Chapter

Communication and Interaction between Humanoid Robots and Humans

Arbnor Pajaziti, Xhevahir Bajrami and Gazmend Pula

Abstract

This paper deals with future robots that will be developed to assist and/or partially replace human activities that would provide for humans very much and frequently needed general-types of repetitive services for their daily tasks and engagements. As indeed the very name of humanoid robots intensely suggests, these engagements despite being routinely self-understood by implication as necessities of daily life, their frequency and repetitiveness, alongside other necessities of distributed elements of an increasingly intelligent daily environment, impose the need for deployment of various kinds of robots. It is to be assumed that there will be middle grounds between different types of humanoid robots, depending on the strength of their field of application. Collaborative robots that are conceived and intended to work i.e., collaborate safely with humans in a joint and shared workspace will expand and develop and be applied in increasingly diverse functions and working environments. Nowadays, intelligent robots are of course widely feasible and also increasingly available, but needless to say, even in the long run they will and cannot surpass the people in their creativity, their ability to learn in their differentiation, and maybe not even manage to catch up with all human complex requirements and needs. People will understandably continue to have a firm grip on the main switch.

Keywords: Artificial Intelligence, Humanoid Robots, Communication, Interaction, Kinect

1. Introduction

A variety of humanoid robots have been developed and researched in more than 500 research institutes and universities all over the world. Humanoid robots are robots that have a shape and form resembling that of humans including structural i.e., anatomical similarities such arms and legs as well as facial ones such heads containing eyes and mouths. However the most challenging and complex issue remains the development of the two-legged robots, reliable and capable enough to be meaningful partners to humans, in order to be able to perform actions that humans are capable of, but nevertheless are also needy of having them done all too frequently, especially those of a repetitive kind. Humanoid robots are thus intended to be used repetitive and laborious tasks, frequently more dangerous ones such as permanent inspection, necessary repetitive maintenance ones, especially of a repetitive nature or highly hazardous engagements that may emerge in various types of disasters areas as may be needed in case of emergencies in nuclear power plants.

Professional humanoid robots such as Honda and Sony have made significant advances that have enabled highly-capable humanoid robots [1]. Both companies invested more budget and manpower that enabled the design of small, powered joints that achieve power-to-weight performance unheard of in commercially available servomotors.

Humanoid Robots consists of Artificial Intelligence, sensors, mechatronics, and power. The prime task of humanoid robots nowadays consists in developing capabilities of recognizing visual expressions perceptions, and in view of that to enable addressing appropriately tasks of predicting what emotion the human is having by observing the visual facial expressions of humans. Therefore, all the humanoid robots need to have supplied are the data that will provide sufficient and appropriate information to have processed by means of which they will be able to perform and add to their available spectrum of learning and performing activities. The algorithms and other metrologies, such as Deep Learning, Neural Networks will be responsible to extract the features from these images provided to them.

All of these objectives for humanoid robots present a huge challenge and requirement for processing power and it is to be noted that it is not possible for a humanoid robot to use this kind of huge processing power alone. Therefore, the humanoid robots have to absorb, integrate and indeed capture the information from the surrounding environment and to deploy the cloud which the cloud will process further and feed it back to the humanoid robot.

Multisensory perception, cognition and, man–machine cooperation are technological fields of robotics that are being researched as key technologies today. Theses and processes from the research area of Artificial Intelligence (AI) are transferred to robotic systems. Considerable principles of biology serve as role models and recruiting potential for robotics. The highest possible kinematic form of the human body is reproduced with great accuracy. Humanoid, complex mechatronic systems inspired by biology are the prime new field of researching artificial intelligence. The humanoid robots are very interesting not only in their technology but also in its psychological aspects. The visions of science-fiction authors are gradually becoming a reality. That causes - in Europe and America more than in Japan - the number of respective critics of the issue i.e., topic to increase. Some already describe the horror scenarios of human-like robots who gain power over their masters and lead humanity to its downfall [2–4].

The transformative change to an information and knowledge society will steadily increase the acceptance of complex high-tech devices in the everyday environment of humans. According to the forecast of leading scientists, robots will therefore take on increasingly more and complex tasks in the private sphere of humans in the coming generations.

Fields of application for the species “Humanoid” is expected to continue to be focused on supporting humans in household activities, the elderly and nursing-type of care, or simply in some of entertainment aspects in families and households. They are intended to maintain or further improve the standard of living and amenities of the human environment.

2. Humanoid and collaborative robots replacing humans in work places

In the not-too-distant future robots are expected to handle a very considerable amount of all tasks and jobs, perhaps even a half of the actual contingent and thus contribute perhaps to leaving an “army” of people unemployed and perhaps getting concerned people considering this aspect very seriously. However, according to, certain views and analysis, in an alternative scenario, the same technologies that revolutionize certain important achievements as in the area of humanoid and collaborative robots, rather than reducing people's job opportunities, they contribute to raising living standards with new job opportunities not yet imagined and/or visualized clearly.

This is especially the case for collaborative robots, frequently referred to as Cobots, that apply the principle of robotic-type of automation of certain job types with repetitive activities and rather flexible and intelligent adaptations to work procedures. Thus the Cobots indeed contribute significantly in sequential automatic adaptation to job requirements in the common workspace by safely collaborating with human workers especially in job's repetitive and somewhat more menial job segments and tasks that are to be repeated routinely in endless and exhausting work cycles, potentially and especially in more cumbersome and dangerous ones. Due to the intense research and development in the area as well as in AI, by the next decade, the collaborative work and interaction between humans and humanoid robots is expected to become much more refined and indeed much more flexible.

The humanoid as well as collaborative robots will develop increasing capacities of cooperation in specifically designed environment. For example, Toyota is building such a specifically designed urban environment a future city in Shizuoka prefecture. Drones, autonomous buses, taxis and various types of humanoid/collaborative robots will be developed for wider-specter and higher-level collaboration and cooperation with humans. Such a specific environment will expectedly be conceived and designed from scratch in order to provide for such an intense and high-level human-Cobot effective functional coexistence especially in types of assembly factory jobs, delivery and security ones as well.

Indeed this interaction between the humanoid robots and humans is expected to become increasingly natural-felt for end-use consumers i.e., for the humans, both at the household and industrial production frameworks. This is highly probable as humanoid robots are expected to be able to increasingly absorb, capture, integrate and implement processed relevant information, especially as relates to the production environment as well as to the household one. One of the most utilized approaches is learning, interacting and implementing by imitation, by observing and integrating and functionalizing operator's behavioural patterns.

This can be expected with significant probability, especially due to the intense development of AI and related interphases that humanoid robots will be increasingly capable of predicting also human emotions in the forms of sounds of sighting and intricate and elaborate facial expressions of human that manifest the quality and intensity of related emotions and then mould it into a collaborative interaction.

Advances in artificial intelligence, or the ability of machines to learn by processing vast amounts of data, are doing a rethink i.e., reconsiderations of what is believed that only humans can do. Thus 2018 paper by the National Bureau of Economic Research found "a wide range of perspectives on public discourse, ranging from alarmist forecasts of mass unemployment caused by robots to optimistic forecasts of job creation."

Meta-learning which is implemented by reinforcement learning are the type of biologic models that are most commonly used in human-humanoid robot interaction.

However, with the virus pandemic catapulting the world deeper into the fourth industrial revolution, dubbed Industry 4.0 – the ongoing automation of traditional manufacturing and industrial practices, with artificial intelligence and robotics, under cover of "social distancing" which has caused an unwelcoming employment crisis for the working poor, with many of their jobs displaced by robots.

2.1 What jobs could be affected by Artificial Intelligence and robots?

Cashiers, clerks, cooks, waiters, receptionists, security guards, data analysts, tax-preparing personnel and truck drivers are among the jobs often cited as being the most susceptible to these concerns regarding advanced and enhanced development and application of automation.

Other professions that may be less vulnerable to these side-effects and concerns include surgeons, accountants and financial analysts.

Jobs that require repetitive activities to carry out tasks in a structured environment, mainly in production, are the first to be directly affected by automation.

Since 1980, the number of manufacturing workers in the US has decreased by a third, to about 13 million, while production has doubled.

The newer humanoid robots come equipped with “vision, mobility and learning abilities, doing more tasks”. Sophisticated software can conduct phone conversations with clients, for example.

According to a study by the International Machinery Business Institute about 120 million workers in the world’s 12 largest economies may need to be retrained in the next three years as a result of automation and Artificial Intelligence,

According to a this year’s report from the Brookings Institution’s Metropolitan Policy Program found that nearly 36 million Americans hold jobs with “high exposure” to being potentially negatively affected by automation.

It is considered and estimated that by 2030 many people will have to change jobs due to these side-effects of widely deployed automation processes.

2.2 What kind of jobs can be created due to of automation?

It has always been much easier to identify jobs at risk from technology than to anticipate the new types of jobs that can be created as a result of sweeping automation. Before the advent of the internet and smartphones, it would have been difficult to foresee the need for social media apps or specialists, much less the emergence of, for example, the “YouTube influencer” as a well-paid profession.

2.3 When will all this happen?

As it is being rather widely reported this has already begun. Thus according to the International Federation of Robotics Sales of professional service robots, those used for non-industrial functions like logistics, inspections, and maintenance have totalled some 271,000 units in 2018 accounting for a 61% increase as compared to the previous year 2017.

2.4 What can people do?

There is general agreement that human workers will require more education and skills to keep up with technological development and change and get accustomed and ready to change jobs and even professions more often than before, if and when required by the respective technological developments in the area of robotics and automation.

It is clear that there is hardly any rationale in, slowing down, stalling or preventing the expansion of automation processes to be applied for instance in manufacturing factories, by only considering potentially resulting and indeed likely job employment reductions and shedding a as the overall result might turn out to be negative and hence also counterproductive. Experts suggest that people should focus on the enhancement and automation of the production process and tasks being successfully completed rather than on the number of job employment opportunities, especially as automotive repetitive tasks provide more time available for much more creative and productive activities, which can result in the creation of even more new and creative job opportunities and profession that don’t currently exist. According to the World Economic Forum some 133 million new positions and job opportunities might be created along these lines However, businesses shouldn't only set out to maximize profit with large scale deployment of automation processes and machines, but they must proactively seek new job opportunities and stimuli for their employees to help them advance their spectre of professional skill sets. Here's how to join the robot revolution.

2.5 What you'll pay?

If you have decided to buy a robot you have to search online at different sites such as auction sites, electronic stores and hobby shops, or seek out the components to build the robot type and shape based on your requirements. You will get different prices that depend on the number of sensors and motors, time of the processing speed, memory, battery life, and storage, etc.

For example, the Walker robot shown in **Figure 1** is an intelligent humanoid robot to ease your everyday household work and making life easier, smarter and more convenient. It has two seven degrees of freedom robotic arms which provide a wide range of arm movements, flexible manipulation and obstacle avoidance by using visual and first sensor. It can also maintain its body language while moving and carrying objects. Using gait planning and control it can adapt to complex surfaces and walk on any surface required easily by using advanced control algorithms and thus it can maintain stable control of its hands and arms while swiftly moving through the surrounding environment. With a new vision navigation system, this robot can recognize contour colour depth and others without any visual aids.

The first Williams- robot type worked with the now-discontinued Aibo-robot type as shown in **Figure 2**, a dog-like robot manufactured by Sony between 1999 and 2005.

Aibo is a robotic pet that brings warmth with lovable behaviour and delights your everyday life. It is equipped with a 64-bit quad-core CPU which can deliver fast performance and interaction to provide you real dog-like experience. This robot

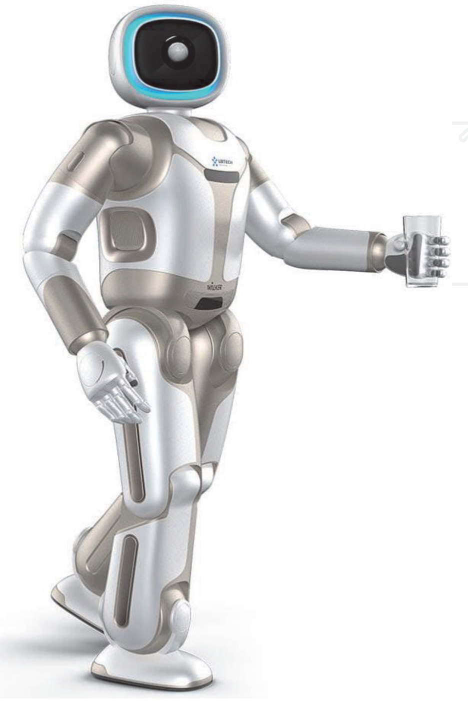

Figure 1.
Walker robot [5].

has one main camera and another slanted camera in which animals need to memorize up to 200 different interactions and can recognize and respond appropriately to them. The Aibo-robot is also equipped with six sensors, a motion detector and a lie detector which enables the robot to detect obstacles and move flawlessly around the house. This robot has also four microphones, thus being able to hear and respond accurately to your voice commands. You can get this robot at around three thousand dollars and they are available online.

The Temi robot, as shown in **Figure 3**, is the first robot that interacts with humans while providing a flawless connection between devices and your loved ones. It is equipped with a navigational robot system, 360-degree Lidar, true depth camera, RGB camera, 5 proximity sensors and real-time sensor fusion which analyses data and ensures autonomous navigation through a 3D mapping path, planning obstacle avoidance using detection and tracking its features at 10.1 inches per second. LCD touch colour display with a pixel density up to 225 PPI, comprising a brushless DC motor and planetary gear with which it can autonomously track the face and tilt the screen with accuracy you to interact with a robot with the clarity it has a 13-megapixel high resolution which can record thousands of ATB videos at 30 FPS while providing two-way live conversation with their loved ones. Temi-robot has 20 Watt speakers with high fidelity equalizers which provide the best quality music. It also has four omni-directional i.e., all-directional digital mics with real-time localization, in order to provide the best audio call experience. With built-in Alexa, one can command the TV to play music, place calls, check the weather and even control smartphone devices without leaving your comfort. Temi is a personal robot that you can order and get online for a price of some1500 dollars.

2.6 Speech recognition

To create a humanoid robot to enable speech recognition one has to use different hardware and software elements. These elements are as follows: Python

Figure 2.
Aibo robot [6].

Figure 3.
Temi robot [7].

programming language, different AI packages like speech-recognition and chatter-pot that need to be integrated into a pocket PC such as Raspberry Pi. Nowadays, humanoid robots can recognize the words of multiple people speaking simultaneously, can get certain information from the internet and so on. Certain types of them can be used in halls and offices and can communicate with many people [8].

Nao humanoid robot is also able to see, talk and hear. Nao can also naturally interact with humans. A shown in **Figure 4**, it has 4 built-in microphones and loudspeakers, 2 cameras. Nao can learn and adapt to almost every interaction and becomes more and more intelligent with time and empirics i.e., experience. He remembers answers and content and can immediately use them again in similar situations. It acquired its skills through a programming interface to IBM Watson's Language, Vision, Speech and Data APIs. These present almost endless possibilities for further development.

The Sophia from Hanson Robotics shown in **Figure 5** is a good example of how the AI is implemented in humanoid robots. Within its Robot Intelligent System it has some unstructured language learning as well as statistical natural language learning and natural language generation, but for some answers she might go to the Web, and some of the answers, might go to natural language learning. However some answers might enter into its robotic personality and hence it can behave similar to a human. The above-mentioned components that are implemented in the hardware and software are not distinct things, the real cracks of intelligence are in fact how they come and interact together to form an entire architectural organism as shown in **Figure 5**. The AI algorithms are included in Humanoid Robots for reasoning (logics), learning, perception and interaction, all of which as a whole inter-operates together in a complex way of communication and interaction with humans.

Figure 4.
Nao robot [9].

Figure 5.
Sophia Intelligent Robot [10].

3. Humanoid robot testing

TRI – the Toyota Research Institute was founded in 2016. Their role is to perform research, identify and create new capabilities Toyota intends to have in the future [11]. Toyota is trying to approach the future from a human-centred perspective with the goal of facilitating and bringing significant amount of fulfilment and happiness preferable to a majority of people of all walks of life on a basic i.e. fundamental level. This pursuit is based on a powerful idea that is contained even in some prominent constitutions that each person's life should strive towards happiness, meaning and purpose. In Japan, this is called Ikigai. Studies of Ikigai teach people that they feel most fulfilment when their lives incorporate work that they love and help society to enable more people to achieve their Ikigai. They pursue new forms of automation in society with a human touch to develop capabilities that amplify, rather than replace human ability. This is Toyota's historic philosophy of Jidoka, an idea that embraces the concept of Artificial Intelligence (AI), in other words, the human, and the machine work together in order to do something better than if either one of them could do on their own.

They are currently pursuing this vision in four research areas: Robotics, Automated Driving, Accelerated Materials Design and Discovery, and Machine Assisted Cognition [11].

TRI vision and mission are focused on solving the problem of how technologies can enhance and ease the human experience bringing forth a higher quality of life, independence and happiness. TRI envisions a future where Toyota products can improve the quality of life for societies around the world with an outstanding performance and contribution, their mission being the development of automated driving, robotics and other human enhancement and amplification technology from Toyota. Technological capabilities that will help people navigate safely from their kitchen to their living rooms, or safely across town, and most importantly, by providing this kind of human amplification technology, they hope to make the quality of life for everyone much better [11].

A growing number of Japanese businesses are testing robots as a viable solution to the country's shrinking workforce. They're popping up in stores, banks and soon are expected also in hotels. Bank of Tokyo-Mitsubishi UFJ is testing Nao, a robotic client service that answers basic questions and is designed to speak 19 languages. Multilingual polyglot robotics has been planned to serve foreign clients during the Tokyo 2020 Olympics.

By the time, the bank hopes to have even more robots on its staff. Pepper is a humanoid robot talking to clients. A humanoid has human-like features, for example, arms, legs as well as a head - but it is designed to look like a robot. Producer Softbank hopes Pepper will be a family robot, as in the Jetsons cartoons.

A hotel planned to open at Huis Ten Bosch Amusement Park in Nagasaki this summer aims to have 10 robots as staff members and soon to increase the number to more than 90 percent of hotel services being provided by robots as shown in **Figure 6**.

Today's innovation may be the necessity of tomorrow. Japan has an aging population that has fuelled heated debates about the involvement of robots in the state's workforce. A survey by home service operator Orix Living found that more seniors feel comfortable being nursed by a robot than when receiving services from a foreign nurse. The number of elderly citizens in Japan is steadily increasing, thus bringing about a real need for humanoid service robots to help them out in dealing and taking care of various home tasks.

In a country where the population is shrinking due to various reasons, where the workforce is shrinking and there is considerable resistance to an influx of immigrants as in Japan, it appears that robots may play a very big role in their future [13].

3.1 Pepper robot understands the emotions

One group that seems to want to embrace robots are elderly citizens of Japan who are cared for by robots. Using emotion recognition functions, the Pepper robot, released in February 2015, can understand and respond to people who joke, dance, and even make rep music in the Japanese language, see **Figure 7**. Pepper robot is

Figure 6.
Robot chief in preparing the pancakes [12].

Figure 7.
Pepper robot at the working place [14].

1.20 meters tall, has been designed by Softbank Robotics and can handle a conversation with people.

It can analyse human expressions, voice tones and gestures, thereby enabling them to respond. This type of robot can serve for education, health and entertainment purposes, its primary purpose however being not hard work, but home entertainment or shopping.

Pepper is the ideal robot for a family and can very quickly become the family of those individuals living alone and feeling lonely in their households, as it makes the elderly feel very comfortable in their interactions with these types of humanoid robots. In this context it should be mentioned that the Japanese society is prone to a friendly approach in its relations to robots in general and humanoid robots in particular. This is related also to their history and especially their world famous manga books.

4. The gesture-based remote human-robot using Kinect

4.1 Structure of the control system

Kinect is a line of motion sensing input device signals produced by Microsoft. Initially, the Kinect was developed as a gaming accessory for Xbox 360 and Xbox One video game consoles and Microsoft Windows PCs shown in **Figure 8**.

Figure 8.
Kinect sensor [15].

Microsoft Kinect sensor is comprised of three sensors: an infrared projector, an infrared camera and RGB camera to capture high resolution 3D images. The Kinect sensor is a popular sensor for robotics due to the advanced capabilities it offers for the human-robot interaction. Microsoft Kinect sensor is a major innovation in robotics.

With the use of dedicated software, users can easily control the movements of a robot by using an Xbox Kinect and their bodies to dictate and instruct the desired modalities.

4.2 Software description

A Microsoft Kinect v2 camera is used to track human motion using skeleton tracking. This technique has some limitations on tracking particular motions, especially motions of the palm of the hand that cannot yet be recognized. For example, the motion primitive "close hand" can be commanded while remotely operating the arm to hover over the grasping position. An online tracking system has been developed to control the arm of a Bioloid robot using Kinect sensor. The task of this work was hand-guiding robot arms using Microsoft Kinect v2. This objective has been achieved using a Kinect v2 and a Bioloid robot, which is a humanoid robot with 18 degrees of freedom (DOF) in total. The joint motions of the operator's arms and legs in the real world captured by a Kinect camera can be transferred into the workspace mathematically via forward and inverse kinematics, realistically through data-based UDP connection between the robot and Kinect sensor. The user assumes a specific pose to initiate a skeletal tracking. After the tracking begins, the user can start controlling the robot. After turning the motors on, the user can operate the robot remotely. The initial location of the user becomes the origin of the control coordinate system.

5. Connecting the Bioloid robot with Kinect

This system consists of both hardware and software. The way it functions is by capturing the user gestures, processing them and sending the processed signal further to the humanoid robot. Initially, the user makes a certain body gesture maintaining it for a short period of time [16].

The Kinect sensor is then used to capture the depth image of the user and recognizes the gesture by tracking the user's skeleton. This stage is called the image capturing stage. The depth image captured is processed into a computer in order to obtain an approximation of the positions of each body joint. In the gesture recognition stage, the angle between some of the body joints are then calculated and used as features for gesture classification. Once the correct gesture is recognized robot will then execute the motion correlating it with the recognized gesture [16]. The robot receives the command via a wireless interface. A built in mechanism is also embedded in by the PC with additional stability control to maintain the balance while moving and giving it the ability to get back up from potential falls autonomously [17].

The hardware used for this system are: Kinect sensor, PC, humanoid robot-kit, along with other additional tools. The Kinect used in this research is a depth imaging camera originally used for entertainment and gaming for Xbox game console made by Microsoft Corp. The humanoid robot kit used is Bioloid Premium Kit.

Above is presented the Kinect v2 connection method with the Bioloid robot using V-Rep simulation software.

The robot simulator V-REP with the integrated development environment is based on a distributed control architecture: each object/model can be individually controlled via an embedded script, a plug-in, a ROS or BlueZero node, a remote API client, or a custom solution. This makes V-REP very versatile and ideal for multi-robotic applications. Controllers can be written in C/C++, Python, Java, Lua, Matlab, or Octave. V-REP is used for fast algorithm development, factory automation simulations, fast prototyping, and verification, robotics-related education, remote monitoring, safety double-checking, etc. [18–20].

A direct connection for the human gait parameters using Kinect camera that is capable of providing human body tracking in real-time is shown in **Figures 9–11**. The position of the hands is then continuously updated and relayed to the robot, which moves towards the indicated position.

5.1 Pseudo-code for communication with a humanoid robot

The pseudo-code for connecting Kinect to MatLab and v-Rep software is given as follows:

Algorithm 1

Initializing parameters $\leftarrow$ $Neck, Head, Right\ Leg, Left\ Leg, Right\ Hand, Left\ Hand\&\&Spine \in SkeletonConnectionMAP$

Insert variables: **if**

$$SkeletonConnectionMAP \in \begin{bmatrix} 3 & \cdots & 15 \\ \vdots & \ddots & \vdots \\ 12 & \cdots & 24 \end{bmatrix}_{MxN}$$

end

Insert variables: VREP API

$\mathbf{vrep} \leftarrow remApi\{vrep.simx \in \forall;$

$clientID \in remApi \| true;$

$\mathbf{if} \leftarrow clientID > -1;$

$\mathbf{disp}(\mathbf{vrep} \in API);$

end

Create Right Arm :

$$\mathbf{return} \leftarrow vrep.simx.Object \begin{bmatrix} 1 & \cdots & 3 \\ \vdots & \ddots & \vdots \\ 4 & \cdots & 6 \end{bmatrix} \in clientID\&\&ART(n:m);$$

Create color and depth videoinput objects :

$\mathbf{colorVid} \leftarrow input \in kinect_1;$

$\mathbf{depthVid} \leftarrow input \in kinect_2;$

$\mathbf{depthSource} \leftarrow Frame, Trigger \in depthVid;$

$\mathbf{himg} \leftarrow figure;$

while

$trigger \in depthVid\&\&colorVid;$

$colorIMG \leftarrow getDATA \in colorVid;$

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```
                    metaDATA ← getDATA ∈ depthVid;
  if
     trackedBODIES ← find ∈ metaDATA;
        trackedBODIES ← find ∈ metaDATA;
           jointCoordinates ← metaDATA ∈ JointPOSITIONS;
           ColorJointIndices ← metaDATA ∈ JointINDICES;
  robotArmControl {
        image ← colorImg (⟨: | : | :⟩, 1);
          nBODIES ← length ∈ trackedBODIES;
  for i = 1 : 25;
  for body = 1 : nBODIES;
          end
  end
  end
  end
```


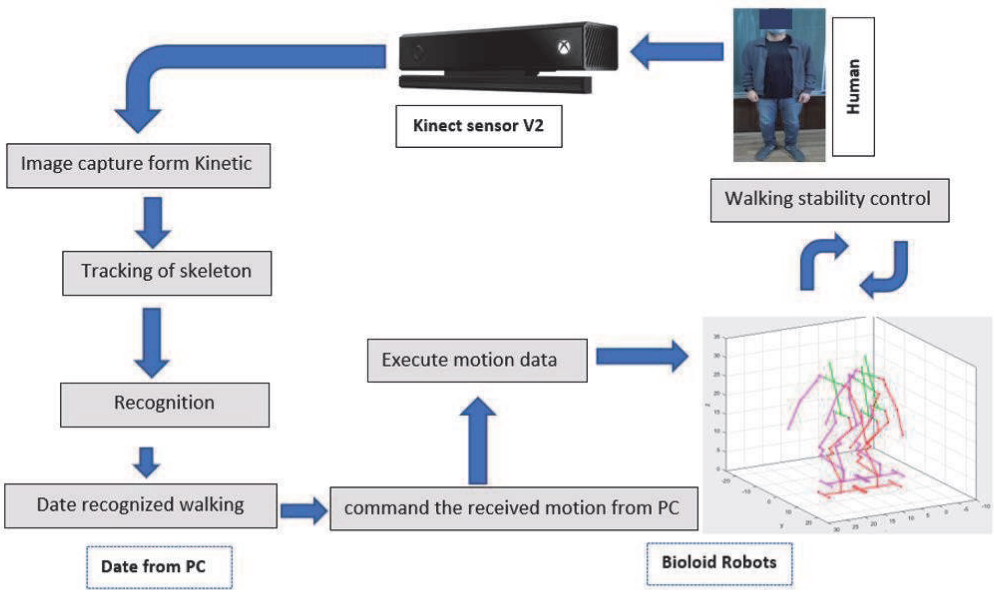

Figure 9.
Interaction between Bioloid Robots and Humans control architecture.

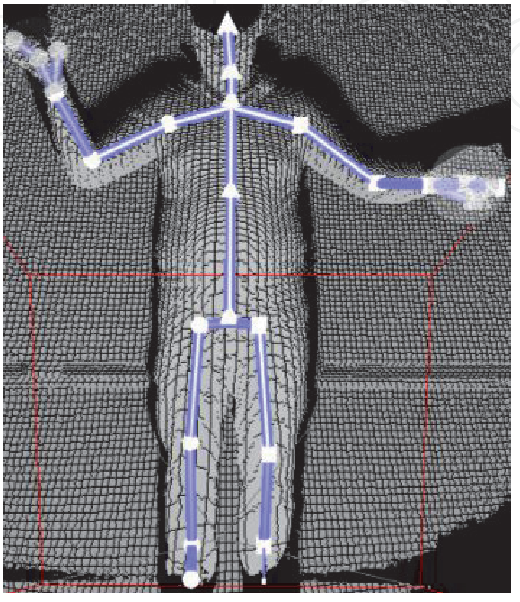

Figure 10.
Extraction of arm reference points.

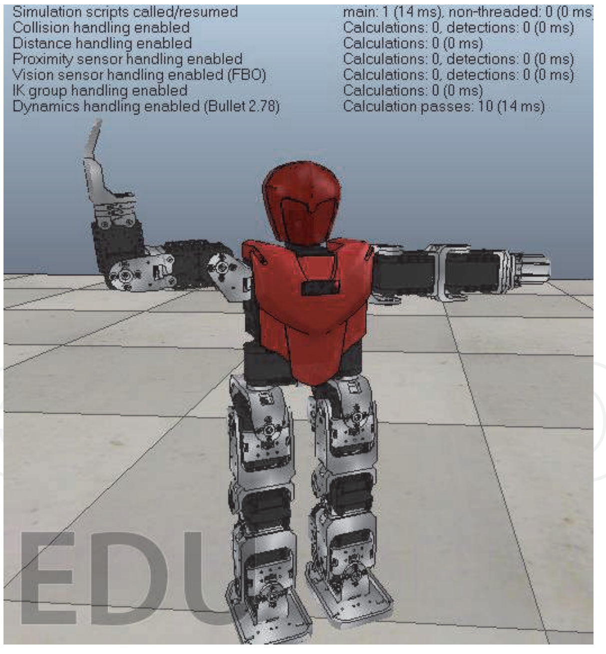

Figure 11.
Arm movement after parameter setting.

6. Conclusions

Regarding the application and future development of Humanoid Robots the following conclusions could be summarized as presented below:

- dependency on the expected wider-scale deployment and dependency on humanoid robots in daily life of citizens is likely to expand significantly and thus influence increasingly daily routines of their everyday life.

- If accepted on a wider scale by people, in the very near future these humanoid robots could become as important as computers currently are already.

- It could potentially be expected that in the foreseeable future human communication and interaction with a humanoid robots is likely to become increasingly similar to inter-human communication.

- The authors have independently developed and presented the Kinect v2 connection method with the Bioloid robot using V-Rep simulation software.

Thus the Cobots indeed contribute significantly in sequential automatic adaptation to job requirements in the common workspace by safely collaborating with human workers especially in job's repetitive and somewhat more menial job segments and tasks that are to be repeated routinely in endless and exhausting work cycles, potentially and especially in more cumbersome and dangerous ones. Due to the intense research and development in the area as well as in AI, by the next decade, the collaborative work and interaction between humans and humanoid robots is expected to become much more refined and indeed much more flexible. The humanoid as well as collaborative robots will develop increasing capacities of cooperation in specifically designed environment.

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