

## Report on Kibertron - a Full-sized Autonomous Humanoid

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### 1. Introduction



Kibertron is a Full-sized Autonomous Humanoid project - the creation of a robot with anthropoid structure which resembles a human being and has capabilities similar to the human ones to a certain degree. Nevertheless Kibertron has unique structure and intellect. In constructing Kibertron we pay great attention mostly to the software that we intend to use and simultaneously we are constructing a rather functional body. Our basic objective is to create a self-educating machine with a purpose and motivation for its existence. All humanoid robots created so far worldwide are based on fixed mathematical algorithms. Although they may appear

intelligent they actually only imitate artificial intellect. This is the reason why their developers come to a dead-lock too soon as they need a lot of computing resources. The basic difference between them and our project is the fact that a great part of the systems of our humanoid work on the principle of self-education which in our opinion is the key for the realization of extremely complicated and intelligent systems and knots that need great functionality and efficiency and require little computing power. The basic problem that our team faces is to set a purpose for existence and motivation for development for the humanoid, i.e. to create a functioning intellect and not simply an imitation of one. An important prerequisite for this achievement is the construction of a functional body giving the humanoid the possibility to walk, run, climb and descend stairs, react adequately in cases of tripping or coming upon other unpredicted obstacles, bend and stand up from different postures and walk over various terrains including insuperable or dangerous for people terrains. Another characteristic feature of Kibertron is its universality. With slight changes in design and body it can be used for various activities. It can work in environment unfavourable or even dangerous to people. It can serve as an industrial robot or as a space explorer on other planets. It can also become simply a home assistant performing the daily monotonous and boring household chores for us. Kibertron can replace people in almost all hazardous situations thus avoiding the risk of hundreds of human victims. It is capable of neutralizing bombs or terrorists, extinguishing great fires. It can assist handicapped people.



The basic advantage of humanoid robots compared to industrial ones is the fact that they can easily be adapted to operate machines and equipment usually exploited by people. From this point of view humanoid robots are universal robots and this is what makes them so necessary. Their great efficiency is reinforced by the fact that it is not necessary to educate each separate humanoid individually. Once a single one acquires the knowledge database it can be cloned in the other humanoids afterwards. Kibertron is a full-sized autonomous humanoid. Therefore the intelligence of all its systems is of extremely high level and this applies not only to its unique intellect and integrated systems but also to the self-diagnostic system of all its knots and devices by means of which the humanoid controls with maximum efficiency all its basic components. In this manner Kibertron becomes a rational being of its own unique kind with its own unique soul and self, capable of feeling and experiencing emotions similar to the human ones and yet unique.

Kibertron is not a copy of man and it is not a threat for him or for any other living being on the earth. Kibertron is being developed by people with free minds, not accepting limitation of creative thinking, people not being influenced by the conventional idea that it is impossible to create a rational being with intellectual capacity close to the human one. Actually we think that the main reason for people feeling apathy on this topic is the wrong approach most projects develop - they cannot develop efficiently even a small part of it because all knots of the humanoid form an organism in which there are no independent modules and knots and if a single one is inefficient it reflects on the efficiency of the whole organism.

## 2. Mechanics and movements.

### 2.1 Technical data



The Kibertron prototype we are currently working on is 1750 mm tall and it is expected to weigh approximately 90 kg after completion of all knots and mechanisms. Our present calculations for energy consumption show that 150W will be needed for minimal loading, from 600W to 1000W for walking, from 1000W to 1500W for heavy loading of the motors, and there is a possibility for extreme loading with energy consumption above 1500W. Energy consumption in case of heavy loading is approximately equal to the one of a standard heating radiator (for household needs). Currently the most favourable option is the use of lithium-ion accumulator thanks to which the humanoid can work up to 7-8 hours without reloading. We are also working on alternative energy sources.

These are not final data; they depend on the selection of power supply accumulators, body weight of the humanoid and the power of the motors used. All systems of the humanoid are innovative and this is the basic reason for their multi-functionality and the optimal quality of each parameter.

### 2.2 Skeleton

The current version of the skeleton has 82 degrees of freedom (these include 56 for the arms, 20 for the legs, 3 for the neck and 3 for the abdominal area) realized by different movements. Its appearance is futuristic and simple.

The arm excels in dynamics the functionality even of the human one in certain aspects.

It has 28 degrees of freedom, 20 of which are for the fingers, 1 for the palm, 2 for the wrist, 1 for the elbow, 2 for the shoulder and 2 for rotation around its own axis (1 in the forearm and 1 in the armpit). Each finger has 4 degrees of freedom grouped in 3 joints by means of which their mobility is identical to the mobility of human fingers.

### 2.3 Materials

The skeleton and the basic parts of Kibertron are constructed mainly from aluminum and titanium alloys, different steel and plastics, carbon elements and others.

The outer casing (the skin) is a complex, multi-layer, non-homogenous material which is specific for each area of the body. The basic criteria for material selection are: flexibility, elasticity, strength, heat-resistance, humidity-resistance and heat-conductivity. The requirements are caused by the fact that a significant number of sensors for temperature, pressure, humidity, chemical composition and others are placed within different layers of the casing. The specific materials and design can be defined according to the field of application of the humanoid.

### 2.4 Operation

Electric motors produced by leading companies in this field and electro-mechanic muscles for moving the specialized joints developed by the Kibertron team are used for operation. We have developed electro-mechanic muscles able to contract and relax suddenly. There is a possibility to work in free mode, i.e. free motion under the influence of outside forces. When in contracted condition the mechanism does not need energy. It consumes energy only when changing condition. In transition from relaxed to contracted condition the muscle makes greater energy consumption than in the reverse process. The mechanism is able to change conditions not only suddenly. It also has a possibility for smooth transition. The electro-mechanical muscle actuator is an electric engine connected in a suitable manner to an electro-mechanical knot that we have developed. The muscle's functionality is possible thanks to this knot.



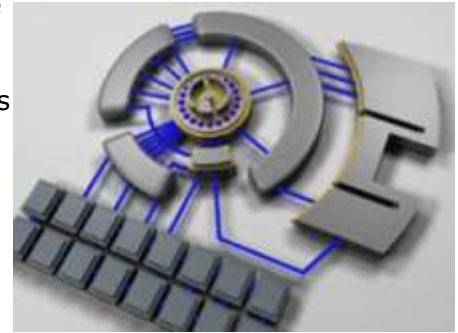
The skeleton construction has joints with different numbers of degrees of freedom - from 1 to 3. They are developed in a manner that allows each degree of freedom to be independent on the others which, on the other hand allows for simultaneous motions along each one of them. This is extremely important for the construction of the equilibrium system of the humanoid because if any degree of freedom would block when shifting degrees the equilibrium system

would not be capable of efficiently performing its functions and this might cause the humanoid to become unstable in certain situations.

The algorithm used for controlling every motor of the humanoid i.e. for controlling every constituent part of its body is similar to the algorithm used by people. It is based on the moving from one point to another on the principle of self-education due to which optimal efficiency can be achieved in all parameters without consuming extreme computing power and other resources characteristic to all robot systems, devices and knots developments so far. It is exactly this approach that makes Kibertron so dynamic, flexible and having smooth motions similar to the human ones.

### **3. Software and Hardware Solutions**

All modules and systems of the humanoid are integrated due to the basic operational system which organizes their functions and the interaction between all hardware modules and the software applications which control them i.e. it is this system that makes programming at high level possible. The software depending on the specific field of application is written in C++, Assembler, and VHDL. All modules and systems are united due to the Kibertron Real-Time operational system developed specifically for this purpose.



The hardware solutions for each separate module of the humanoid are selected in such a manner that they provide the necessary dynamic functionality of each one of them. The main electronics consists of RISC and DSP processors. For the input-outgoing systems and the transmission of the information from various sensors in the humanoid we use FPGA and CPLD processors, AVR microcontrollers and standard semi-conducting elements. The key to the realization of all functions of the humanoid by means of simple hardware solutions is the synchronous development of all modules of its artificial intellect especially the system for associative addressing of the memory. The development of specialized modules and components aiming to miniaturize and improve certain parameters is pressing because of the goal to create an autonomous humanoid and the limited space in which they must be located and integrated.

### **4. Information System Organization and Interface**

The humanoid's structure stands out mainly because of its dynamic hierarchy whose architecture changes depending on the momentary condition of the system and the environment. This dynamic hierarchy is valid for all modules, knots and functions of the humanoid - controlling all limbs and feedback, registering and processing the whole incoming information from the different sensors and the different outgoing streams by means of which the humanoid interacts with its environment.

Man and all living creatures have evolved for thousands of years. During this process each of them has undergone a number of transformations to finally reach their current pattern, the result of the influence that nature exerts on all of us. There is no point in trying to be greater than nature in order to achieve our goal. Nature has already given us the key to every solution - all we have to do is discover the keyhole it was meant for...