FLASH Robotics

EMYS

EMotive headY System

OVERVIEW

revision 1.31

FLASH ROBOTICS

A head for socially aware robot plays a fundamental role in the interaction with humans. It should be able to behave naturally and express emotions that are easily understandable for a person. These are the key features in successful interaction with humans.

Meet EMYS - a robot ready for the challenges of the modern society.

EMYS is an expressive robotic head. It consists of three independent discs of which the upper and lower ones are movable. The robot's popping eyes are situated in the middle disc. Thanks to its unique shape, the head is always well received by its users and they have no problem with recognizing the emotions that EMYS expresses.

Visually Perceptive

EMYS can detect and track a person, their hand-held objects and their gaze targets. You can interact with him in a natural way - he can understand social ques, share attention, and learn to recognize new colors.

His vision system is comprised of a hi-res camera mounted in his nose and a Microsoft Kinect device playing the role of an advanced motion sensor. It allows him to detect humans as well as provide information on position of particular parts of their bodies. It also provides gesture recognition algorithms, 3D face tracking, and recognition of some facial features.

Streams from both devices can be processed by algorithms which provide basic image processing (e.g. blurring, thresholding and morphological operations), object detection (e.g. human faces or certain body parts), color and movement detection, and much more.

Communicative

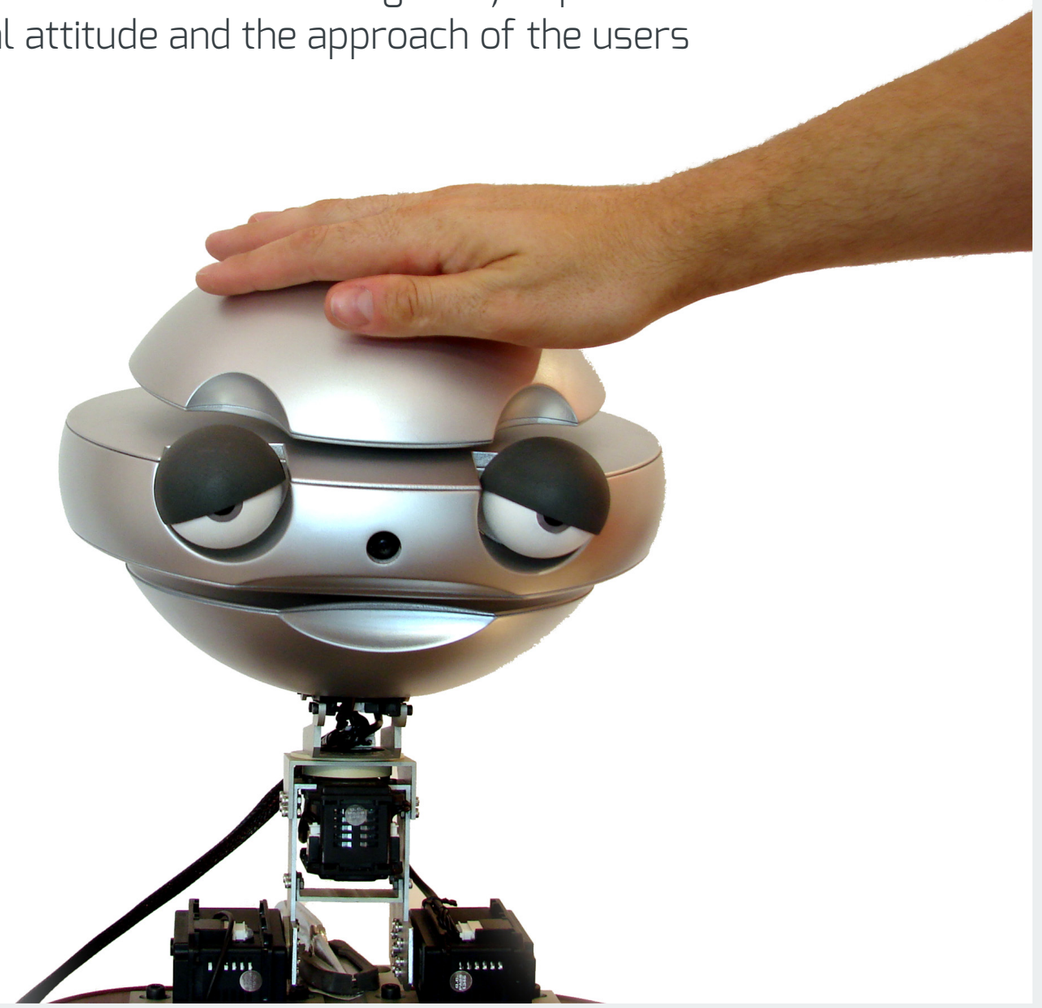
EMYS can speak using 27 different voices and languages.
He can recognize your commands and react to them.

His audio system is comprised of a microphone mounted within his middle disc and a premium speaker. His facial expressions are synchronized with the uttered phrases, imitating corresponding mouth movements. A Kinect sensor provides speech recognition and detection of voice direction utilizing a microphone array.

Sensitive

EMYS can feel your touch in many points. You can pat and tickle him and he reacts to it in a natural way.

Physical contact with robots and their autonomous behavior have a large impact on the perceived human-likeness and credibility. Being able to touch EMYS and see him react can greatly improve the general attitude and the approach of the users



Connective

EMYS can connect to the Internet and browse news services, send and receive emails, check weather forecasts, use your Facebook account, Google Calendar, Google Contacts,...

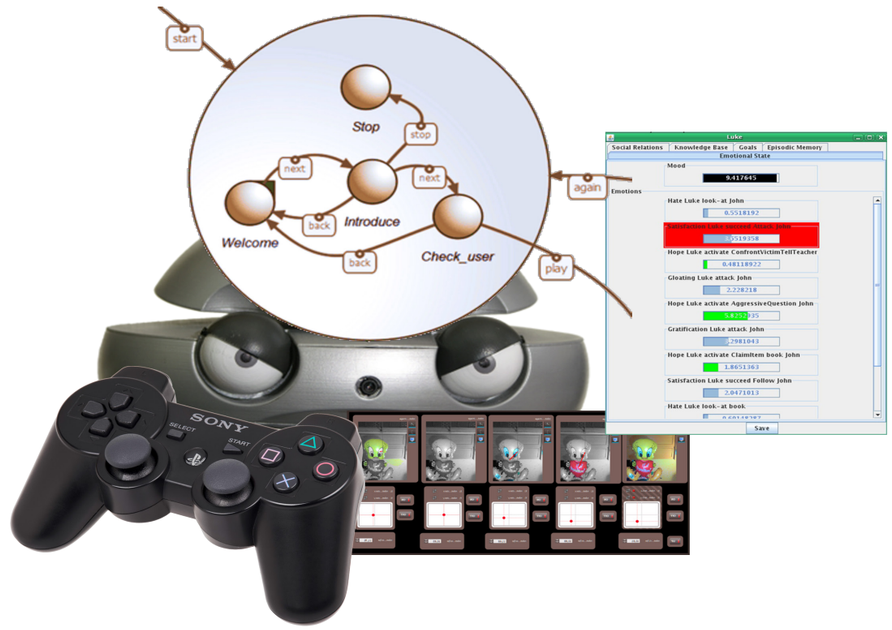
Information gathered by the robot could potentially be used to stimulate everyday human-robot interaction. A robotic companion could become an interface to the external world by enabling the human to use the above mentioned media in an accessible manner. This is especially important for people not familiar with modern means of communication.

Intelligent & Controllable

EMYS' decision system can easily be adapted to your needs since it supports different design approaches.

During short-term HRI, the role of this system is often played by finite-state machines enabling reliable operation and quick development. For long-term interaction, the robot can be enriched with an emotional component providing non-repetitive actions. The decision system can also be assisted by a human operator.

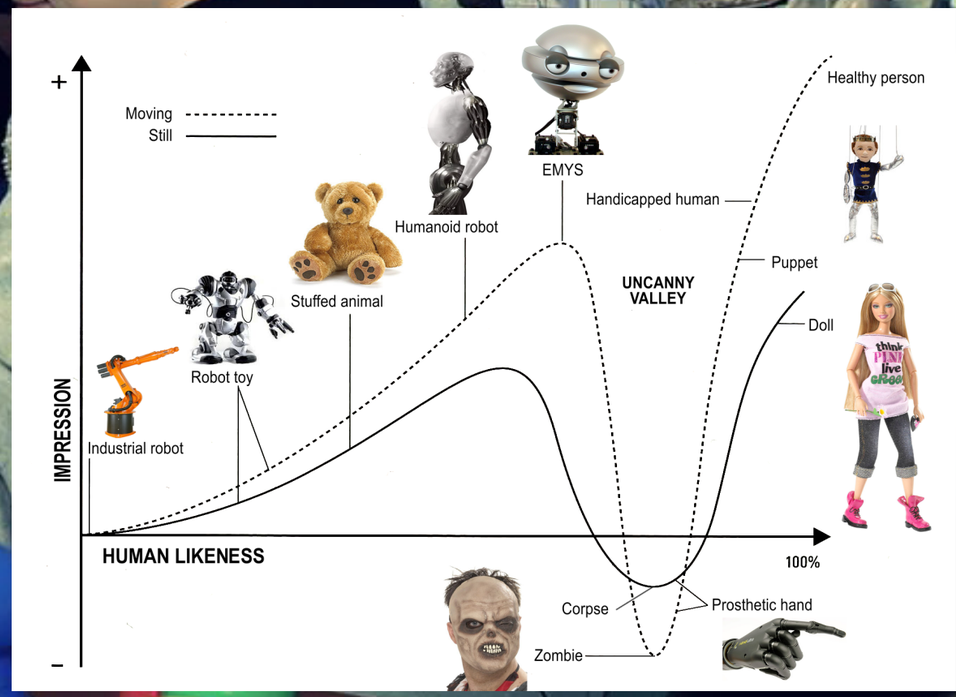
Thanks to the integrated computational model of emotion with appraisal capabilities, information gathered from the Internet like news, weather forecasts, messages, etc. can be affectively assessed to extract the emotional meaning.



The introduction of robots into the human environment is not only associated with the development of technology including control systems, mechatronic or sensory solutions. The appearance of the robot is also an important factor. The physical realization should reflect the actual capabilities. When this balance is upset, the robot cannot be fully accepted by humans or might even cause disgust This phenomenon is called the uncanny valley

EMYS is viewed as friendly and kind which is crucial for stablishing and maintaining relationship. He arouses positive emotions and people feel safe with him. They recognize that his appearance as well as his behaviors, are human-like.

His unique, mechanoidal shape allows him to avoid the uncanny valley phenomenon and, although he consists of only three discs, he can effectively express various emotions.



Technical specification

PHYSICAL PARAMETERS

SIZE:
height: 351 mm,
base width: 186 mm,
head diameter: 248 mm,

WEIGHT:
approx. 5kg (11 lbs),

MATERIAL:
chassis: aluminum,
covers: PA2200 (printed in SLS technology),
possible custom colors.

MOTION

NECK & DISCS DRIVE SYSTEM:
Robotis Dynamixel MX-series, all utilizing Maxon RE-max series motors with 12-bit magnetic encoders.

EYE EJECTION MECHANISM:
Eyes pop out 10cm. Driven by maxon DCX-series motors with 10-bit magnetic encoders.

EYELID & EYEBROW DRIVE SYSTEM:
High performance analog micro RC-servomotor.

Communication with all motors is achieved using Dynamixel protocol through serial ports. It enables controlling the actuators and provides all necessary functions like velocity and position control with torque and angle limiting.

TOUCH SENSORS

Five touch sensing points (electrodes) based on capacitive scan method. Accessed via Dynamixel protocol.

FEATURES:
Noise detection and touch detection algorithm for reduced false touches when faced with electrical noise.

POWER SUPPLY & CONNECTORS

POWER:
external fanless power supply:
12V DC, 15A.

CONNECTORS:
1x USB 2.0 (all robot's subsystems),
1x USB 3.0 (when using Kinect v2),
1x power connector (custom).

CONTROL PLATFORM

MASTER PC CONTROLLER:
Two possible options:
Mobile DC powered computer integrated into the robot's base.
External AC powered computer

SPECIFICATION: 3rd Generation Intel Quad Core i7 Platform, 8GB Memory (DDR3 1333/1600MHz), embedded graphics (Intel® HD Graphics), Gigabit LAN controller (Intel 82579LM), Audio Line-Out and Mic-In, Wireless LAN (optional), 2x USB 2.0, 2x USB 3.0, 1 x 2.5-inch SATA II min. 120GB SSD, 1 x full-size mSATA.
POWER: ACPI 3.0, external power supply 19V DC 3.42A (ATX/AT mode).
OPERATING SYSTEM: Microsoft Windows 8, Windows 7, Windows Embedded, Linux Ubuntu.

ONBOARD MOTION CONTROLLER:
SPECIFICATION: ARM Cortex M4 @ 100MHz 512KB.
OPERATING SYSTEM: Freescale MQX RTOS.

VISION

RGB CAMERA: integrated in EMYS nose: 15fps@1080p, 30fps@720p HD video, high-precision glass element lens, 75° diagonal field of view, automatically controlled exposure providing bright and colorful video.
RGB-D SENSOR: Microsoft Kinect sensor.

AUDIO

MICROPHONE: omni-directional wideband microphone mounted in the robot's nose area.
STEREO SPEAKERS: mounted in the lower disc (option).
MICROPHONE ARRAY: four microphones integrated with an Microsoft Kinect sensor.

All of EMYS' subsystems can be controlled via ROS. Communication with motors and touch sensors is realized using protocol from the Robotis' Dynamixel servomotors, which have their own dedicated ROS node. The head's sensors (Kinect and RGB camera) can also be accessed via ROS.

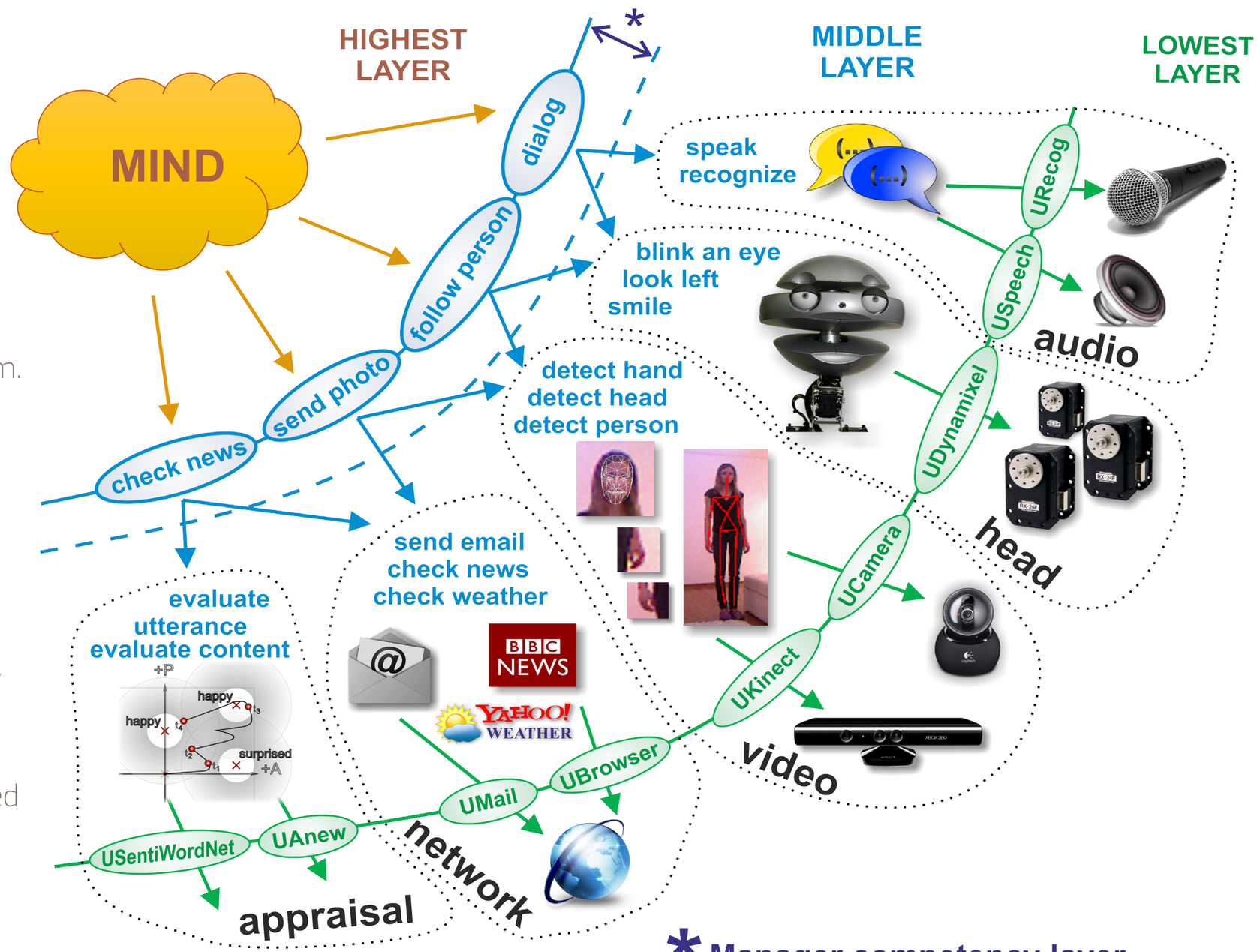
ROS

When situated in home environment, EMYS can provide new possibilities related to increasing the humans' activity, help children learn, assist people in their everyday activities or help the elderly use modern means of communication.

The abundance of information and the universal access to the Internet have contributed to what can be described as an addiction to mass media. Effortless access to data has become the basis of a complex new system of social communication, influencing our intellect, emotions, and social behavior. EMYS possesses functions allowing him to find and read news from the Internet (and communicate them with regard to emotional content), browse websites, RSS channels, TV guides, weather forecast, stock exchange, etc. EMYS can also provide many different communication channels such as: e-mails, Facebook, Google Contacts, etc.

Control system

The control system complies with three-layer control architecture paradigm. Its lowest layer provides necessary hardware abstraction, and integrates low-level motion controllers, sensor systems, and algorithms implemented as external software. The middle layer is responsible for the functions of the robot and the implementation of his competencies (formed by combining low level functions). It defines a set of tasks the robot will be able to perform. The highest layer may incorporate a dedicated decision system, a finite-state machine. or a comprehensive system simulating human mind functionalities.

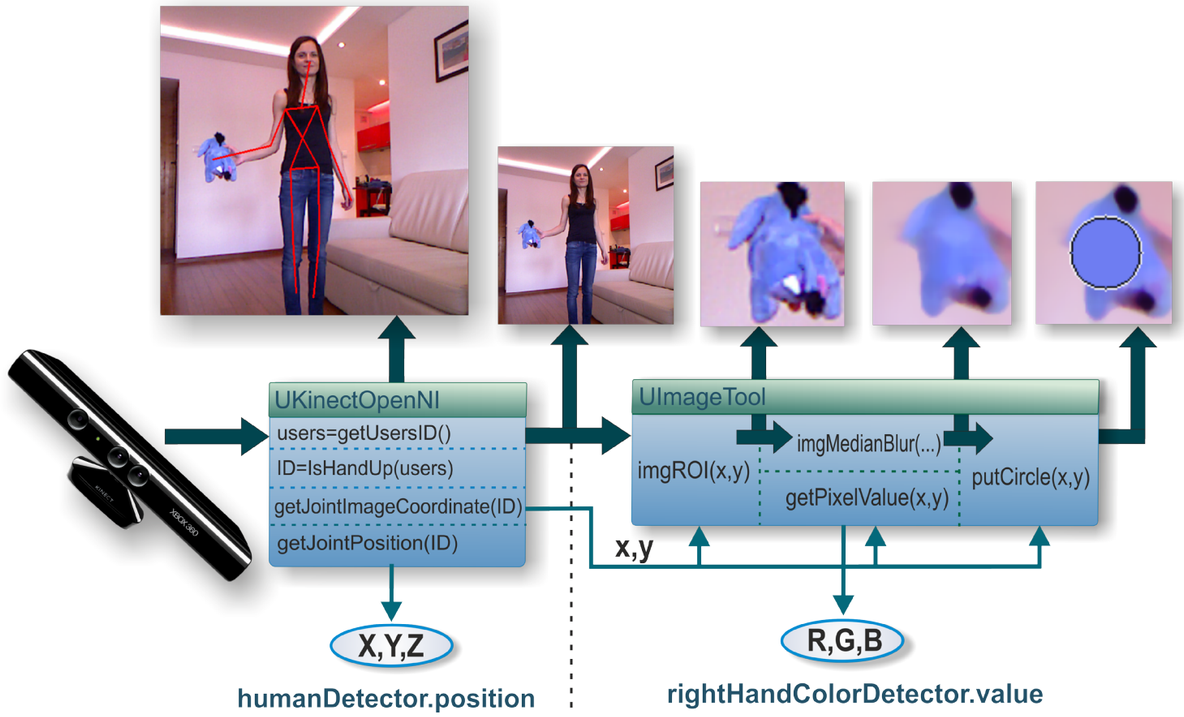


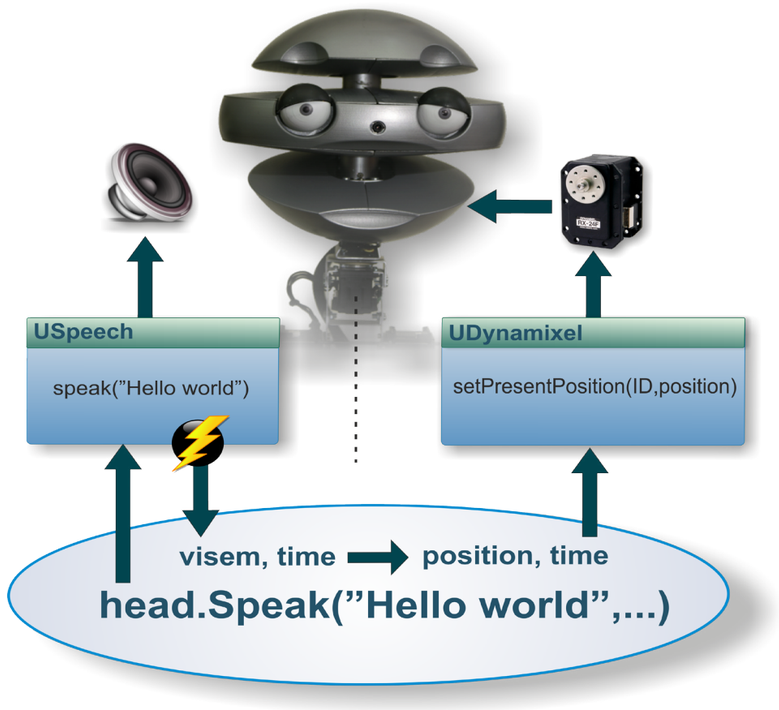
EMYS possesses a set of competences allowing interaction with people, multimodal perception of environment, and collecting many types of data. Thanks to his features, he is perfectly suited to performing tasks requiring social skills from a robot.

The modularity and flexibility of the robot's control system allows for easy development of his capabilities and adaptation to new applications.

Everything must happen in time...

Urbi platform is used as the main tool for handling the various software modules. It integrates and provides communications between the two lowest levels of the architecture. This allows dynamic loading of modules and provides full control over their operation. Urbi also delivers urbiscript – a script programming language for use in robotics, oriented towards parallel and event-based programming. It serves as a tool for management and synchronization of various components of the control system. Urbiscript syntax is based on well-known programming languages and urbiscript itself is integrated with C++.





Of particular interest is the orchestration mechanism, built into Urbi, which handles among others the scheduling and parallelization of tasks. Thanks to this feature all the activities of the robot can be synchronized with each other, e.g. movements of joints during head and arm gesticulation, mouth movement with speech, tracking of objects detected in the camera image, etc.

Additionally, it is possible to launch ROS nodes using urbiscript so the two systems can be used together to get the best of both worlds.

Everything is on-board

The lowest layer of the control system consists of dynamically loaded modules called UObjects which are used to access hardware or software components, such as actuators and sensors on the one hand and voice synthesis or face recognition algorithms on the other hand. Components with an UObject interface are supported by the urbiscript programming language.

COMMUNICATION MODULES

UDynamixel - transfers data using Dynamixel protocol which enables controlling the actuators driving the head.

UAria - enables controlling the mobile platform via ARIA protocol. It gives FLASH full compatibility with Mobile Robots products and offers a support for popular laser scanners.

USerial - transfers data via serial port. General purpose module that many other robot functionalities are based on.

AUDITORY MODULES

UPlayer - simple module for playing pre-recorded .wav files.

UPlayerNext - advanced module for playing and recording (WAV/AIFF/MP3/MP2/MP1/OGG/URL Streams). It enables the robot to play back sounds from files/broadcast streams, record from microphones with many effects (equalizer, phaser, autowah, echo, distortion, chorus, dynamic aplification, BPM counter and beat trigger...).

URecog - this module uses Microsoft Speech Platform to recognize speech using available microphones.

USpeech - this module uses Microsoft Speech Platform for real-time speech synthesis.

UMP3 - PCM (wav) to MP3 converter.

VIDEO MODULES

Group of modules provides image processing capabilities on RGB and RGB-D data. Images from a sensor can be accessed and processed by modules implementing OpenCV library functions.

UCamera - image capture functions and camera settings.

UImageTool - basic image processing such as blurring, thresholding, morphological operations, drawing basic shapes, color conversion, I/O operations, etc.

UObjectDetector - detecting objects, e.g. human faces or body parts using Haar classifier.

UColorDetector - color detection in HSV space.

UMoveDetector - movement detection.

UKinectOpenNI2/UKinect - extracting RGB-D data from a Kinect sensor, measuring the distance to objects present in the image, detecting human silhouette, providing information on position of particular body parts, and recognizing simple gestures. UKinect is based on Kinect SDK and provides additionally such features as 2D and 3D face tracking and microphone array support, speech recognition and detection of voice direction.

MACHINE LEARNING MODULES

UKNearest - data classification alghorithms (e.g. color learning).

UEigenfaces - user recognition alghoritm.

EMOTIONAL MODULES

UWasabi - implementation of Wasabi emotional system (by Becker-Asano).

UPAD - implementation of dynamic PAD-based model of emotion.

APPRAISAL MODULES

Information gathered by the robot (from the websites, e-mails or via auditory modules) can be affectively assessed to extract their emotional content using the following modules:

UANEW - utilizes ANEW (Affective Norms for English Words) project. It can be used for evaluating a word or a set of words in terms of feelings they are associated with.

USentiWordNet - is based on a project similar to ANEW - SentiWordNet. It is a lexical resource for opinion mining and assigning ratings to groups of semantic synonyms (synsets).

UWordNet - is an interface to WordNet - a large lexical database of words, in which nouns, verbs, adjectives and adverbs are grouped into synsets, each expressing a distinct concept. It can be used as a synonym dictionary to find the basic form of a word.

NETWORK MODULES

UBrowser - implements the functions of a web browser and an RSS reader. The module provides a wide variety of functions needed for extracting particular information from the Internet, like weather forecast or news.

UMail - serves as an e-mail client with the ability to check and read mails and send messages with various types of attachments (e.g. image from the robot's camera or a voice message recorded by a Kinect sensor).

UFacebook - module to handle Facebook's social networking services. Using this module, the robot is able to post new messages, upload photos (e.g. from his camera), retrieve posts and a variety of other tasks that a FB app might require.

UGCalendar - allows to connect EMYS with personal Google Calendar and Google Contacts.

UTextTool - implements text functions like encoding, removing html markups, I/O operations, date/time processing, etc.

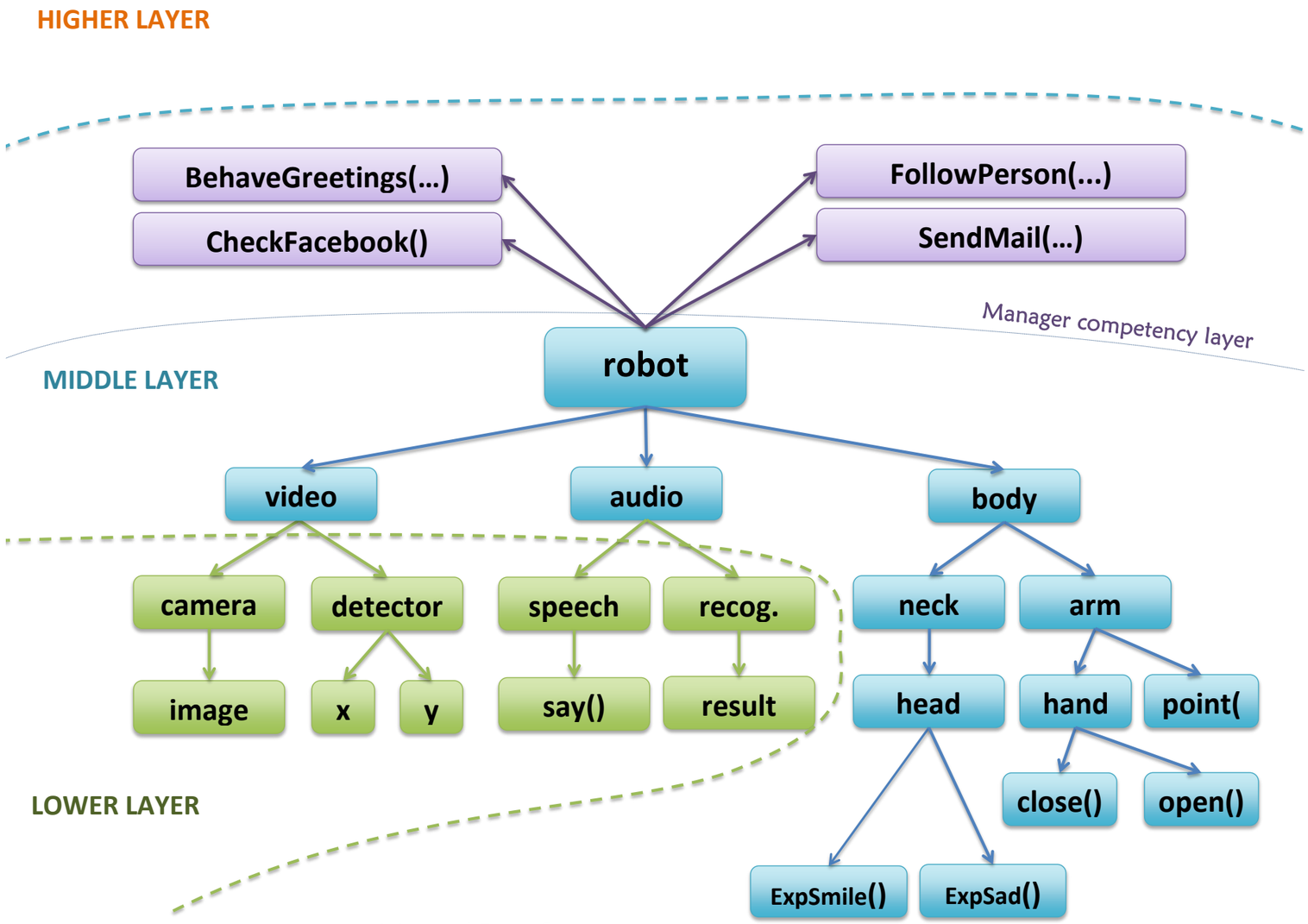
REMOTE CONTROL MODULES

UJoystick - Module to handle pads, joysticks, etc.

UKeyboard - Module for capturing pressed keys.

Easy to program

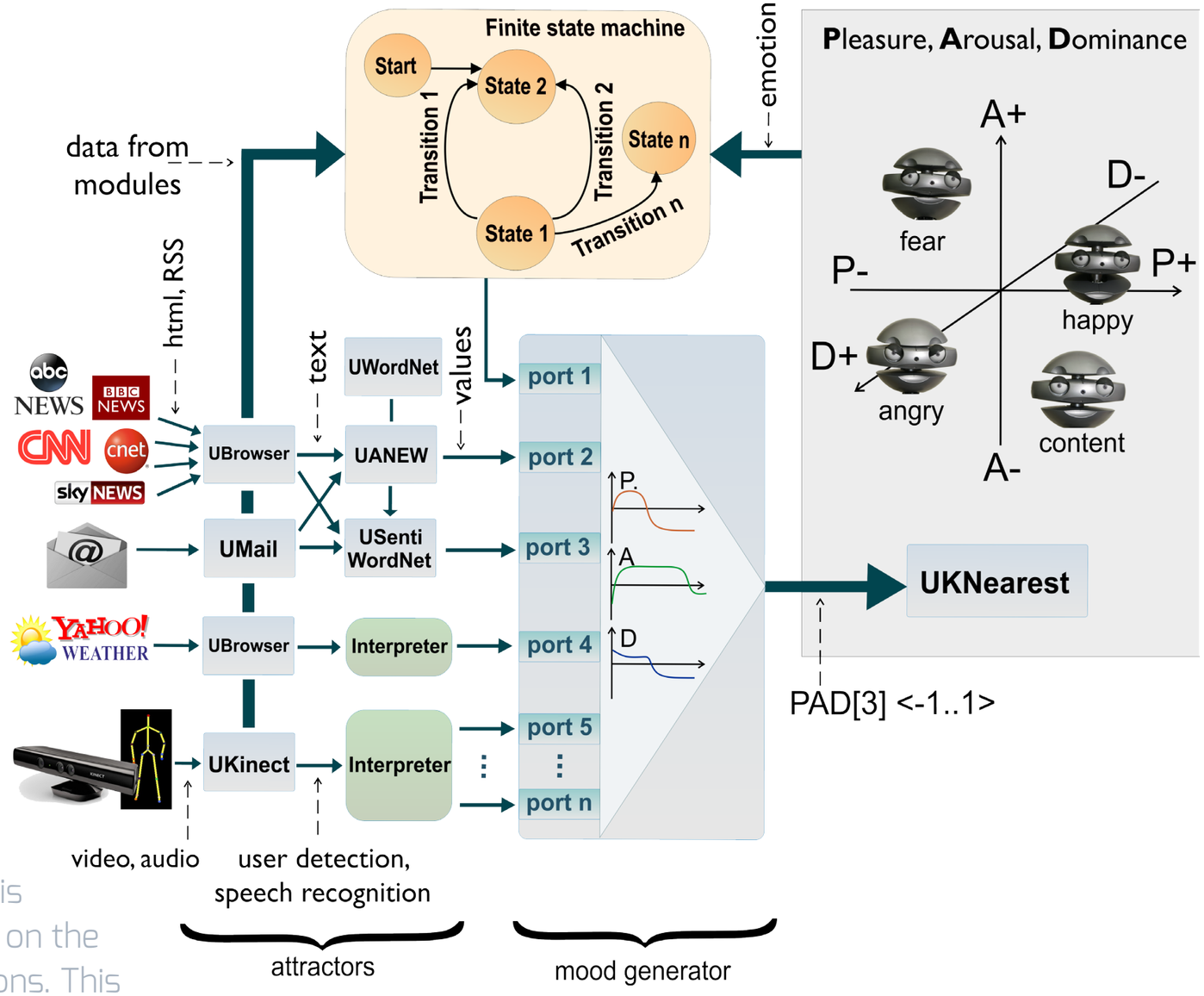
The robot can be programmed in urbiscript by sending instructions to the Urbi engine through a client application. Specific functions, competencies and parameters can be accessed by API in a unified manner - using a tree structure: "robot". By inserting the names of suitable branches preceded by a dot, one can access subsequent components, e.g.




```
robot.body.neck.head.Smile(3s);                          // smile for 3 sec.
robot.audio.speech.recognition.result;                   // get speech recognition result phrase
robot.video.camera.image;                                // get image from camera
robot.video.humanDetector.position;                      // get human xyz position
robot.video.rightHandColorDetector.value;                // get color of the object held in the hand
robot.ml.colorLearning.LearnFromRightHand("red");        // teach robot colors
robot.network.weather.condition.temperature;             // get the temperature from weather forecast
robot.network.mail.Check();                              // check if there are new emails
robot.network.facebook.Post("me","Hello world!");        // post a message on Facebook
```

Beautiful mind

In order for a robot to be called social, it should be equipped with some sort of an affective mind. This mind should consist of a rational component, enabling the robot to plan its actions and achieve its goals, and an emotional system, which would simulate its emotions and produce reactive responses. The role of an emotional component in HRI is crucial. It influences the control system, changing the perceptions and goals based on simulated mood. Emotions also provide reliable and non-repetitive reactions, and increase the credibility of a social robot's behaviors. This affective mind is housed in the highest layer of EMYS' control architecture.



Perhaps the most advanced available affective mind is FAtiMA (FearNot! Affective Mind Architecture) based on the Orthony, Clore and Collins appraisal theory of emotions. This software can be integrated with EMYS' control system. He can autonomously achieve goals defined in the highest layer of his control system using his competencies in an unknown environment.

The project is hosted by SourceForge

http://fatima-modular.sourceforge.net

Two emotional systems - Wasabi by Becker Asano and a dynamic PAD-based model of emotion have been adapted to EMYS' control system. Both systems are rooted in dimensional theories of emotion.

OPEN PROJECT

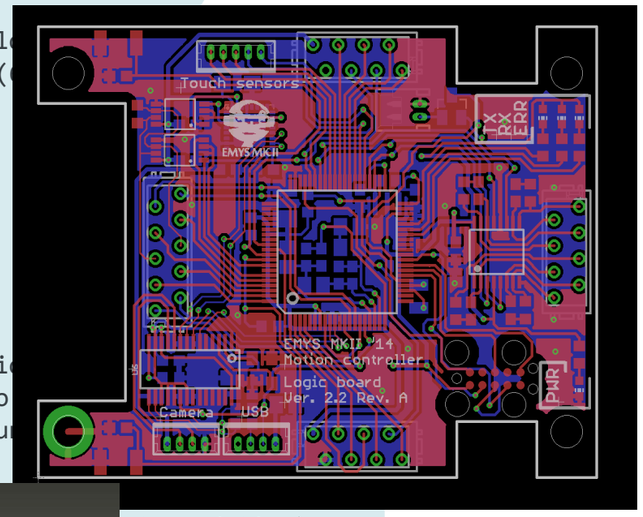
EMYS is a fully open source software & hardware project! As an open system, the design and documentation of all hardware and software is licensed under the Free Software Foundation GNU licences so the system can be freely replicated and customized.

Build your own EMYS or order one today!

http://www.flash.iiar.pwr.edu.pl

```
t_follow: {
  robot.body.neck.head.MoveEyeCl
  robot.body.neck.head.ActAlive(

  var _d_step = 0;
  var _d_bpm = 0;
  var _d_time = 0;
  var _d_inten = 0;
  _d_inten = _d_inten*0.6;
  loop{
    detach({
      _d_time  = (201-robot.audi
      _d_inten = (15+robot.audio
      var _d_tmp = (_d_inten.rou
      if (_d_step==0) {
```



```
_tmp,_d_time),


_inten,_d_time) &
      robot.body.neck.head.MoveRight(0
    },
    if (_d_step==2) {
      robot.body.neck.head.MoveForward(
      robot.body.neck.head.MoveRight(_
    },
    if (_d_step==3) {
      robot.body.neck.head.MoveBack(_d_
      robot.body.neck.head.MoveRight(0
    },
    }),
  _d_step=_d_step+1;
  if (_d_step>3) _d_step=0;
  sleep(200ms);
  _d_bpm = robot.audio.musicPlayer.bpm
ayer.bpmPosition) {sleep(20ms);};
```

Wrocław University of Technology

CAD Mech sp. z o.o.

Produkt Dizajn Studio
Kubasek Krzysztof

About us

We are a team of passionate engineers, designers and psychologists that create and customize social robots to help integrate robotic technology into our daily lives.
We have our own extensive experience in designing, constructing, and developing software for social robots. To date, we have participated in several robotic projects and competitions.

We are interested in cooperation in the following fields:

- widely understood social robotics,
- conducting HRI experiments (especially long-term),
- developing new competencies for social robots,
- improving social robots' perception and communication channels,
- implementing and verifying affective mind theories,
- creating customized version of our robots.

ROBOT APPLICATIONS

The range of the chosen potential applications:

Academic centers – as a flexible research platform in the field of social robotics and other fields where social robots can be utilized, e.g.: medicine, education or marketing,

Innovative educational centers – as an educational tool in teaching foreign languages or programming (at various stages of education),

Modern medical and therapeutic centers – as a trainer of cognitive functions, caretaker, a companion for the elderly,

Marketing companies – as a futuristic host or presenter,

Opinion poll centers – as an interviewer.

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