

Corso di Percezione Robotica (PRO)
Modulo D: Applicazioni ed Esercitazioni

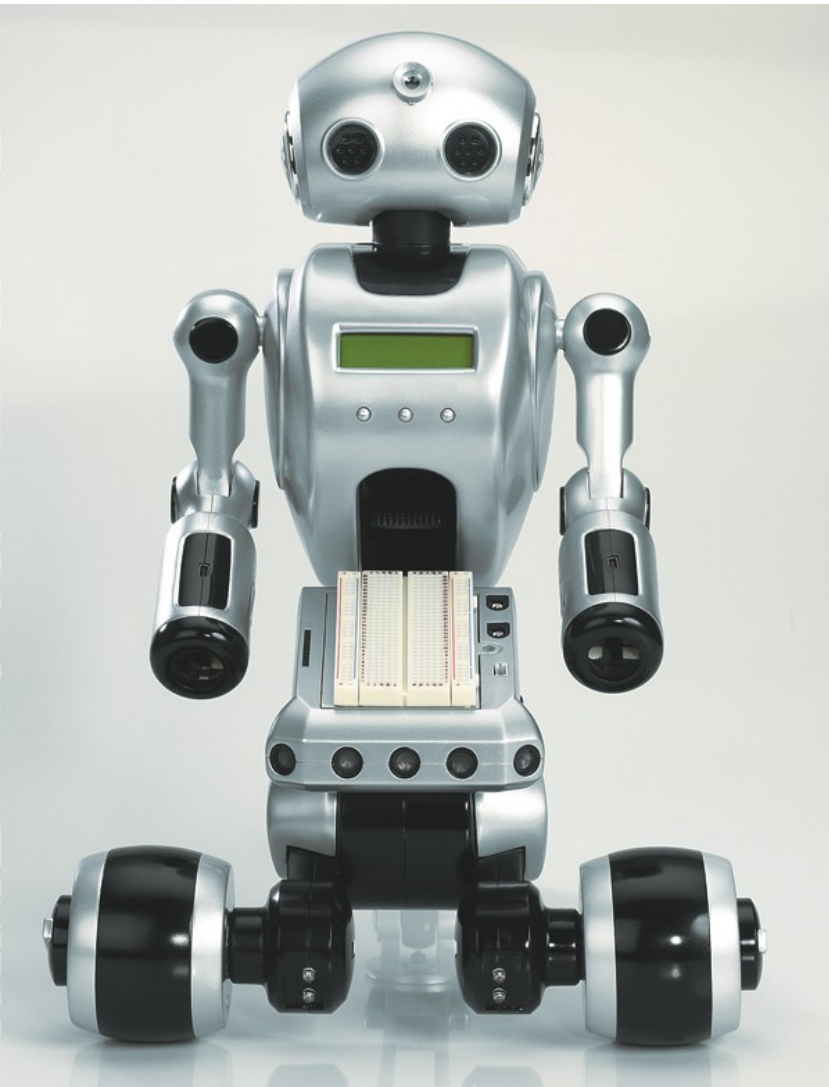
**Esercitazione con un robot umanoide
programmabile per edutainment**

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[I-Droid01 Humanoid Robot]



- 8 dof:
 - base 2
 - trunk 1
 - arms 2
 - head 2
 - hand 1
- 7 Encoders
- 4 microphones
- 1 RGB camera
- 1 Touch sensor
- 3 US sensors
- 2 IR sensors
- 1 Temperature sensor
- 24 led
- 1 universal remote controller



**RED, GREEN
AND YELLOW
EYES LED (3+3)**

CYAN EARS LED

**UP/DOWN
MECHANISM**

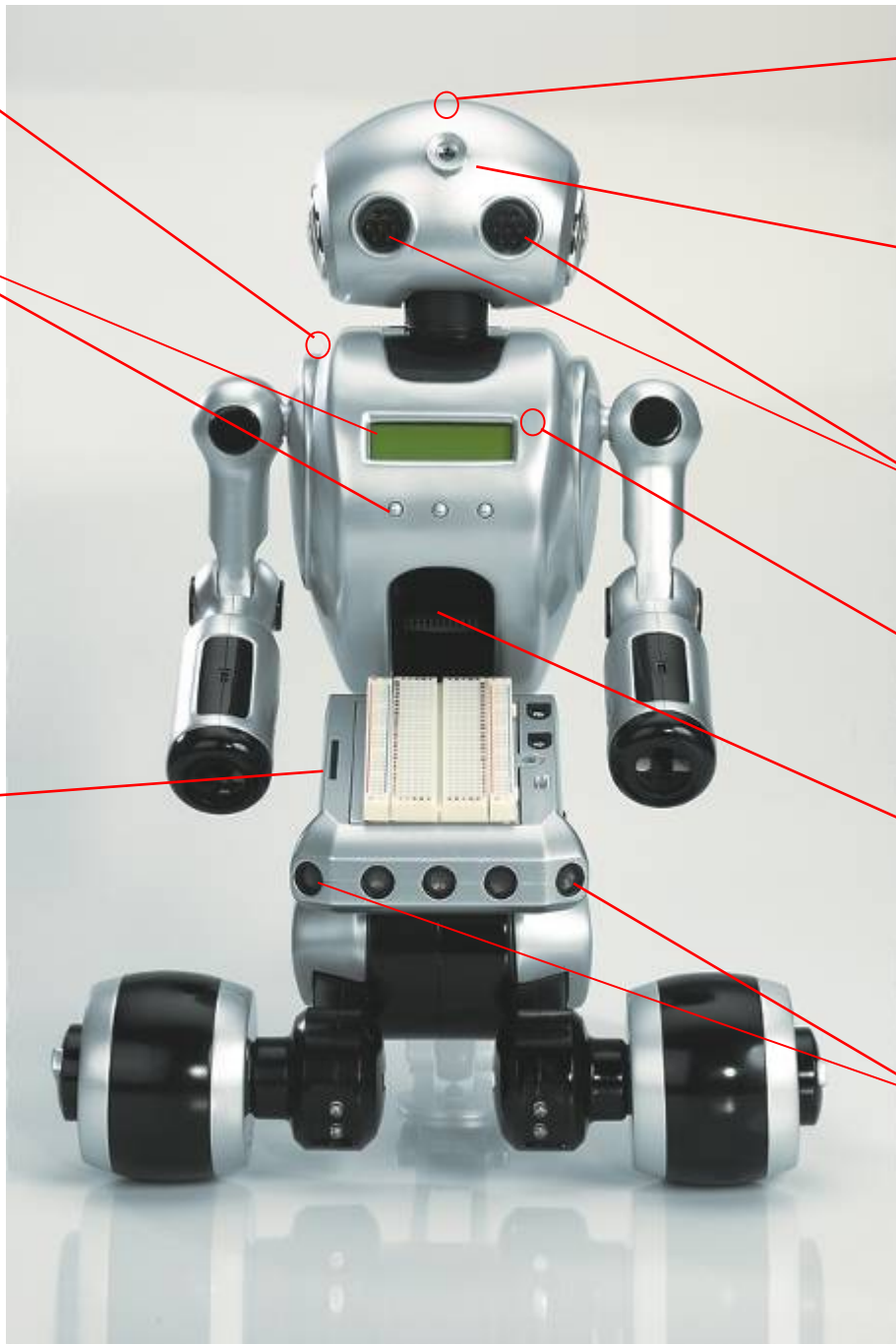
**1 PASSIVE REAR
WHEEL**

**2 DOF HEAD
WITH ENCODERS**

**1 DOF ARMS
WITH ENCODERS**

**PASSIVE ELBOW
JOINT**

**2 ACTIVE
FRONTAL
WHEELS WITH
ENCODERS**



**TEMPERATURE
SENSOR
(BACKPACK)**

**DISPLAY AND
KEYBOARD**

**6 ADDITIONAL
GPIO
(GENERAL
PURPOSE IO
4 DIO, 2 AI)**

TOUCH SENSOR

CMOS CAMERA

**MICROPHONES
(SOUND
DETECTION)**

**MICROPHONES
(SPEECH
RECOGNITION)**

SPEAKER

**ULTRASOUND
SENSORS
(2 TRASMITTER,
3 RECEIVER)**

84 speaker independent commands

1 speaker dependent biometric password

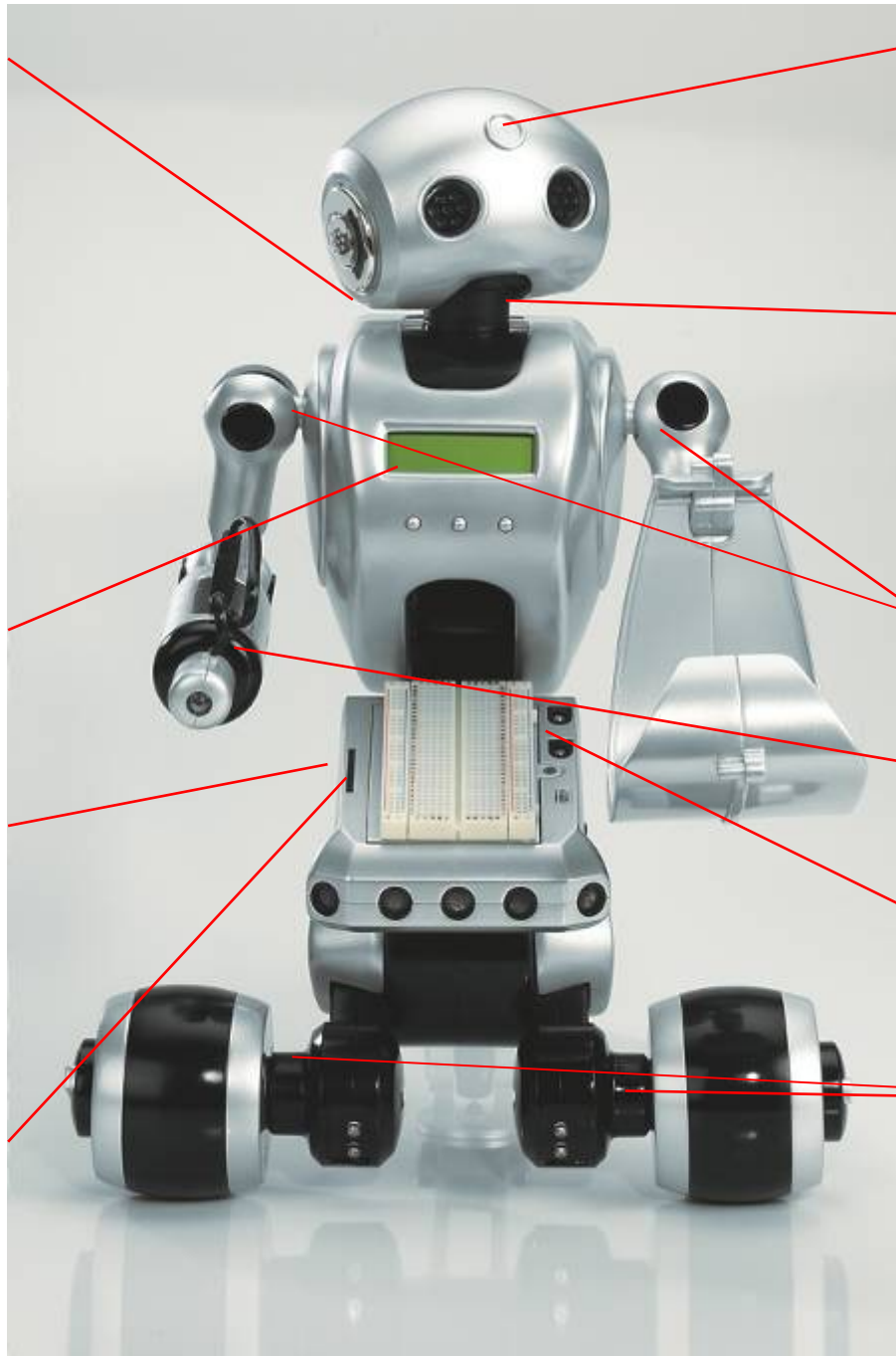
220 preloaded phrases and sounds

10 recordable messages 16 secs each

**Display LCD:
2 rows, 16 columns**

**Batteries:
8 AAA, 1.5V each
4.5V electronics
7.5V motors
4 hours autonomy**

**ADDITIONAL INPUT:
4 Digital Input
0,3V
2 Analog Input
0-3V**



**CMOS Camera sensors:
RGB, 0,3 Mega Pixel;
max resolution 640x480.
standard resolution
160x120.**

**HEAD TILT MOVEMENT:
5 positions
HEAD PAN MOVEMENT:
13 position**

ARMS: 16 positions

HAND: 2 positions

HIP: 2 positions

**BASE:
Max speed:
- 20 cm/s with PID
- 30 cm/s without PID**

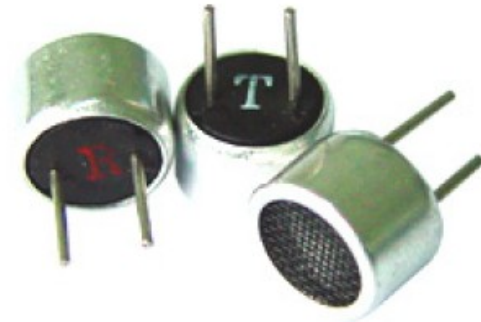
I-Droid01 Humanoid Robot

Technical Specifications

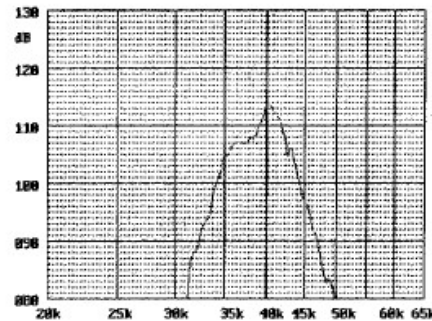
- Weight: 2 Kg
- Dof: 8 actuated, 4 not actuated
 - 2 actuated wheels, max speed 30 cm/s
 - 1 actuated hip joint for stand up/sit down movement
 - 2 dof pan/tilt head: 13 pan positions, 5 tilt position
 - 2 dof left and right arm: shoulder actuated, 16 positions
 - 1 dof hand
- Vocal recognition:
 - 84 "speaker independent" commands
 - 1 "speaker dependent" biometric password
- Speech Synthesis: 220 pre loaded phrases and sounds
- Records up to 10 messages, 16 seconds each
- CMOS Camera sensors: RGB, 0,3 Mega Pixel, max resolution 640x480
- Bluetooth module class 2 (10m-30m)
- 1 RS-232
- 1 USB ("device", non "host")
- 1 Analogic output (B&V module): PWM, low-pass 8KHz
- 2 Analogic inputs (Arms module)
- 4 Digital input/output (Arms module)
- Ultrasound sensors: 2 emitters, 3 receivers
- 1 temperature sensor, accuracy 1°C, operative range 5°-35°
- 2 IR sensors: operative range 20-60cm
- DISPLAY LCD, 2 raw, 16 columns
- Batteries: 8 stilo, 4 hours autonomy (tipical)

US Sensors

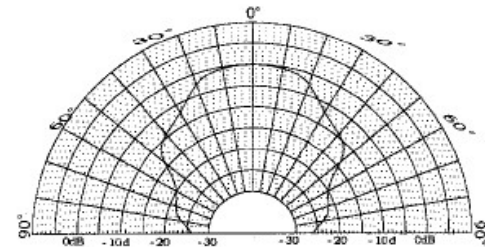
Picture



Frequency Response Curve



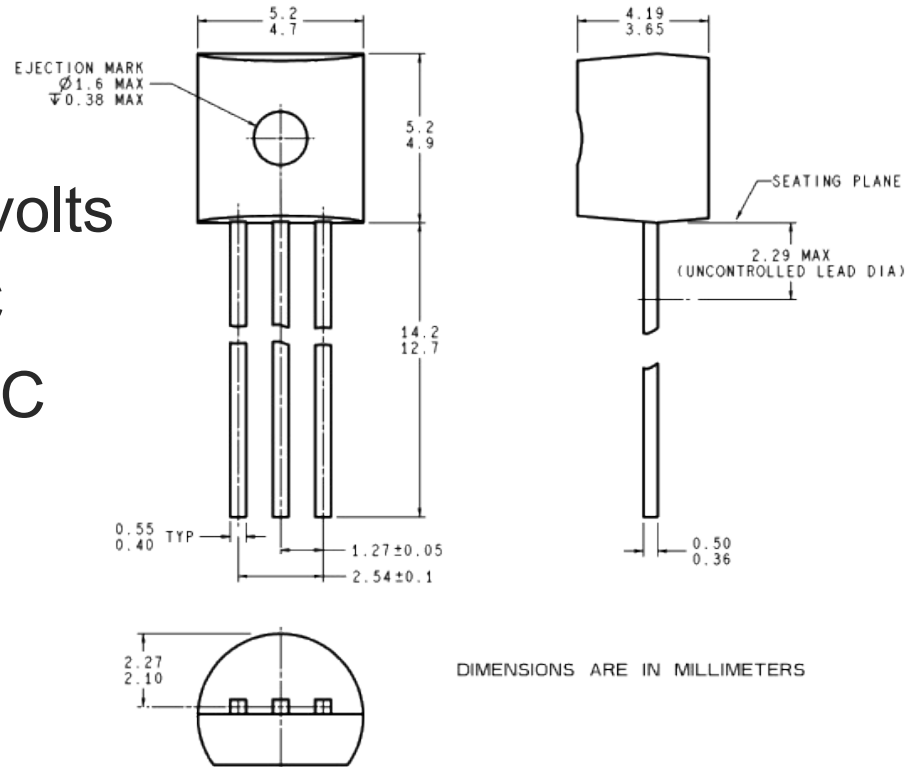
Angle Curve



- Receiver: ChinaSound CUR10G1A-40
- Transmitter: ChinaSound – CUT10G1A-40
- Size: 9.9 x 6.0 mm
- Range: 260mm-1000mm
- beam: 55°
- Freq: 40KHz
- www.chinasound.com

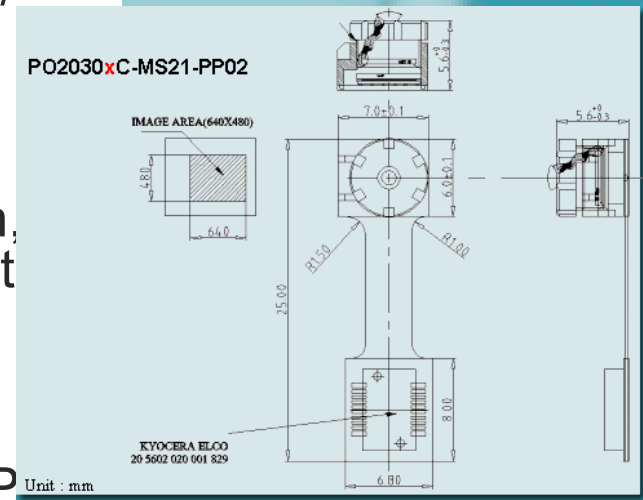
Temperature Sensor

- National LM35
- Operates from 4 to 30 volts
- Range: -55° to $+150^{\circ}\text{C}$
- 0.5°C accuracy at $+25^{\circ}\text{C}$
- www.national.com



CMOS Sensor

- Pixel Plus VGA P02030NC
- 1/4.5 inch 640 X 480 active pixel array with color filters and micro-lens
- Power supply 2.5V for core and 2.5 ~ 3.3V for I/O
- Output formats:
8bit YCbCr / YUV / 9Bit Bayer data / 5:6:5 RGB, 12bit 8:8:8 RGB
- 30 frames/sec progressive scan.
- Image processing on chip:
defect correction, color interpolation, color correction, edge enhancement, contrast stretch, white balance, exposure control, color saturation, gamma correction.
- Package : 40 pin CLCC, 32 pin CSP
- <http://www.pixelplus.co.kr/>



I-Droid01 Humanoid Robot

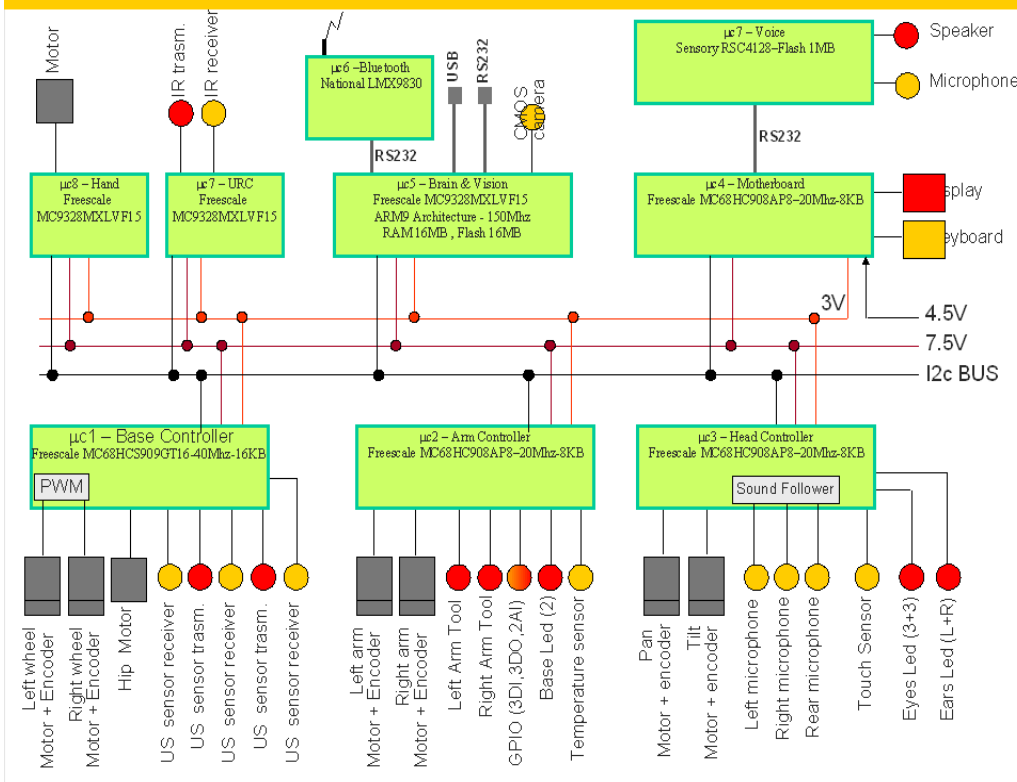


- Speech recognition and synthesis capabilities (Voice control)
- Image processing and visual recognition capabilities
- Detection of sound direction
- Obstacle avoidance (US sensors) capability
- Emotion and mood expression
- Behavior based and Neural Network based software control system
- Remote control by mobile phone and PC via Bluetooth
- Reprogrammable
- “Breadboard” for user custom circuits development

I-Droid01 Humanoid Robot

Distributed control

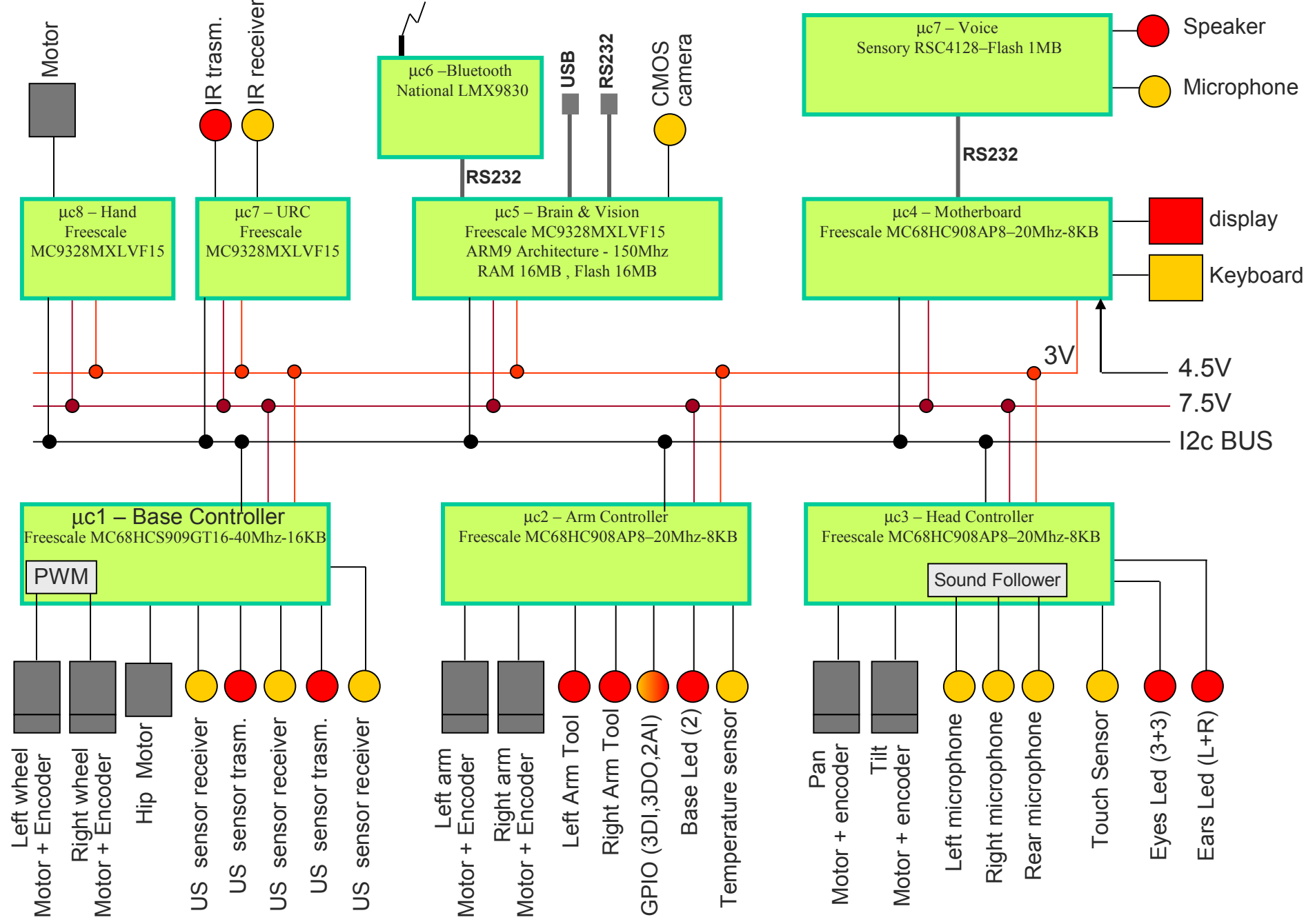
I-DROID01 HARDWARE ARCHITECTURE



Distributed control (9 microcontrollers):

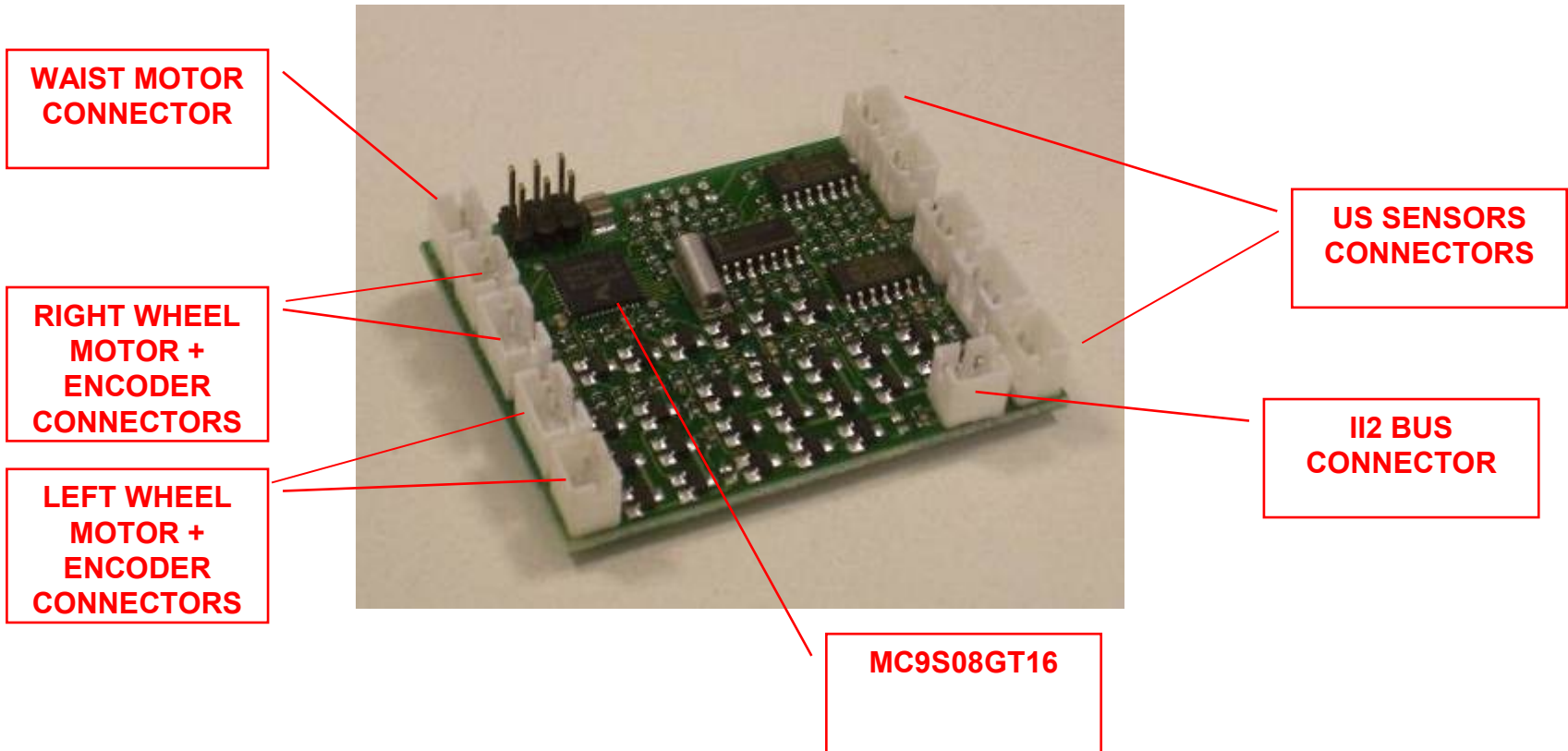
- Head/SoundFollower: Freescale MC68HC908AP8
- Motherboard: Freescale MC68HC908AP8
- Voice: Sensory RSC-4128, 1MB Flash Simultaneous R/W
- Bluetooth: National LMX9830A
- Brain & Vision:
 - Freescale MC9328MXL 150MHz, 16MB Flash, 16MB SDRAM
 - Operative System: Embedded Linux (2.4) with C compiler (Tyni C) on-board
- Base: Freescale MC9S08GT16
- Arms: Freescale MC68HC908AP8
- Hand: Freescale MC68HC908AP8
- URC: Freescale MC68HC908AP8

I-DROID01 HARDWARE ARCHITECTURE



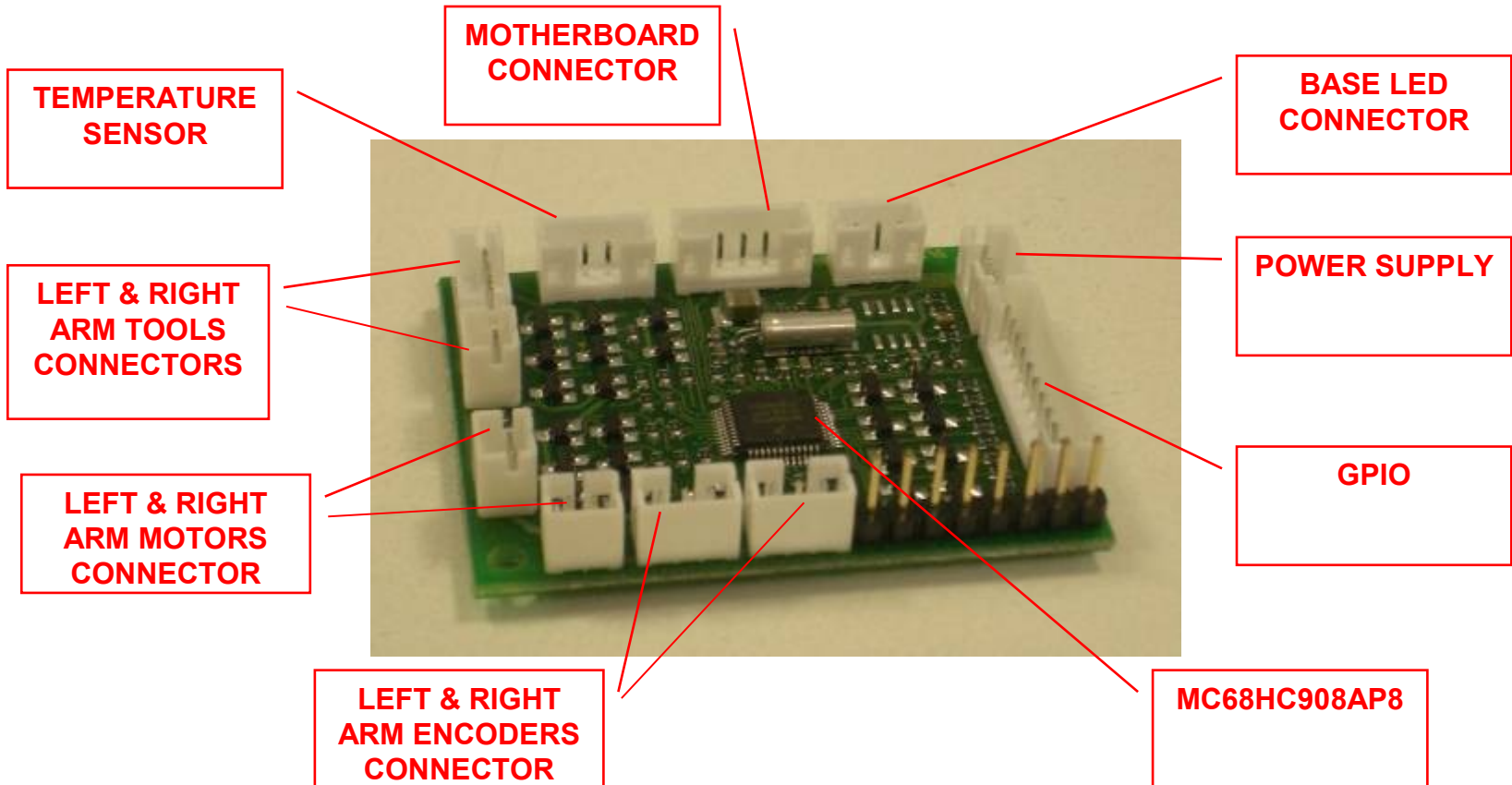
BASE CONTROLLER

Freescle MC9S08GT16-40Mhz-16KB



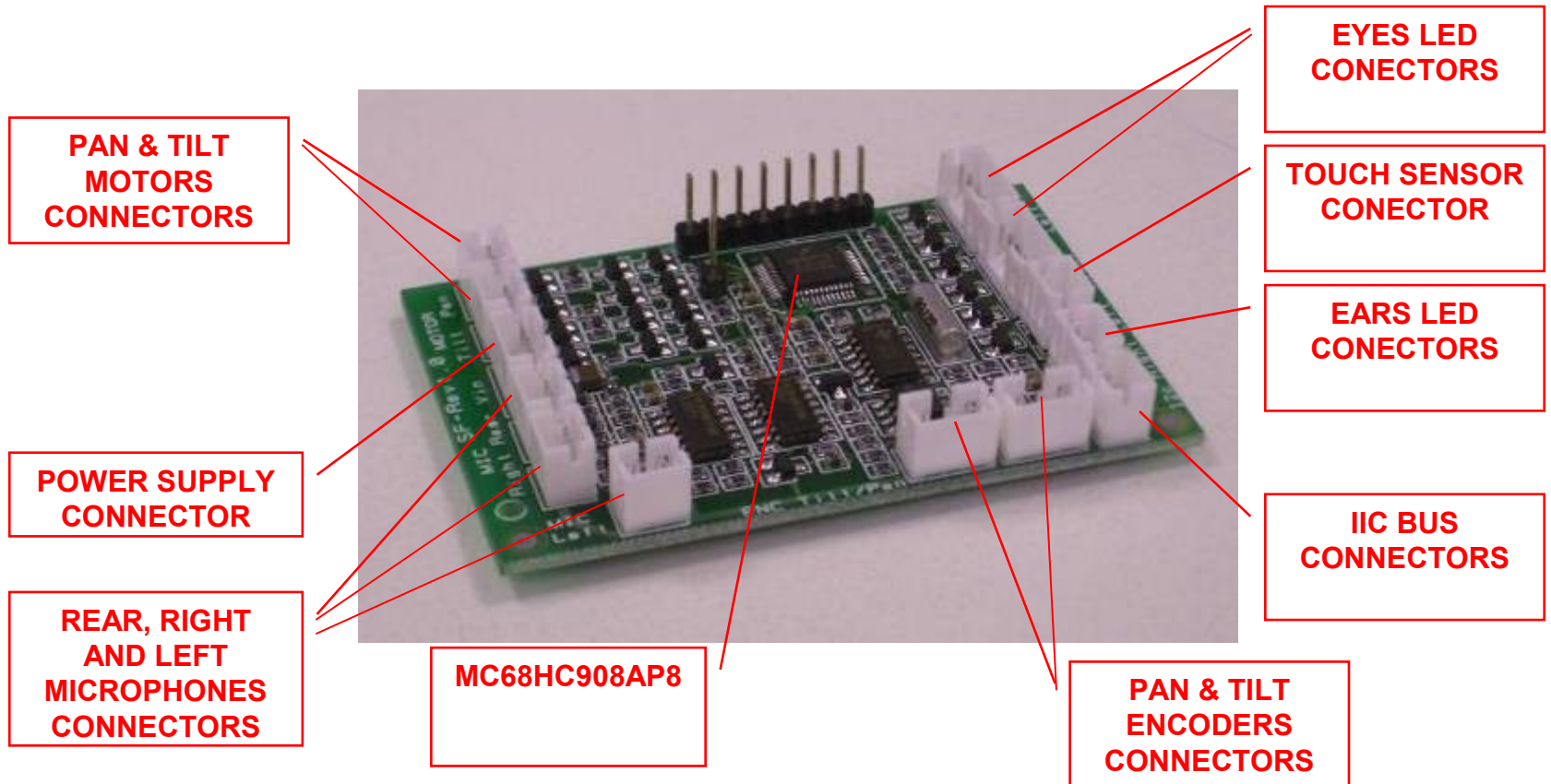
ARM CONTROLLER

Freescal MC68HC908AP8-20Mhz-8KB



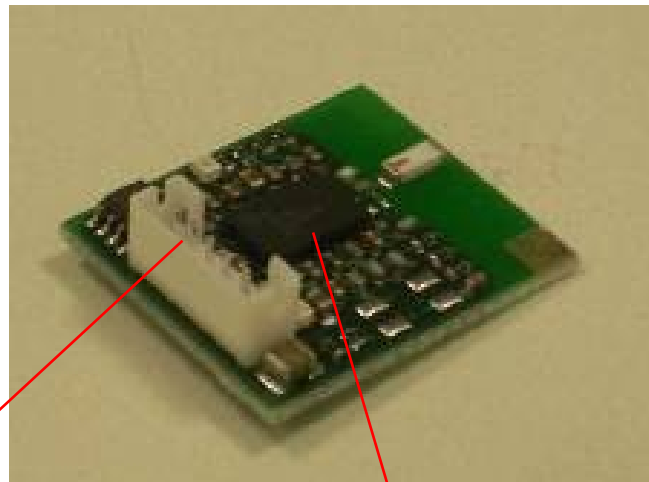
HEAD CONTROLLER

Freescal MC68HC908AP8-20Mhz-8KB



[BLUETOOTH MODULE]

National LMX9830

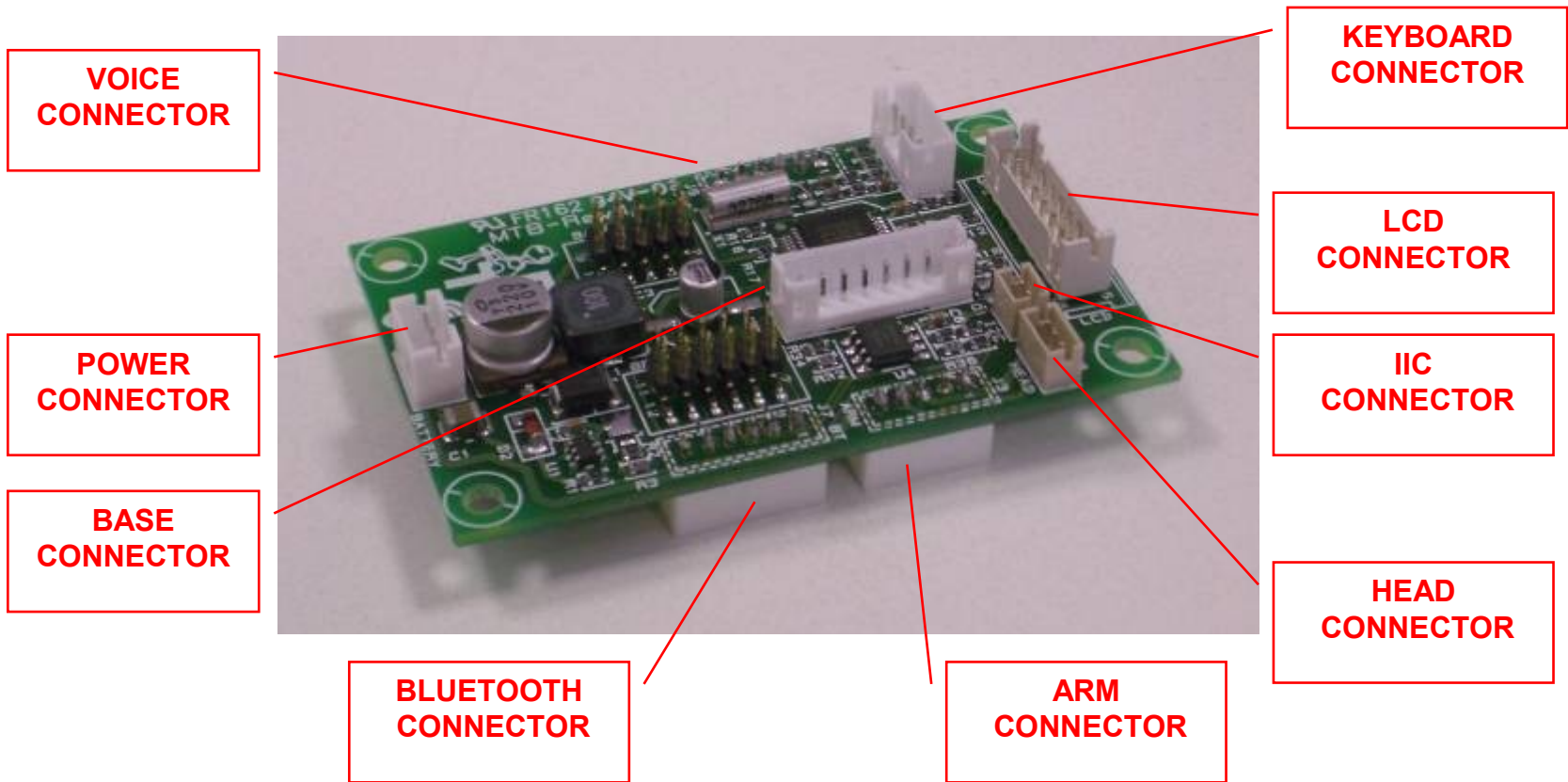


**POWER
CONNECTOR &
RS232
CONNECTORS
(BRAIN&VISION)**

LMX9830

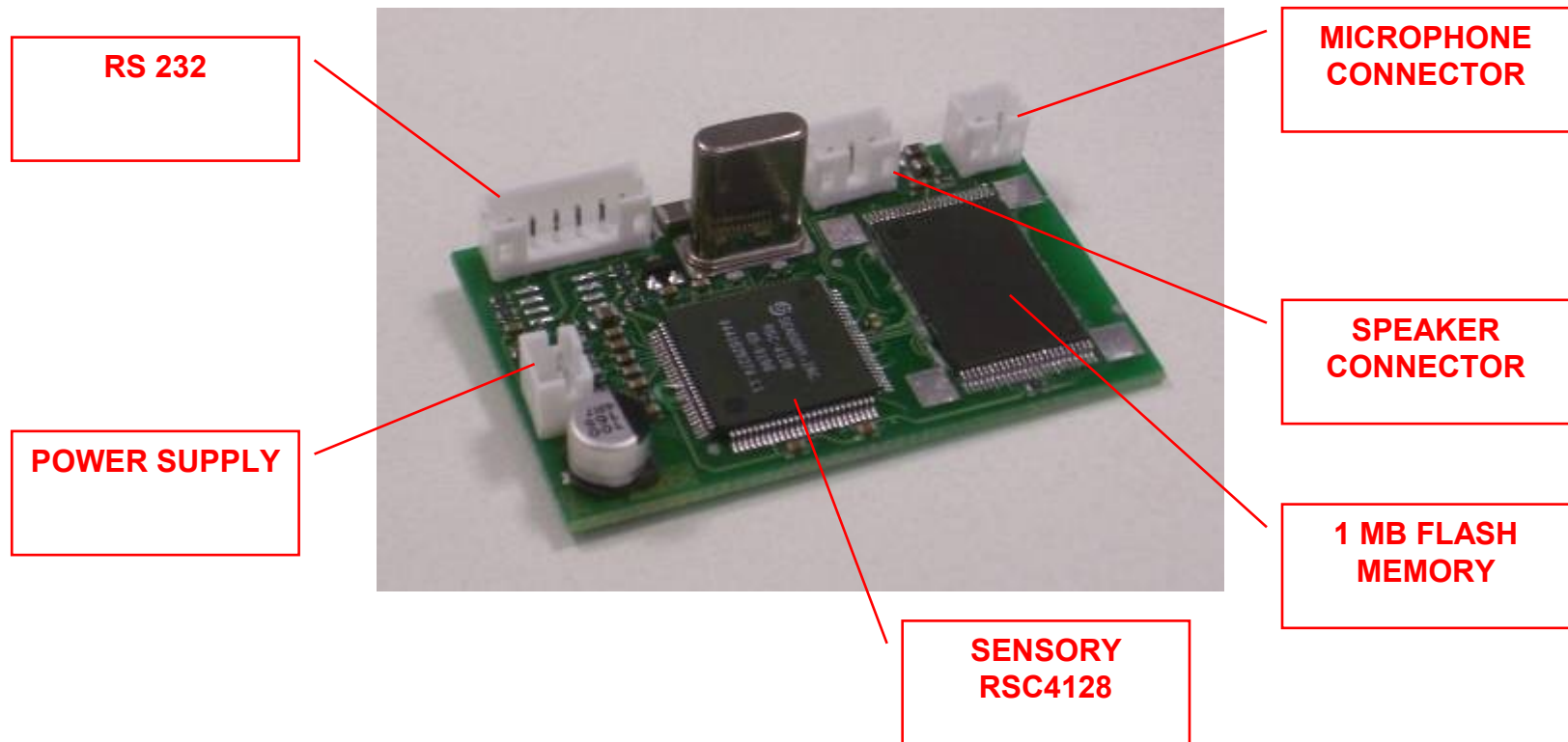
MOTHERBOARD

Freescle MC68HC908AP8-20Mhz-8KB



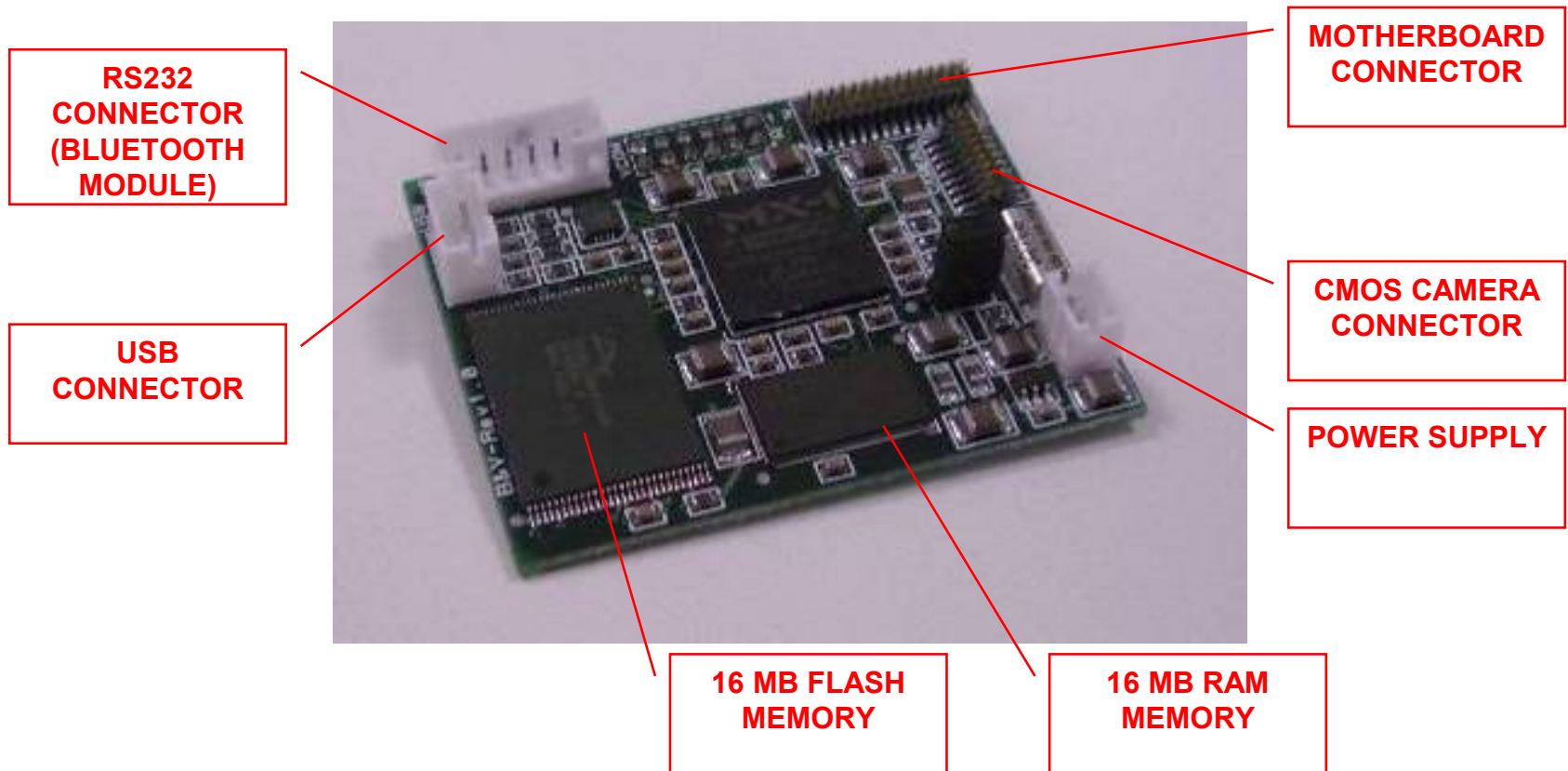
[VOICE]

Sensory RSC4128–Flash 1MB



[BRAIN & VISION]

Freescle MC9328MXLVF15



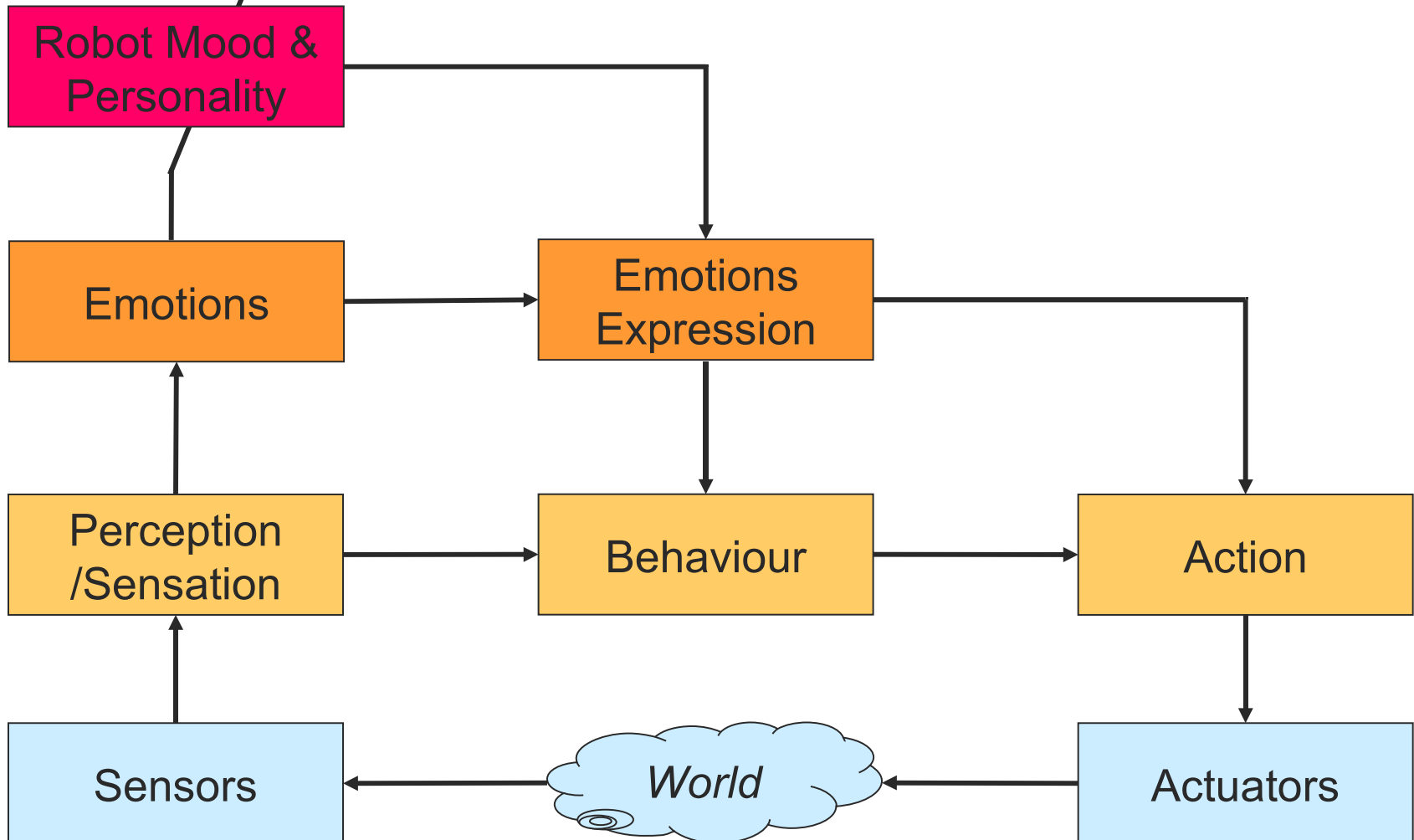
Software Architecture

- Operative System:
 - Linux 2.4 for Arm Processors with C Compiler (Tyni C) on-board
- Two Main Process:
 - *System Controller* for running robot behaviours
 - *User Process* for running user programs
- Multi Treads Architecture
 - A process run for each behaviour and for the main robot functionalities
 - 9 threads run concurrently
 - Robot status is implemented as global structure shared between threads

[Basic Robot Behaviours]

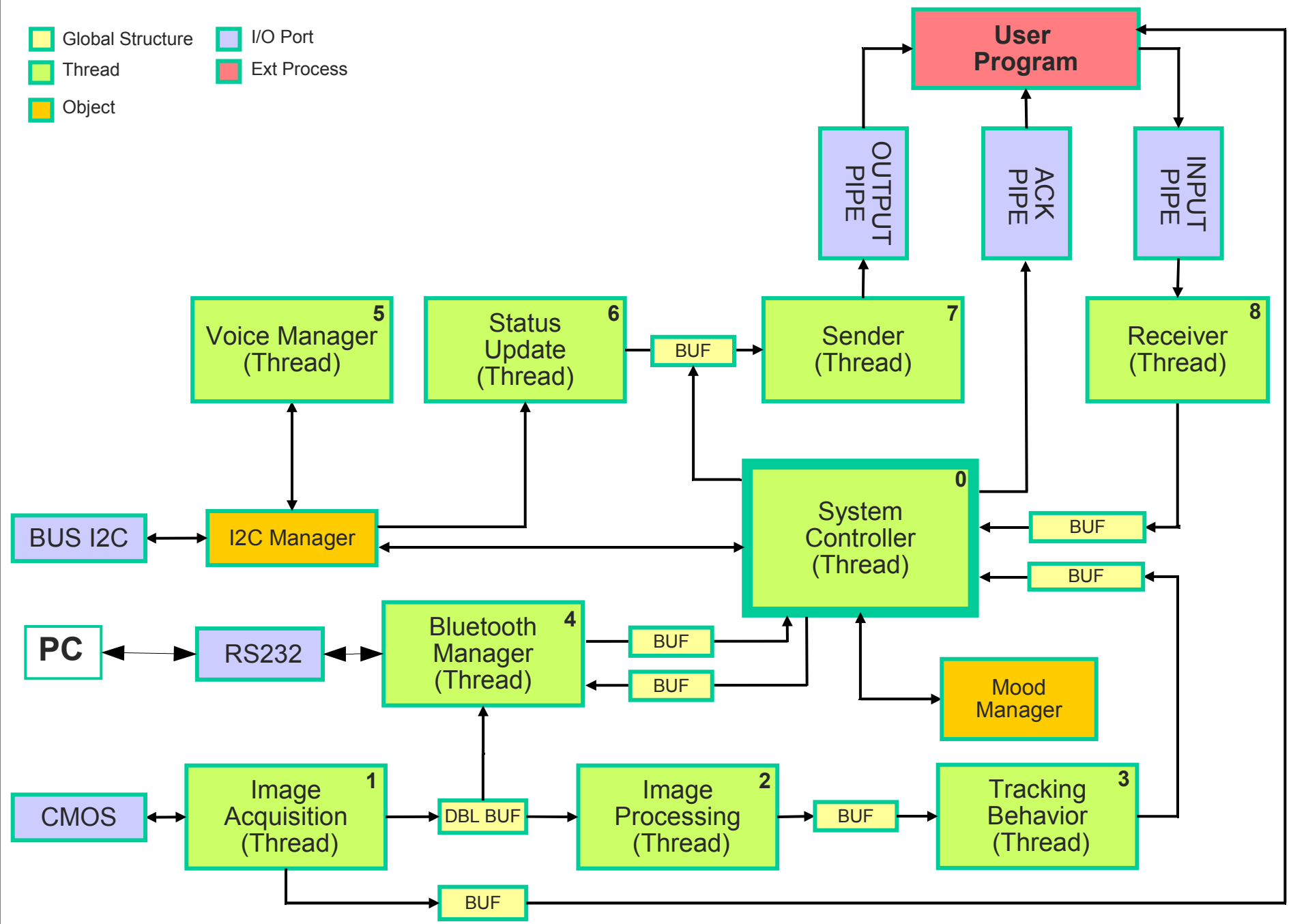
- Execute user commands (voice or mobile phone/PC via Bluetooth)
- Rotate Head toward sounds (on request)
- Rotate Head toward people (on request)
- Track and follow moving object (on request)
- Avoid obstacle during motion (on request)
- Emotions and Personality

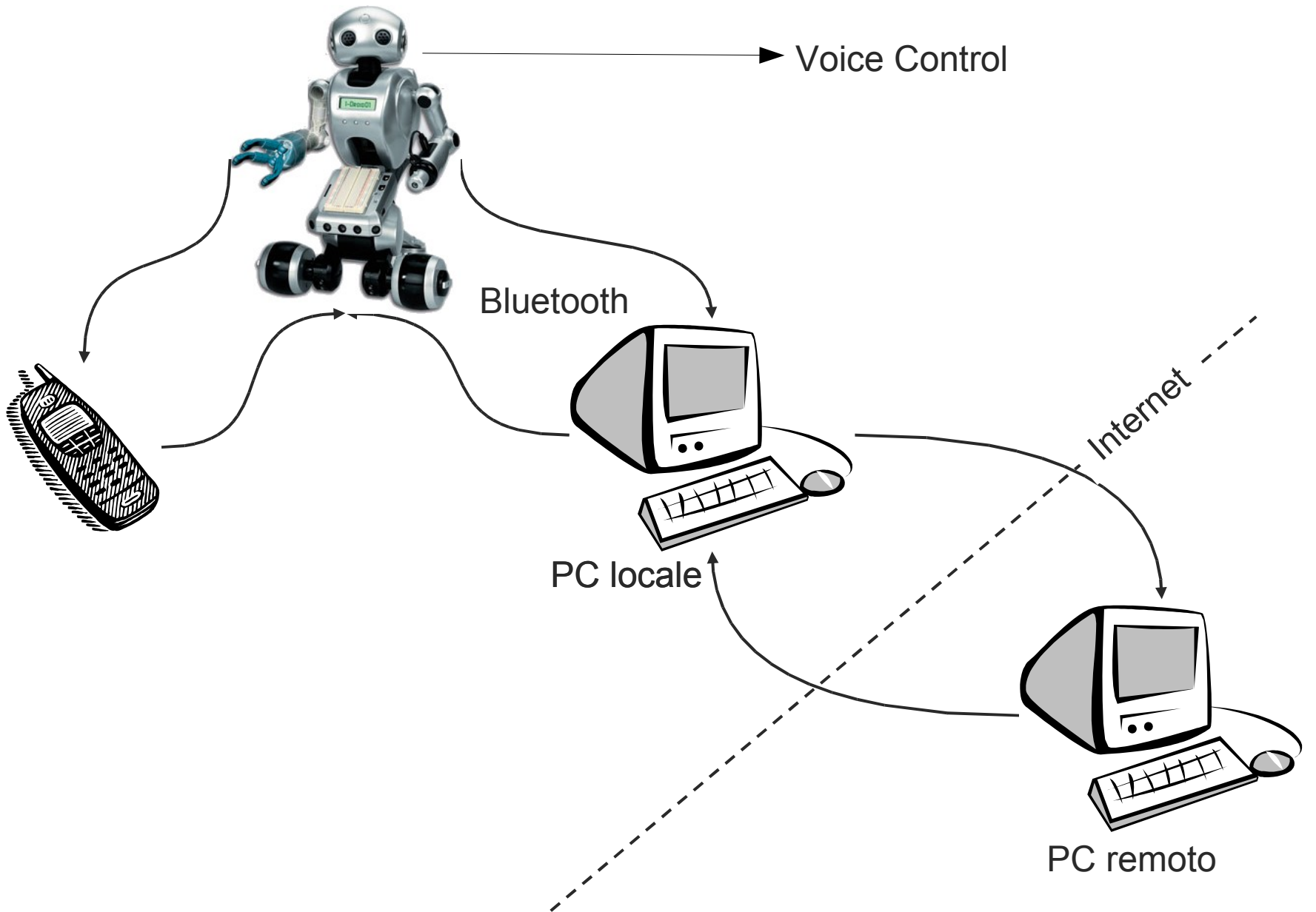
Behaviour based control architecture



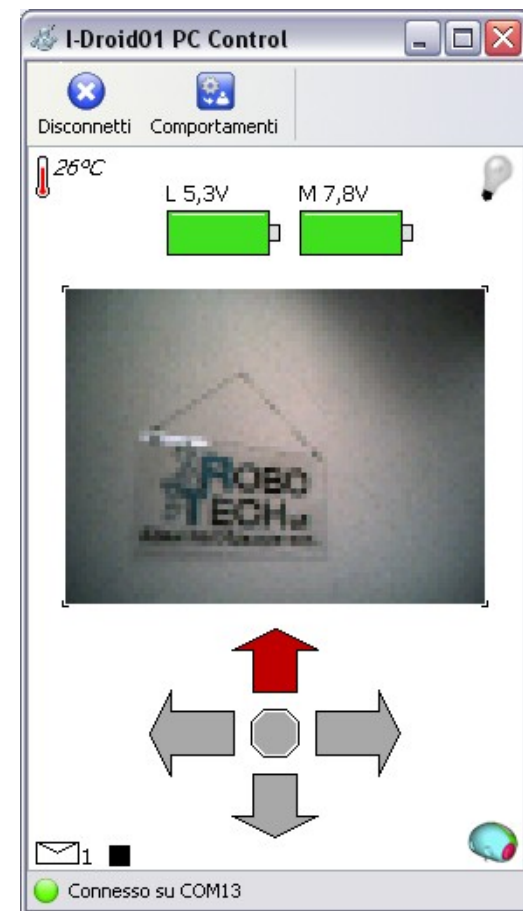
I-DROID01 SOFTWARE ARCHITECTURE

- Global Structure
- Thread
- Object
- I/O Port
- Ext Process





GUIs for PC and Mobile Phone (remote control)

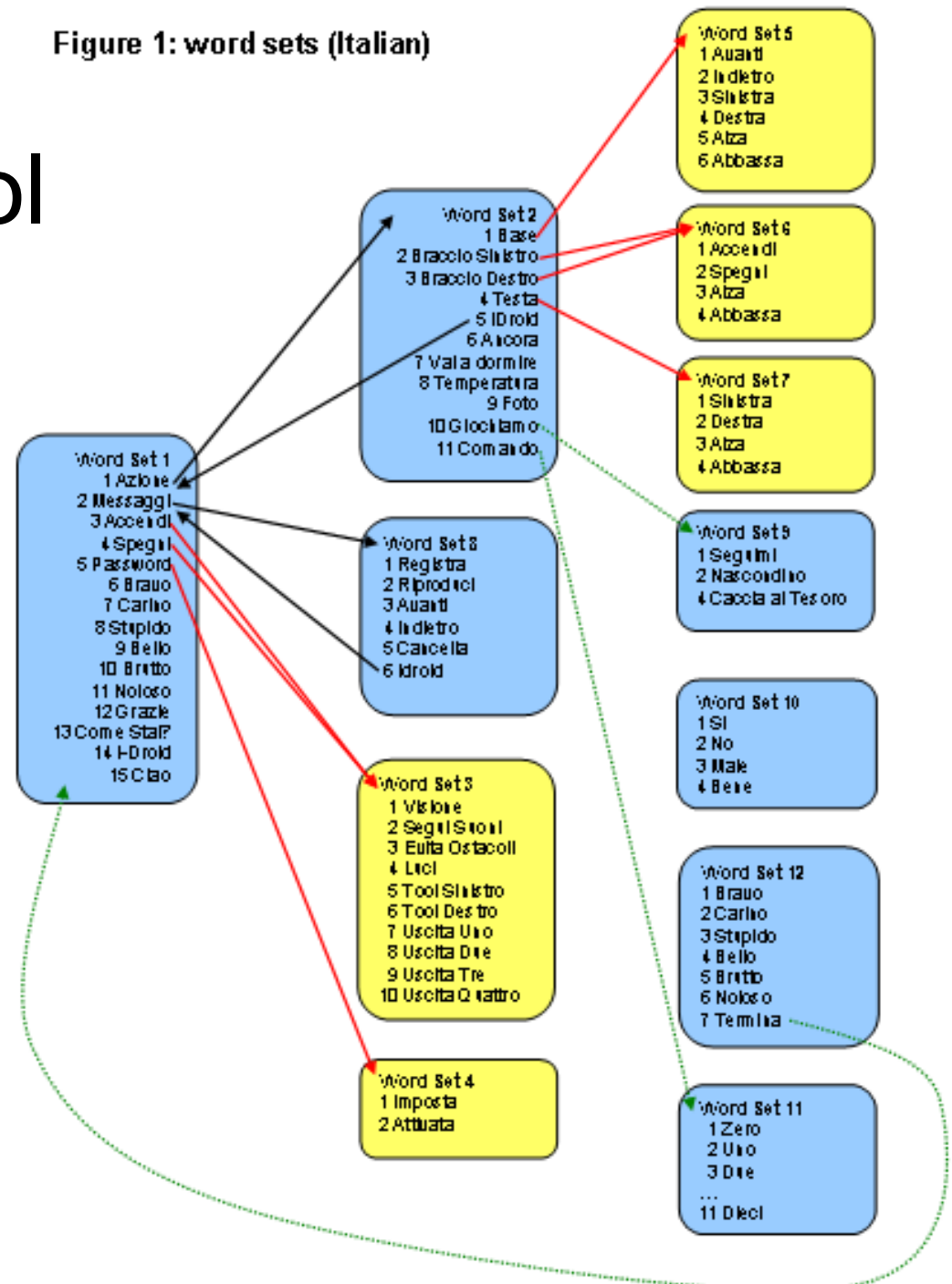


Based on Java
Technology

Voice Control

- 11 wordsets
- 84 different commands

Figure 1: word sets (Italian)



[Robot Programming]

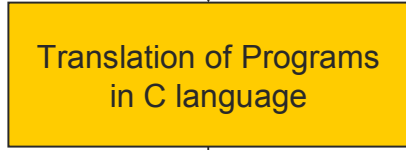
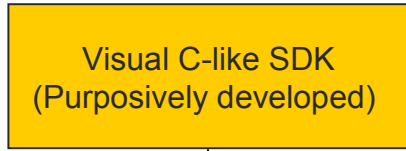
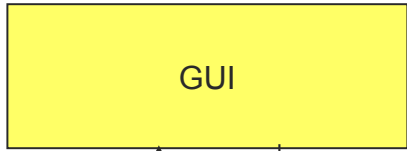
- Three different programming modalities:
 - Basic level: graphical/icons (Visual C-like)
 - Intermediate level: C-like
 - Advanced level: Java

Remote Control (PC/Mobile Phone)

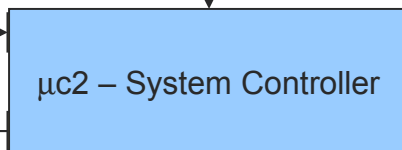
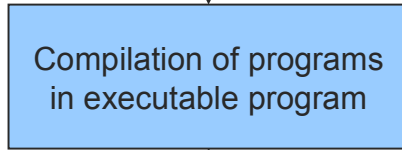
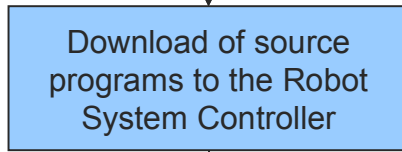
BASIC

INTERMEDIATE

ADVANCED



PC
B&V

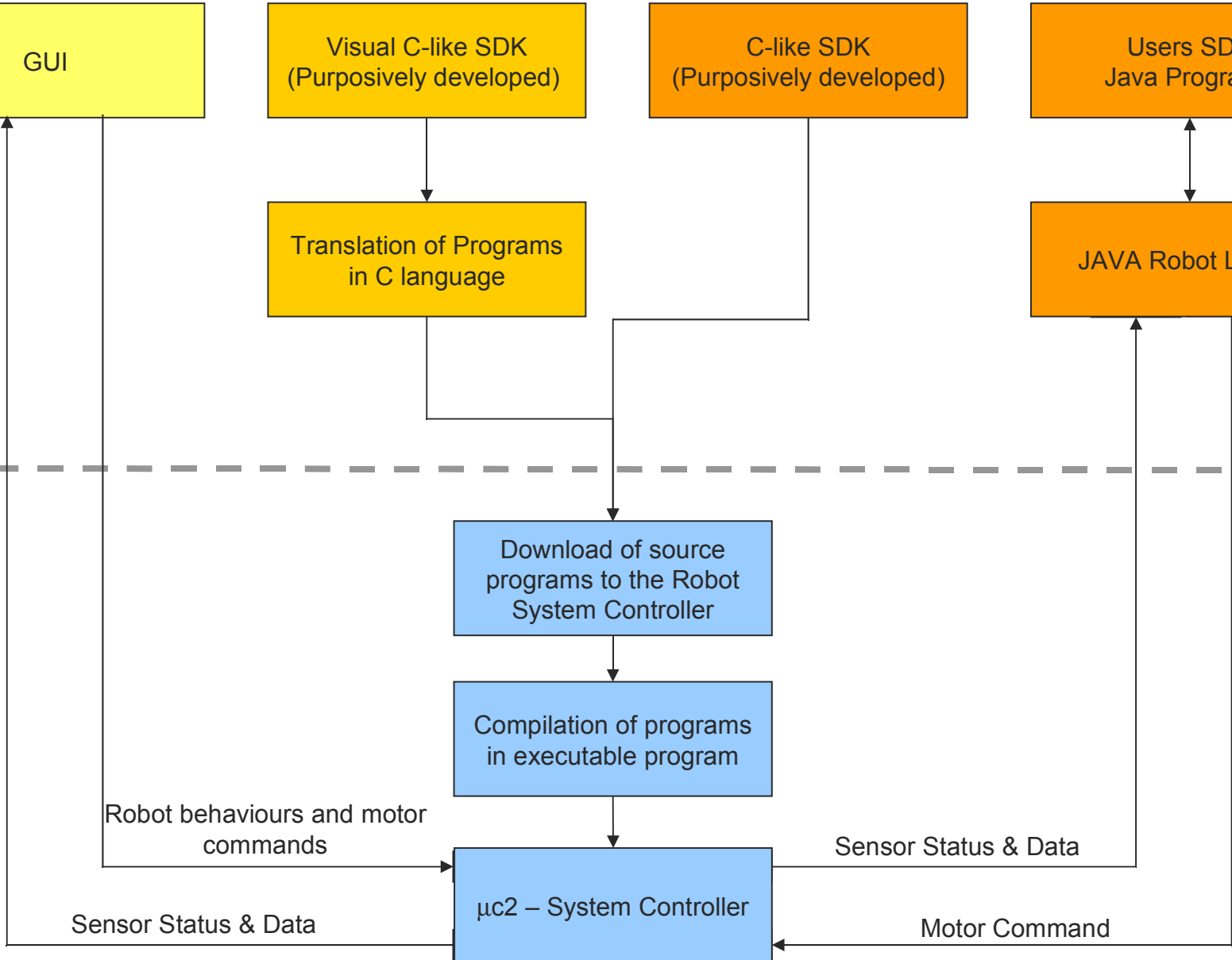


Robot behaviours and motor
commands

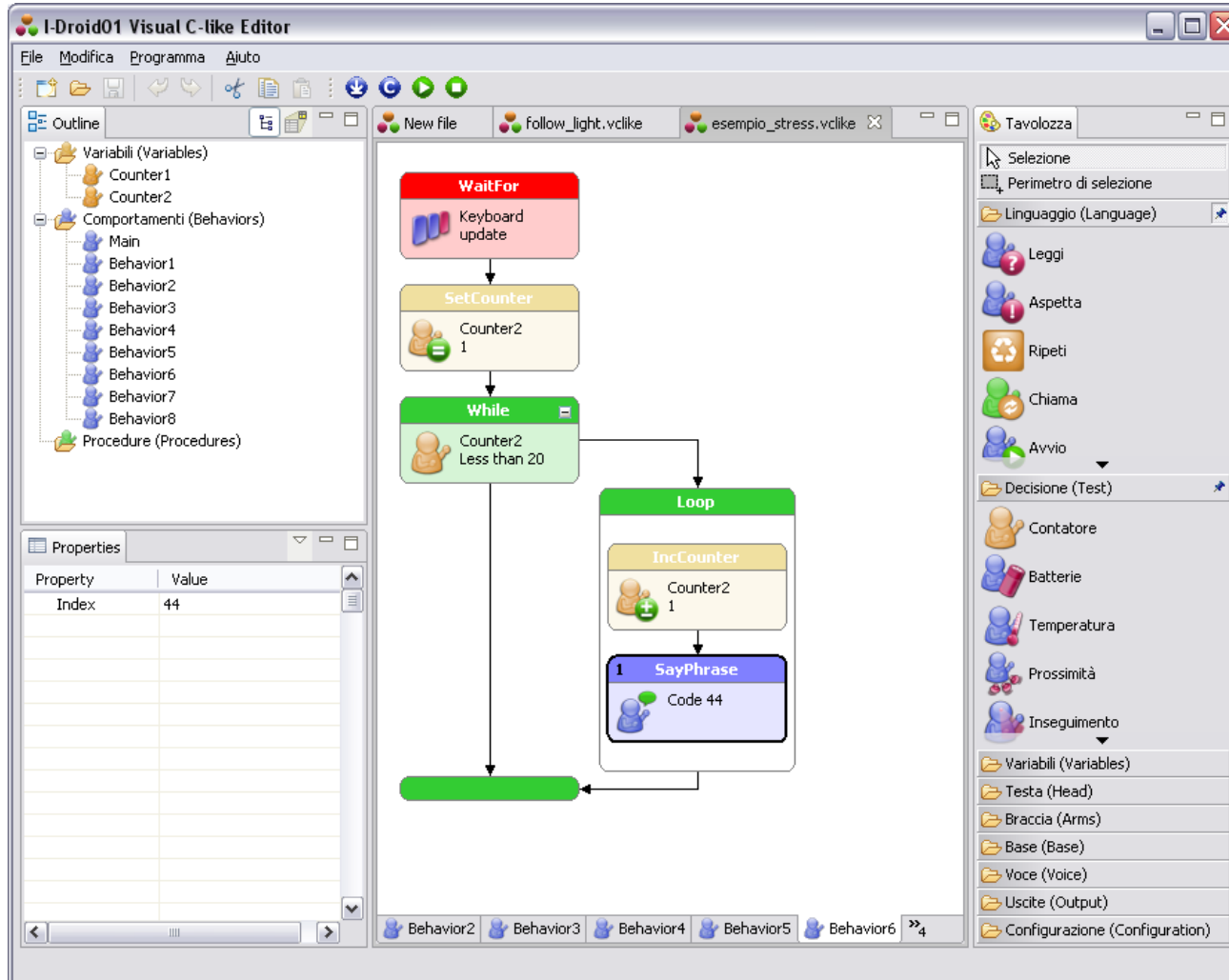
Sensor Status & Data

Sensor Status & Data

Motor Command

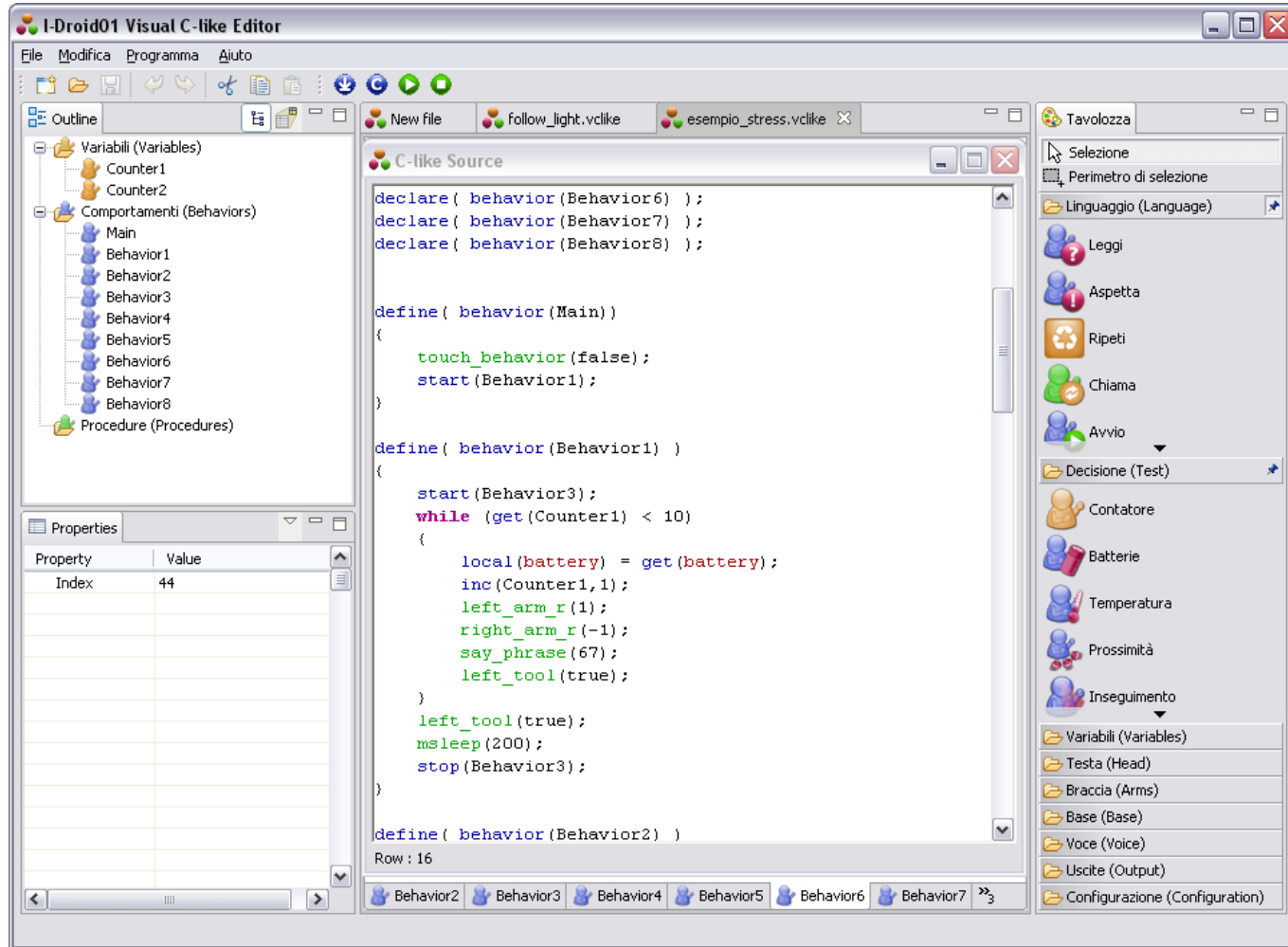


Robot Programming: Visual C-like



Behaviour based

Robot Programming: c-like



Automatic translation from Visual C-like to C-like language

Additional GPIO and breadboard for user custom circuits development

- 1. GND
- 2. I2C-SCL
- 3. I2C-SDA
- 4. Digital I/O 4
- 5. Digital I/O 3
- 6. Digital I/O 2
- 7. Digital I/O 1
- 8. Analog IN 1
- 9. Analog IN 2
- 10. 3V

