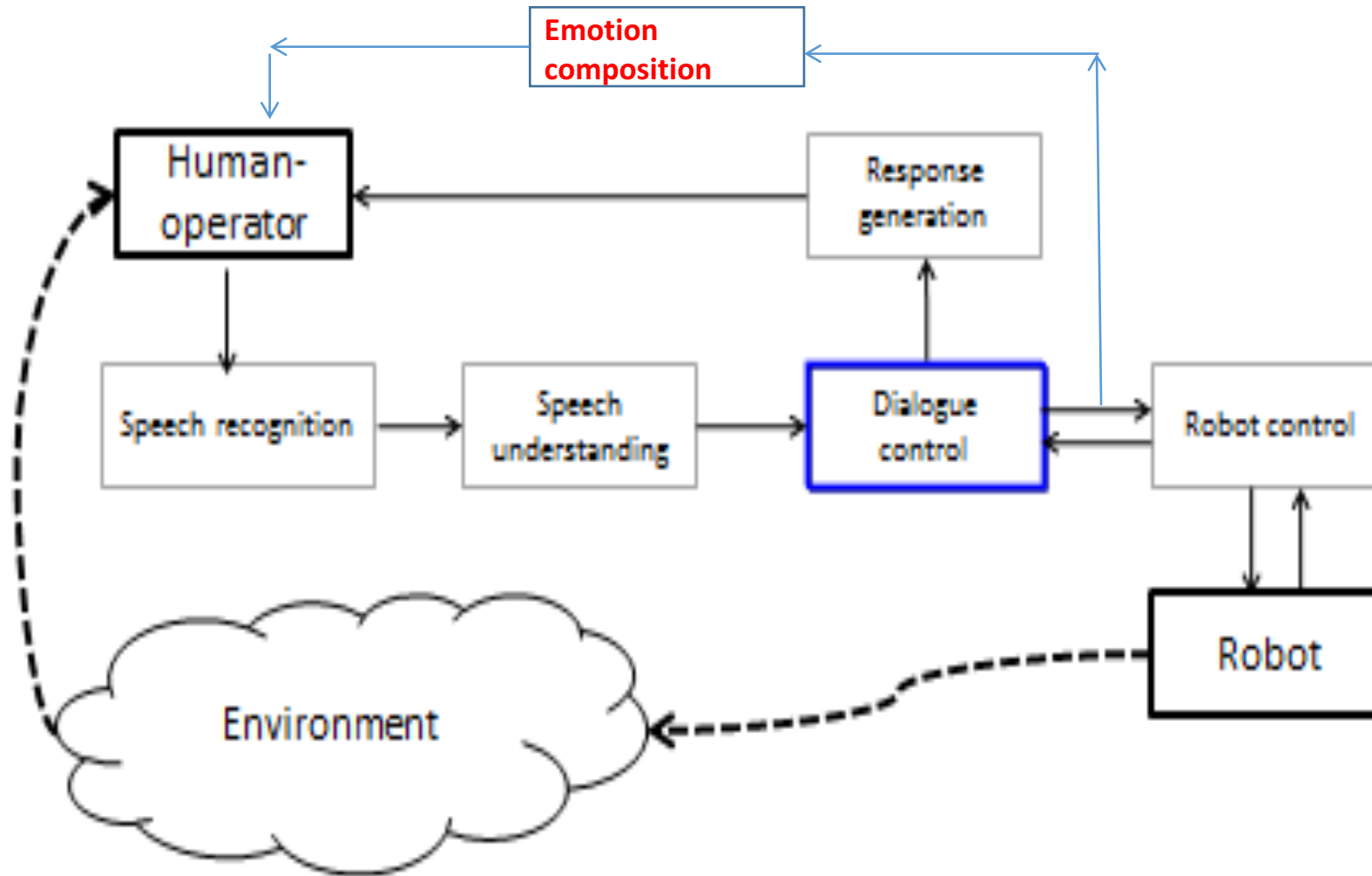
Speech control of collaborative robots

Mobile robot GODOT

Industrial manipulator (BMSTU)

Diagram of speech and emotion interface

Dialogue control include:

• Explanation of the real situation by robot (situation analysis)

• Explanation of the working plan compiled by robot (operation planning)

• Robot's inquiry to operator for explanation the task.

• Evaluation by robot the results of operation (previously evaluation)

• Evaluation by robot it's own state for operator's inquiry.

• Evaluation by robot the state of operator and his possibility no control the robotic system (ergonomic expertise).
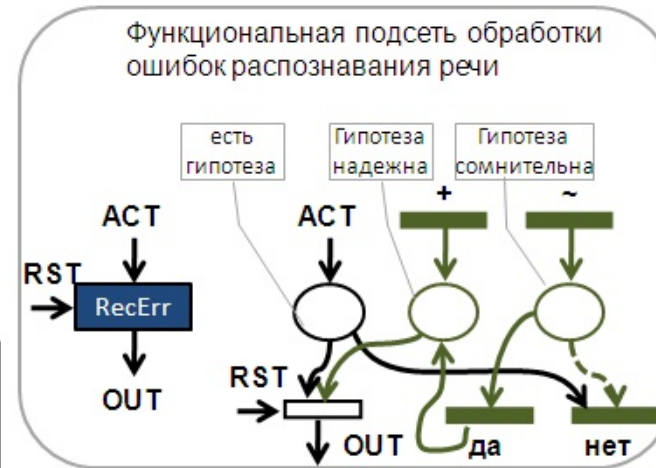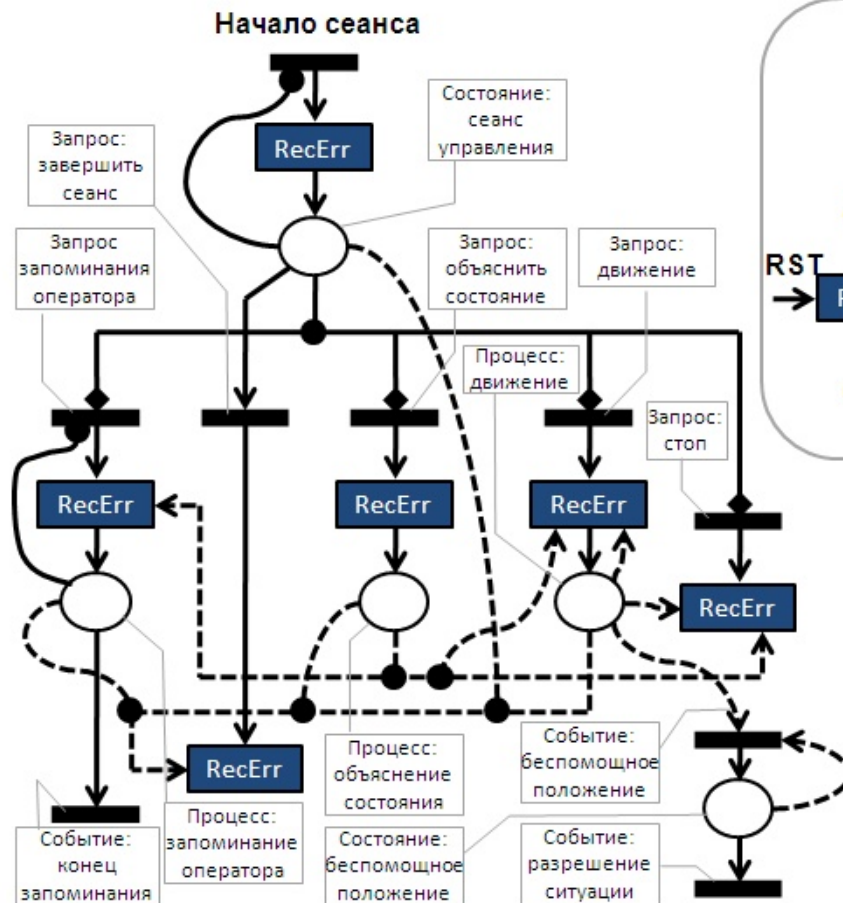
All tasks may be implemented by facial recognition and reproduction

The facial expression is determined by dialogue scenario

An Example of Human-Robot Dialogue Scenario

Human commands	Human's face (?)	Robot's reply	Robot's "face"

Human commands

- To find the object A

- Move in the direction to A

- Go round the obstacle and continue the way

- Go on till the A is near
- Go back
- Try to avoid the collision

Robot's reply — **Robot's "face"**

- Not in sight — Sadness
- In sight — Neutral

- O.K. — Neutral
- An obstacle right forward — Fear

- O.K. — Neutral
- Impossible — Surprise
- Obstacle is moving — Fear

- O.K., the A is near — Happiness

Dialogue manager in form of Petri net

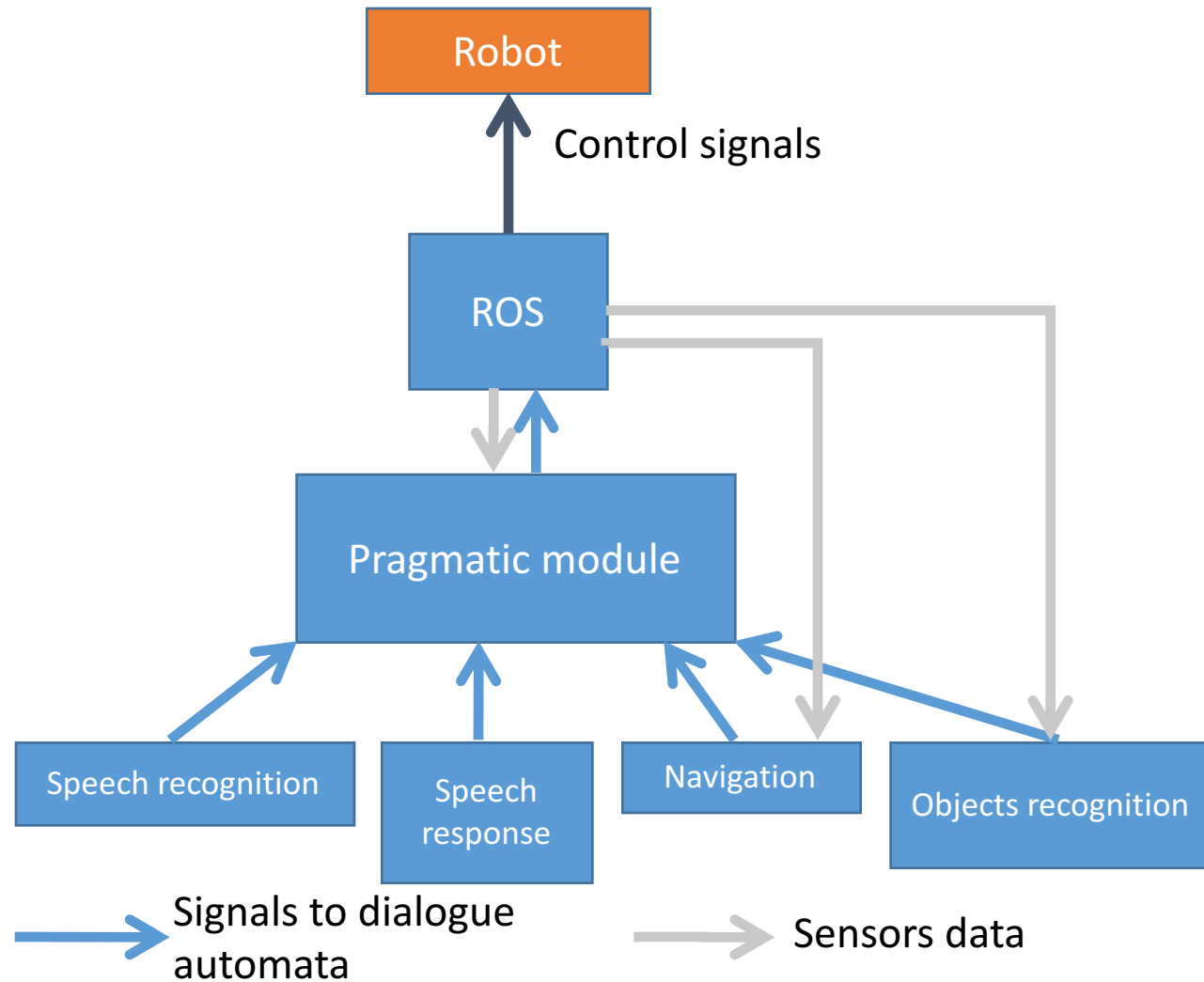

The subnet for error recognition by hypothesis comparison

The main scenario:
- **Basic commands of movement**
- **Stop, Begin**
- **Memorization of operator**
- **Inquiry of human**
- **State explanation**

Speech dialogue control by mobile robot PCBOT

Conclusion

The main task for collaborative robotics to-day is to include robots into humanitarian society.

Now the psychological and etic problems are necessary to solve:

- The problem of mutual understanding of Human and Robot.

- Anthropocentric mode to create the intelligent interface including the emotional level

- Concordance of Human psychology and Robot behavior and social problems

- Etic laws of robotics

Thank you for attention!

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