F-2 EMOTIONAL ROBOT: A RESEARCH BASE FOR COMMUNICATION AND COGNITION[1]

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F-2 emotional robot is a model and an experimental base for studying human communication and cognition. The robot was named after F-1 historic nuclear reactor in Kurchatov Institute. The goal of the project was to design a computer implementation of a cognitive architecture, able to receive incoming phrases, process them via a linguistic and cognitive procedures, select a corresponding output reaction (possibly – emotion) and animate a robot. In an isolated running mode the architecture reads diverse texts (prose, blogs or news) and saves the extracted semantics with the suggested reaction for the robot – to a database.

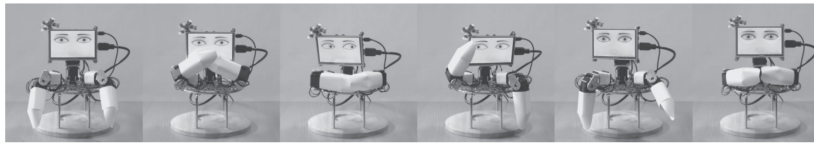

Fig. 1. **F-2 Emotional Robot**

The F-2 robot was designed, having in mind cartoon characters or toys. While advanced robots may encounter the problem of "uncanny valley" (a very human-like robot loses human confidence due to minor divergences with natural human behavior), F-2 is initially considered as a non-anthropomorphic, cartoon-like or toy-like device. F-2 should maintain the emotional contact with a user through speech, facial expressions and gestures – like cartoon characters – thus bypassing the "uncanny valley" pitfall. It was designed to be easily assembled from standard electronic components by other research groups. So, as a physical robot, it may serve as an experimental base for human-robot interaction. F-2 has 6 degrees of freedom (2 in the neck, 2 in each hand) and projects its face to a 5" monitor (epyface). It has soft hands, so it can touch itself or automanipulate. It can also receive the coordinates of surrounding human faces via an external face-detection system (e. g. MS Kinect) and simulate gazes towards the eyes of the addressee. The behavioral patterns for the robot are designed basing on facial expressions and gestures in the Russian Emotional Corpus (REC). The patterns are extracted from the corpus, drawn in

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Blender 3D and exported to MySQL database. The software, running the robot, receives behavioral scripts in BML format (Behavior Markup Language), for each BML retrieves the corresponding patterns from the database and executes the patterns on the robot. It also maintains a queue of BMLs so that BMLs, invoked by different internal states of the robot, compete with each other, while some BMLs may run simultaneously.

The general cognitive architecture of F-2 robot (Fig. 2) is a pipe of consecutive processors. The robot may receive speech input from (a) oral speech – we rely on Yandex Speech API to extract the written form, (b) a text file – like fiction, and (c) news and blogs from RSS – we run the software daily to collect actual news and discussions. Each utterance is processed by (a) morphological analyzer, (b) syntactic processor, (c) reactions / scripts – which generates behavioral reactions in BML and feeds them to (d) robot controller. The output of each processor may be saved to a database (PostgreSQL). The configuration of the pipeline is customizable – for example, for test purposes reactions can be saved to a database without the actual transfer to the robot controller.

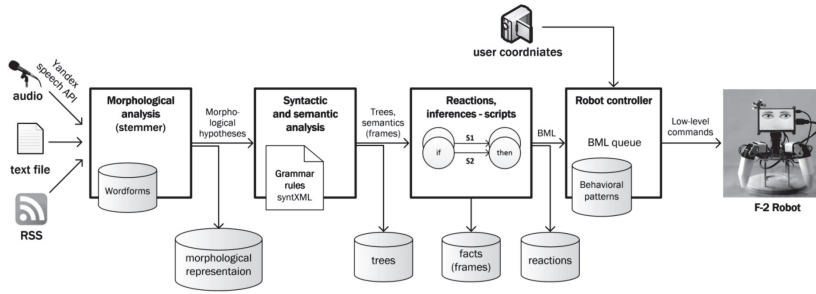

Fig. 2. **Software architecture of F-2 Emotional Robot**

The system allows the developer to design the grammar structure in syntXML format for a particular natural language – we use the representation of Russian grammar in 550 syntXML rules. It also lets design own dictionary with grammemes and semantic markers for each word – we use a dictionary of 100,000 words, where 30,000 words are annotated by semantic markers. Syntactic component constructs a set of syntactic trees with semantic representations, and the representation of each tree is compared to a list of scripts in the reactions component. Scripts are responsible for the detection of emotionally relevant events (or other semantic representations, requiring special response in a communication). The list of scripts includes representations of positive events – like script taste('something is tasty'), attention ('somebody

pays attention at me') and negative events like danger('something harms me'), inadeq ('the antagonist is inadequate') or unneed ('nobody needs me') [Kotov, in print]. The list of scripts suggests, that the robot treats each incoming event (semantic representation) as one of the scripts – or rather as an array of proximities to each script. For example, an incoming question can be treated as an attention ('they ask = they pay attention at me') and as inadeq ('they ask me, because I told something stupid'). This ambiguity may serve (a) as a basis for simultaneous contradictory reactions for the robot – it may express approach and withdrawal patterns simultaneously, (b) as a basis for irony simulation, where the minor reaction is used as an ironic response. As we ague in [Kotov, 2017] the array of contradictory representations of an incoming event may be used to distinguish "self" reactions – the representations with higher activation, and "non-self" reactions – the representations with minor activation and used for irony, imagination and the theory of mind (the representation of other's thoughts and actions). Thus the architecture may be used to simulate 'self'/'non-self' distinction and approach the computer simulation of consciousness – see [Kotov, 2017].

The suggested architecture of F-2 robot may serve as an experimental base to simulate and study robot-human interaction as well as deeper cognitive functions, like text comprehension, semantic processing, invocation of emotions and – to some extent – consciousness.

Kotov A. A. 2017. A computational model of consciousness for artificial emotional agents. Psychology in Russia: State of the Art. Vol. 10, Issue 3, 57-73.

Kotov A. A. (in print). Mechanisms of speech influence. M.: Kurchatov Institute.