

Original Research Paper

# Inverse Kinematics at the Anthropomorphic Robots, by a Trigonometric Method

<sup>1</sup>Relly Victoria V. Petrescu, <sup>2</sup>Raffaella Aversa, <sup>3</sup>Bilal Akash, <sup>4</sup>Ronald B. Bucinell, <sup>5</sup>Juan M. Corchado, <sup>6</sup>MirMilad Mirsayar, <sup>2</sup>Antonio Apicella and <sup>1</sup>Florian Ion T. Petrescu

<sup>1</sup>ARoTMM-IFTToMM, Bucharest Polytechnic University, Bucharest, (CE), Romania

<sup>2</sup>Advanced Material Lab, Department of Architecture and Industrial Design, Second University of Naples, 81031 Aversa (CE), Italy

<sup>3</sup>Dean of School of Graduate Studies and Research, American University of Ras Al Khaimah, UAE

<sup>4</sup>Union College, USA

<sup>5</sup>University of Salamanca, Spain

<sup>6</sup>Department of Civil Engineering, Texas A&M University, College Station, TX (Texas), USA

## Article history

Received: 03-01-2017

Revised: 05-01-2017

Accepted: 27-04-2017

## Corresponding Author:

Florian Ion T. Petrescu  
ARoTMM-IFTToMM,  
Bucharest Polytechnic  
University, Bucharest, (CE)  
Romania  
Email: scipub02@gmail.com

**Abstract:** A robot is a machine especially programmable one through a computer capable of performing a complex series of actions in the automatic mode. Robots may be guided by a control device or external control may be incorporated in the inside. Robots can be built to take human form, but most robots are machines designed to perform a task without taking into account the manner in which it looks. The branch of the technology which is concerned with the design, construction, operation and application of robots, as well as other information systems for their control, the feedback of the touch screen and processing information is quite robotic. These technologies do with automatic machine, which may take the place of the people in hazardous environments or manufacturing processes, or looks like people in appearance, behavior and/or cognitive. Many of the robots of today are inspired by nature which contributes to the field of robotics bio-inspired by it. These robots have created a new branch of robotic (robotic soft). From the time of the ancient civilization there have been many accounts of devices user-configurable automatic and even similar to automatic and people, intended primarily as entertainment. As the mechanical techniques developed by the era of industrial, there were several practical applications, such as automatic machine, remote control and wireless remote control included. Anthropomorphic robots have in their component a plane structure 2R, which is a basic structure. In the reverse (inverse) kinematic, are known the kinematic parameters  $x_M$  and  $y_M$ , which represents the co-ordinates of scaling point M (endeffector M) and must be determined by analytical calculation the parameters  $\varphi_{20}$  and  $\varphi_{30}$ . First, it determines the intermediary parameters,  $d$  and  $\varphi$  with relations (1). For the purpose of determining angles can be used various methods (trigonometric, geometric, etc.), of which will be presented below one of them (as the most representative): A trigonometric method.

**Keywords:** Inverse Kinematics, Kinematics Parameters, Position Angles, Scaling Endeffector Point, A Trigonometric Method, Mechanical Systems, Anthropomorphic Robots

## Introduction

A robot is a machine especially programmable one through a computer capable of performing a complex

series of actions in the automatic mode. Robots may be guided by a control device or external control may be incorporated in the inside. Robots can be built to take human form, but most robots are machines designed to

perform a task without taking into account the manner in which it looks (Aversa *et al.*, 2016a; 2016b; 2016c; 2016e; 2016f).

Robots may be autonomous or semi-autonomous and varies from those humanoids such as Advanced Step Honda in Innovative Mobility (ASIMO) and TOSY ping pong Robot plays TOSY (TOPIO) for industrial robots, robots medical operating, patent to help the robots, robots dog therapy, collectively swarm robots programmed, drones UAV, such as MQ-1 " Predator and robots nano microscopic even. By imitation a natural look or automation movements, a robot can transmit a feeling of intelligent or thought of his own. The branch of the technology which is concerned with the design, construction, operation and application of robots, as well as other information systems for their control, the feedback of the touch screen and processing information is quite robotic. These technologies do with automatic machine, which may take the place of the people in hazardous environments or manufacturing processes, or looks like people in appearance, behavior and/or cognitive. Many of the robots of today are inspired by nature which contributes to the field of robotics bio-inspired by it. These robots have created a new branch of robotic (robotic soft).

From the time of the ancient civilization there have been many accounts of devices user-configurable automatic and even similar to automatic and people, intended primarily as entertainment. As the mechanical techniques developed by the era of industrial, there were several practical applications, such as automatic machine, remote control and wireless remote control included.

The word 'robot' has been used for the first time to designate a fictional humanoid in a R.U.R. 1920 plays the Czech writer Karel Čapek but was his brother Karel Joseph Čapek, which was the real inventor of the word. Electronic has evolved in the driving force of development, once the first robots electronic autonomous created by William Gray Walter in Bristol, England, in 1948. The first programmable robot digital and was invented by George Devol in 1954 and was named Unimate. It has been sold to the General Motors in 1961, which has been used to raise the metal pieces when warm from the casting die at the inner Guide Fisher from plants in the western part of the Trenton Ewing Township, New Jersey. Robots have replaced people in the realization of the repetitive tasks and dangerous that men prefer not to make, or are not in a position to do due to the limitations of size or which are taking place in the extreme environments such as space or to the bottom of the sea. There are concerns with regards to the use of robots and their roles in society. Robots are blamed for an increase in unemployment, as replacing the workers in the growing number of

functions. The use of robots in the fight military raises problems of the nature of ethics. The possibilities for the autonomy of the robot and the potential effects have been addressed in fiction and could constitute a realistic concern in the future. The idea of automatic has its origin in the mythology of many cultures around the world. Engineers and inventors of ancient civilization, including ancient China, Ancient Greece and the Ptolemaic age Egypt, has been trying to build cars for self-operation, some resembling animals and people. The descriptions of the automatic early include pigeons artificial Archytas, poultry artificial Mozi and Lu Ban, a "talk" automaton of national Hero of Alexandria, a automaton washer from Philo of Byzantium and a human automaton described in Lie Zi.

In 1928, one of the first robots human aspect has been exposed to the annual exhibition of the company model engineers in London. Invented by W. H. Richards, the robot Eric consisted of aluminum body armor with eleven electromagnets and an engine supplied from a power supply of twelve volts. The robot would be able to move the head and arms and could be controlled by means of a remote control or checking voice mail.

Westinghouse Electric Corporation TELEVOX built in 1926; it was a cut of cardboard connected to a variety of devices on which the users can enable and disable. In 1939, the robot humanoid known under the name of Elektro has been started at Fair 1939 in New York the world crisis. Seven feet high (2.1 m) and a weight of 265 pounds sterling 120,2 (kg), it would be able to travel by voice command, talk about 700 words (using 78 revolutions per minute turntable), the smoke of cigarettes into the air balloons and to move the head and his arms, consisted of a skeleton of steel, the camshaft sensor and the engine, covered by a skin of aluminum. In 1928, the first robot in Japan, Gakutensoku, has been designed and built by biologist Makoto Nishimura.

The first robots autonomous electronic with a complex conduct were created by William Gray Walter of neurological institute load at Bristol, England in 1948 and 1949. He wanted to show that the rich connections between a small number of cells of the brain could give rise to behaviors very complex - in essence, that the secret of the way in which the brain worked is in the manner in which it was wired. Its first robots, called Elmer and Elsie, were built between 1948 and 1949 and have been often described as turtles due to their shape and the slow pace of movement. The three-robots of turtle were able to photo taxis, through which you could find their way to a recharging station when they ran low power battery. Walter stressed the importance of the use of pure electronics analog to simulate the processes of the brain, at a time when his contemporaries, such as Alan Turing and John von Neumann were all turning to view of mental processes

in terms of digital calculation, with his inspired subsequent generations of robotics researchers, such as Rodney Brooks, Hans Moravec and Mark Tilden.

The robots who moves in the structures of the controls are used the sectors almost all vital humanity (Tong *et al.*, 2013).

The robots are capable of processing integrated circuits (Aldana *et al.*, 2013), sizes micro and nano, which man can be seen even with the electronic microscopy (Lee, 2013).

Parts to painting in toxic environments, who works in environments chemical and radioactive materials, or at depths and the pressure at the bottom of the huge oceans, or even the conquest of the cosmic and supervision of exo-planets, are now possible and have turned into from the dream in reality as mechanical platforms of the sequential gearbox (Dong *et al.*, 2013).

The man will be able to carry out its mission supreme-conquer or new galaxies (Aldana *et al.*, 2013; Dong *et al.*, 2013; Flavio de Melo *et al.*, 2012; Lee, 2013; Garcia *et al.*, 2007; He *et al.*, 2013; Liu *et al.*, 2013; Garcia-Murillo *et al.*, 2013; Padula and Perdereau, 2013; Perumaal and Jawahar, 2013; Petrescu and Petrescu, 2011; 2012a; 2012b; 2013; Petrescu *et al.*, 2009; Reddy *et al.*, 2012; Tang *et al.*, 2013; Tong *et al.*, 2013; Wang *et al.*, 2013; Wen *et al.*, 2012), as the systems sequential controls the gearbox.

Robots were developed and diversified different aspects, but today, they are beginning to be turned into two main categories systems: Serial and parallel systems (Padula and Perdereau, 2013).

Parallel systems are more solid, but more difficult to designed and manipulated, on systems which serial number were those who knew a heart-level most.

The Systems serial and have different constructive charts, but over the past 30 years have been focused on anthropomorphic structures (Reddy *et al.*, 2012).

These structures are made up of simple components and couplers for the rotation.

Great advantage them is quick movements, dynamic good, a high precision, construction of modules simple STAS, the economy of materials, reduced costs and high reliability.

A disadvantage of the most precise has been removed from the cause of the stepper motors.

In comparison with the parallel systems (more solid, but more impede some) systems for the serial number may present and the disadvantage of the stability of the somewhat smaller.

This disadvantage begins to be exceeded today, in Smart Mode, through the construction of systems of solution composed of items is doubled (in parallel).

This last invention, will lead to further strengthen the serial number systems, as well as to the consolidation of them as incontestable leader in diversity mechatronics and fault finding sequential systems.

This work of starts from a basic idea, to study these systems on a single model, 3R, which has moves in the latter the main located on a single model of aircraft, 2R.

The most frequently used serial structures in the last twenty or thirty years are those of 3R, 4R, 5R, 6R, having as constituents of the kinematic chain essential basic 3R, robot anthropomorphic (RRR), in the case of the main rotation around a vertical axis, causes construction (Petrescu and Petrescu, 2012a; 2012b).

Then there are a kinematic chain, which has two revolutions actuators (i.e., two motors), which is continuously working in one plane and immediately after the main support which supports and turns on the vertical complete assembly (Petrescu and Petrescu, 2011).

This basic structure (Tang *et al.*, 2013), 3R, o I meet at all robots serial number manufactured on the principle of rotation.

Vertical support has been the same, but the axle assembly as follows with the two turns situated in a plan can be positioned vertically (most often, robots anthropomorphic), or horizontally.

Thus, it can move from the movement of the spatial study, which is more difficult with the motion study, the basis for all the robots and the charges movements of rotation in the series.

In motion flat, horizontal or vertical direction is much easier than the spatial integration with mere convenience in the space of which it is part (Garcia *et al.*, 2007).

The basic structure (Petrescu and Petrescu, 2013) existing in several series platforms of rotation, these being the most preferences (more widespread) at present. On this basic model (3R) have developed robots still 6R (He *et al.*, 2013) today (relies solely on the revolutions using the actuator that only the electric motors, compact); they have a hardness above the penetration while maintaining flexibility and models 3R, 4R and 5R.

Almost all the big companies come today with the models of 6R (which improves in continuous mode).

Why they were imposed today these models of robots (after tens of years of diversity was the word of order); May and the need for standardization, or to find a common solution, after a portion very high (however still are not the only robots use category of serial number, but they also have the widest spread) (Petrescu and Petrescu, 2013).

The six turns (complete elimination of translations, which bring many disadvantages due to T coupler itself) are of operation easier, faster with a higher efficiency, more reliable, more compact and more reliable; revolutions, are all the first three, the other three layers (additional), having the role of position can well designed device, endeffector. The results and that the baseline study (mandatory) is not yet for a 3R (Petrescu and Petrescu, 2013).

Structures Serial most used, containing mostly a basic component, 3R, two revolutions lie in a plane, so it can move from study space in the plan, easing thus far methods of calculating.

Powertrain accounting for two rotations flat aims, structure, geometry, kinematics and reverse transition from movement to the flat space, total static balancing, chain kinetostatic balanced, balanced chain dynamics, kinematics and reverse dynamic.

The structures used in the last 20-30 years serial type are the 3R, 4R, 5R, 6R, containing it basic kinematic chain binding 3R, anthropomorphic robot (RRR), where the movement of the main rotating around a vertical axis drives the entire building.

There is then a basic driveline has two cinematic revolutions (two actuators, i.e., two engines) work permanently in one plane and immediately following the main beam which supports and rotates vertically entire assembly.

This basic structure, 3R, a serial robot meet all manufactured on the principle of rotation.

Vertical stand is always the same, but the powertrain which will, with the two turns located in a plane can be positioned vertically (most often, where robots anthropomorphic, Fig. 1b), or horizontally (if robots scale, Fig. 1).

It can thus pass from the study of spatial movement, which is more difficult to study planar movement, motion base for all robots and manipulators series with rotational movements.

Movement flat, vertical or horizontal, is much easier than studying the space, taking advantage of simple integration into the space part.

Next we illustrate the basic structure existing in several series of rotating platforms, which are the most generalized (most common) today.

In Fig. 2 one can see a 6R structure (structure anthropomorphic).

On this basic model (3R) were further developed 6R robots today (Fig. 2 based only on rotations using only the electric motors that drive light, compact); they have higher rigidity and flexibility while maintaining penetration patterns 3R, 4R, 5R and.

Almost all major wine companies today 6R models (which we continuously improve).

Why have won today these models of robots (after decades diversity was the watchword?); perhaps the need for standardization, or to find a common solution after a huge fragmentation (not yet anyway only series robots use category, but the most widespread).

The six rotations (total elimination of translation, which brings many disadvantages due to coupling T itself) make operation simpler, faster, higher yield, more reliable, more compact and safer; basic rotations remain throughout the first three, the other three rotations (additional) serving to better position the end device, endeffector.

The same can be seen in the newest models of various manufacturers of robots (Fig. 3 Kawasaki, Romat, Fanuc, Motoman, Kuka, etc.).

The robotic structures used within cells in general are similarly constructed.

This can also be seen in the new models of the various firms producing robots (Kawasaki, Romat, Fanuc System, Motoman, Kuka, etc). Structures used inside the cells of the sequential gearbox are constructed, in general, in a similar way.

Starting from the platform 3R (Fig. 4) any modern robotic anthropomorphic system can be studied by adding another one system, n-R modern (Petrescu and Petrescu, 2013).

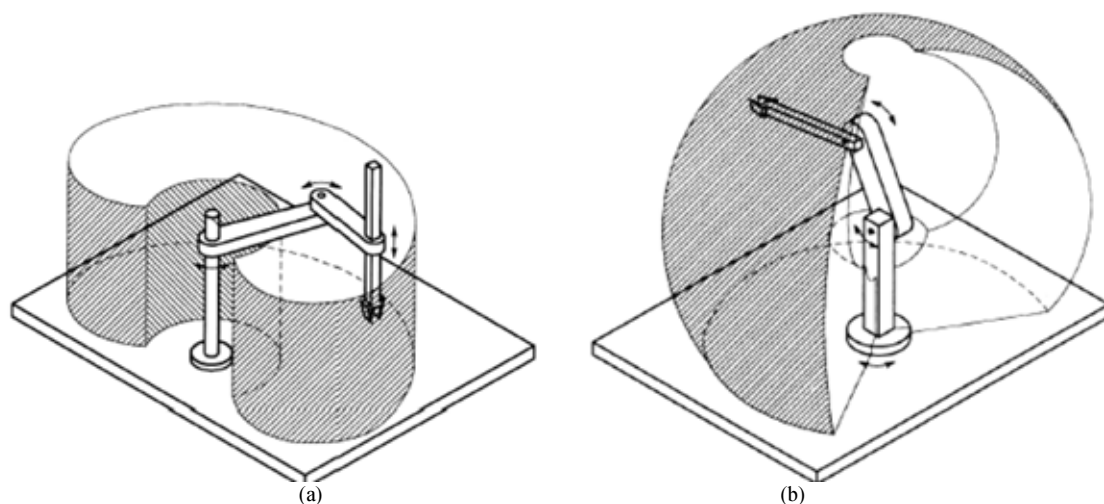


Fig. 1. 3R basic structure (a) structure scale, (b) structure anthropomorphic)

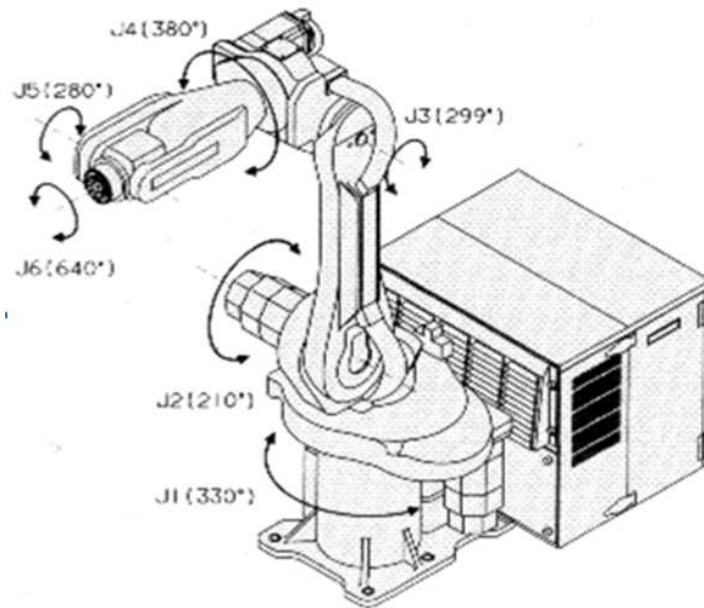


Fig. 2. 6R structure (structure anthropomorphic)



Fig. 3. Various modern structures 6R (anthropomorphic) and two robotic cells prepared specifically for a certain type of operation

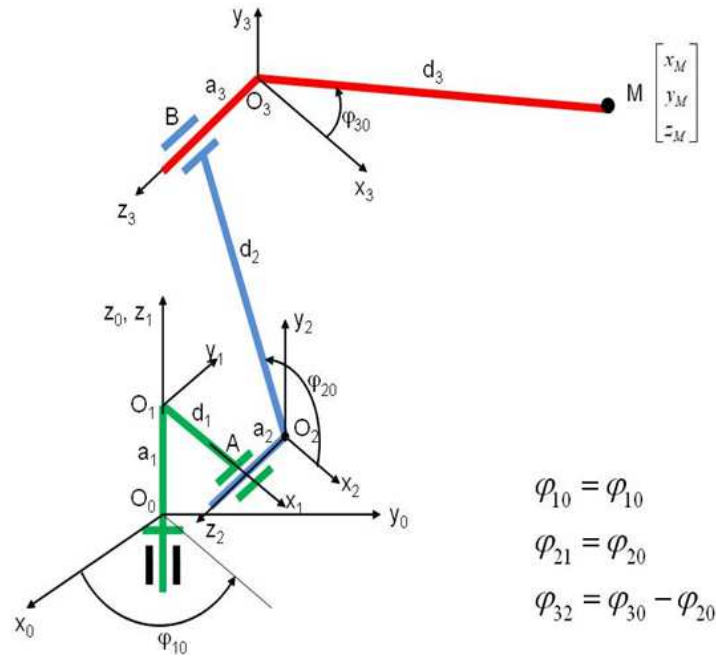


Fig. 4. Schematic geometro-cinematic a structure 3R modern (anthropomorphic)

The platform (system) has three degree of mobility, which can be realized by three actuators (electric motors).

First one engine (electrical) drives the whole system by rotating it around the vertical axis ( $O_0z_0$ ).

Engine (actuator) number 1 is mounted on the fixed frame 0) fundraising campaign and one in the mobile element rotating around the vertical axis (the mobile element 1 then all the other elements (components) of the system).

Follows the plane Kinematic chain (vertical), composed of two moving components and two couplers engines. It's about the kinematic elements 2 and 3, the assembly 2-3 being moved by the actuator of the second mounted to engage A ( $O_2$ ), fixed on item 1.

Therefore the second engine electrical attached to the component 1 will result in the item 2 of rotating relative to the item 1, but he will automatically move entire drive train 2-3 (Petrescu and Petrescu, 2011; 2012a; 2012b; 2013; Petrescu *et al.*, 2009).

Last actuator command (electric) attached to the item (2) and in B ( $O_3$ ), will rotate item 3 (the relative to 2).

Carried out by the rotation  $\varphi_{10}$  first actuator and is relative (between items 1 and 0) and absolute between elements 1 and 0).

Carried out by the rotation  $\varphi_{20}$  second actuator and is relative (between items 2 and 1) and absolute between items 2 and 0), due to the arrangement.

$\theta = \varphi_{32}$  rotation carried out by the third actuator command is only relative (between items 3 and 2); the corresponding absolute between items 3 and 0) as a function of  $\theta = \varphi_{32}$  and  $\varphi_{20}$ .

The drive train 2-3 (consisting of kinematic elements 2 and 3) kinematic chain is a plan, which fall within a

single plane or in one or more of the other plane parallel to each other. It is of particular kinematic system, which will be examined separately.

It shall be i terminological one of which item is 2-3 I caught the drive train being fixed, couplers of the kinematic engines A( $O_2$ ) and B ( $O_3$ ) becoming first fixed coupler and the coupler to make two phones, which has both couplers Kinematic  $C_5$  of rotation, (Petrescu and Petrescu, 2011; 2012a; 2012b; 2013; Petrescu *et al.*, 2009).

Determination of the extents of kinematic chain mobility plan of 2-3, the apply structural formula given by the geosciences ( $M_3 = 3 \cdot m \cdot 2 \cdot C_5 = 3 \cdot 2 \cdot 2 \cdot 2 = 6 \cdot 4 = 2$ ), where m represents the number of elements of the plan mobile Kinematic chain, in our houses  $m = 2$  (as we have talking about noted the two kinematic elements element with 2 and 3) and  $C_5$  represents the number of couplers 'bokeh' fifth-class in the houses in point  $C_5 = 2$  (in the case of couplers A and B or  $O_2$  and  $O_3$ ).

The drive train having degree of mobility 2-3 2 actuated by two motors must be (Liu *et al.*, 2013).

It is preferred that the two actuators to be two electric motors, a direct current, or alternately. Action can be done but with different engines.

Hydraulic motors, system, sonic, etc.

### Structural Schematic Kinematic Chain Plan 2-3

The lead 2 is linked to the element one coupler fixed term by the  $O_2$  engines and drive element 3 is connected to the mobile element engage two engines by  $O_3$ .



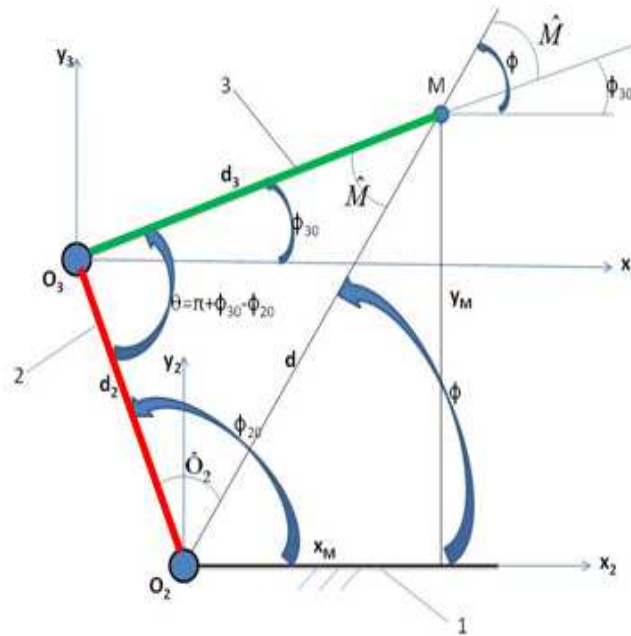


Fig. 5. Cinematic schema of kinematic chain plan 2-3 linked to item 1 considered fixed

This results in the kinematic chain with two open degree of mobility, which can be realized by the two actuators, i.e., the two electric motors mounted on engines couplers A and B or  $O_2$  or  $O_3$  (Garcia-Murillo *et al.*, 2013), (Fig. 5).

In the directly kinematics has known the kinematic parameters  $\phi_{20}$  and  $\phi_{30}$  and must be determined by analytical calculation parameters  $x_M$  and  $y_M$ , the which represents the coordinates of scaling point M endeffector (M).

Designing vectors  $d_2 + d_3$  on Cartesian axis system fixed,  $xOy$ , identical to  $x_2O_2y_2$ . Obtain the scaling equation (2) (Wen *et al.*, 2012).

Anthropomorphic robots (Aldana *et al.*, 2013) their component in the plane have 2R structure, which is the basic structure, the plan 3 Kinematic chain open. In Fig. 2 can be monitored in the kinematic diagram of the kinematic chain open plan 2-3.

In the reverse (inverse kinematic), kinematic has known the parameters  $x_M$  and  $y_M$ , the which represents the co-ordinates of scaling point M endeffector (M) and must be determined by analytical calculation and the parameters  $\phi_{20}$  and  $\phi_{30}$  (Petrescu and Petrescu, 2011; 2012a; 2012b; 2013; Petrescu *et al.*, 2009).

First, it determines the intermediary parameters,  $d$  and  $\phi$  relations (1):

$$\begin{cases} d^2 = x_M^2 + y_M^2; d = \sqrt{x_M^2 + y_M^2} \\ \cos \phi = \frac{x_M}{d} = \frac{x_M}{\sqrt{x_M^2 + y_M^2}} \\ \sin \phi = \frac{y_M}{d} = \frac{y_M}{\sqrt{x_M^2 + y_M^2}} \\ \phi = \text{sign}(\sin \phi) \cdot \arccos(\cos \phi) \end{cases} \quad (1)$$

In some lengths of a triangle  $O_2O_3M$  known of the three sides,  $d_2$ ,  $d_3$  (constant) and  $D$  (variable), so that it can be determined according to the sides of lengths all other elements of the triangle and more precisely the angles, functions trigonometric and their (us one great interest in sin and shopping).

For the purpose of determining angles can be used for various methods (Trigonometric, geometric transformations, etc.), of which will be presented below one of them (as the most representative): Trigonometric method.

## Trigonometric Method

### Positions Determination

Shall write the equations of positions scaling (2) (Petrescu and Petrescu, 2011; 2012a; 2012b; 2013; Petrescu *et al.*, 2009):

$$\begin{cases} d_2 \cdot \cos \phi_{20} + d_3 \cdot \cos \phi_{30} = x_M \\ d_2 \cdot \sin \phi_{20} + d_3 \cdot \sin \phi_{30} = y_M \\ \cos^2 \phi_{20} + \sin^2 \phi_{20} = 1 \\ \cos^2 \phi_{30} + \sin^2 \phi_{30} = 1 \end{cases} \quad (2)$$

These two equations problems of scale, trigonometric, with two unknowns ( $\phi_{20}$  and separately for the angle  $\phi_{30}$ ), is the fact that they are more often met and exceed the slow (are equations, trigonometric equation transcendent, in the case in which the unknown does not appear in the directly, but  $\phi_{20}$ , also in the form of  $\cos \phi_{20}$  and  $\sin \phi_{20}$ , so that, in fact,

within the framework of the trigonometric two equations do not have two unknown, but four:  $\cos\phi_{20}$ ,  $\sin\phi_{20}$ ,  $\cos\phi_{30}$  and  $\sin\phi_{30}$ .

In order to solve the system we need another two equations, so that in the system (2), has yet been added two equations trigonometric, more exactly the equations trigonometric of base "Gold", as they say, for the angle  $\phi_{20}$  and separately for the angle  $\phi_{30}$ .

With a view to resolving the two equation of the system (2) is written in the form (3):

$$\begin{cases} d_2 \cdot \cos\phi_{20} - x_M = -d_3 \cdot \cos\phi_{30} \\ d_2 \cdot \sin\phi_{20} - y_M = -d_3 \cdot \sin\phi_{30} \end{cases} \quad (3)$$

Each equation of the system (3) square, after which summed up both equation (raised square) and obtain the equation of the form (4):

$$\begin{cases} d_2^2 \cdot (\cos^2\phi_{20} + \sin^2\phi_{20}) + x_M^2 + y_M^2 \\ -2 \cdot d_2 \cdot x_M \cdot \cos\phi_{20} - 2 \cdot d_2 \cdot y_M \cdot \sin\phi_{20} \\ = d_3^2 \cdot (\cos^2\phi_{30} + \sin^2\phi_{30}) \end{cases} \quad (4)$$

Now is the time to use the two "equation of gold" trigonometric system written at the end (2), whereby the Equation 4 becomes simplified form (5):

$$\begin{cases} d_2^2 + x_M^2 + y_M^2 - 2 \cdot d_2 \cdot x_M \cdot \cos\phi_{20} \\ -2 \cdot d_2 \cdot y_M \cdot \sin\phi_{20} = d_3^2 \end{cases} \quad (5)$$

Arrange the terms of this Equation 5 in the form most convenient (6):

$$\begin{cases} d_2^2 - d_3^2 + x_M^2 + y_M^2 \\ = 2 \cdot d_2 \cdot (x_M \cdot \cos\phi_{20} + y_M \cdot \sin\phi_{20}) \end{cases} \quad (6)$$

Divide the Equation 6 with  $2 \cdot d_2$  and will result in a new form (7):

$$x_M \cdot \cos\phi_{20} + y_M \cdot \sin\phi_{20} = \frac{d_2^2 - d_3^2 + x_M^2 + y_M^2}{2 \cdot d_2} \quad (7)$$

As shown in Fig. 1 shall be deducted and the relationship (8) which may also appears in the system (1):

$$x_M^2 + y_M^2 = d^2 \quad (8)$$

Enter the expression (8) to (7) and multiply the fraction from the right with  $d$ , so that the expression (7) takes the form convenient (9):

$$\begin{cases} x_M \cdot \cos\phi_{20} + y_M \cdot \sin\phi_{20} = \frac{d_2^2 + d^2 - d_3^2}{2 \cdot d_2 \cdot d} \cdot d \end{cases} \quad (9)$$

Now it's time of introduction of expression cosine of  $O_2$  angle, depending on the sides of the some triangle  $O_2O_3M$  (10):

$$\cos\hat{O}_2 = \frac{d_2^2 + d^2 - d_3^2}{2 \cdot d_2 \cdot d} \quad (10)$$

With the relation (10) the Equation 9 becomes simplified form (11):

$$x_M \cdot \cos\phi_{20} - d \cdot \cos\hat{O}_2 = -y_M \cdot \sin\phi_{20} \quad (11)$$

We want to eliminate  $\sin\phi_{20}$ , from which I isolate the term in  $\sin$  and got to his feet to square the Equation 11, so that by using the equation gold (trigonometric) for the angle  $\phi_{20}$  to transform  $\sin$  in  $\cos$ , equation become one of the second degree in  $\cos\phi_{20}$ . After raising square (11) takes shape (12):

$$\begin{cases} x_M^2 \cdot \cos^2\phi_{20} + d^2 \cdot \cos^2\hat{O}_2 \\ -2 \cdot d \cdot x_M \cdot \cos\hat{O}_2 \cdot \cos\phi_{20} \\ = y_M^2 \cdot \sin^2\phi_{20} \end{cases} \quad (12)$$

Using formula of gold, the expression (12) takes shape (13) which is arranges convenient by grouping terms and bringing it to the form (14):

$$\begin{cases} x_M^2 \cdot \cos^2\phi_{20} + d^2 \cdot \cos^2\hat{O}_2 \\ -2 \cdot d \cdot x_M \cdot \cos\hat{O}_2 \cdot \cos\phi_{20} \\ = y_M^2 - y_M^2 \cdot \cos^2\phi_{20} \end{cases} \quad (13)$$

$$\begin{cases} (x_M^2 + y_M^2) \cdot \cos^2\phi_{20} \\ -2 \cdot d \cdot x_M \cdot \cos\hat{O}_2 \cdot \cos\phi_{20} \\ -(y_M^2 - d^2 \cdot \cos^2\hat{O}_2) = 0 \end{cases} \quad (14)$$

Discriminant of the Equation 14 of second degree in  $\cos$  obtained shall be calculated according to the relation (15):

$$\begin{cases} \Delta = d^2 \cdot x_M^2 \cdot \cos^2\hat{O}_2 \\ + d^2 \cdot (y_M^2 - d^2 \cdot \cos^2\hat{O}_2) \\ = d^2 \cdot (x_M^2 \cdot \cos^2\hat{O}_2 + y_M^2 - d^2 \cdot \cos^2\hat{O}_2) \\ = d^2 \cdot (y_M^2 - y_M^2 \cdot \cos^2\hat{O}_2) \\ = d^2 \cdot y_M^2 \cdot (1 - \cos^2\hat{O}_2) \\ = d^2 \cdot y_M^2 \cdot \sin^2\hat{O}_2 \end{cases} \quad (15)$$

Radical from the second order of the discriminant is expressed as (16):



$$\begin{cases} R = \sqrt{\Delta} = \sqrt{d^2 \cdot y_M^2 \cdot \sin^2 \hat{O}_2} \\ = d \cdot y_M \cdot \sin \hat{O}_2 \end{cases} \quad (16)$$

Equation solutions (14) second degree in cos shall be written in the form (17):

$$\begin{cases} \cos \phi_{20,2} \\ = \frac{d \cdot x_M \cdot \cos \hat{O}_2 \mp d \cdot y_M \cdot \sin \hat{O}_2}{d^2} \\ = \frac{x_M \cdot \cos \hat{O}_2 \mp y_M \cdot \sin \hat{O}_2}{d} \\ = \frac{x_M}{d} \cdot \cos \hat{O}_2 \mp \frac{y_M}{d} \cdot \sin \hat{O}_2 \end{cases} \quad (17)$$

In the solutions (17) are replaced the reports with the corresponding functions trigonometric of the angle  $\phi$ , expressions (17) mellowed form (18):

$$\begin{cases} \cos \phi_{20,2} = \\ = \frac{x_M}{d} \cdot \cos \hat{O}_2 \mp \frac{y_M}{d} \cdot \sin \hat{O}_2 \\ = \cos \phi \cdot \cos \hat{O}_2 \mp \sin \phi \cdot \sin \hat{O}_2 \\ = \cos(\phi \pm \hat{O}_2) \\ \cos \phi_{20} = \cos(\phi \pm \hat{O}_2) \end{cases} \quad (18)$$

Now we're going back to the Equation 11 that is ordered in the form (19), in order to solve them in sin. The Equation 19 rose square and through the use of gold trigonometric equation of angle  $\phi_{20}$ , is obtained form (20):

$$x_M \cdot \cos \phi_{20} = d \cdot \cos \hat{O}_2 - y_M \cdot \sin \phi_{20} \quad (19)$$

$$\begin{cases} x_M^2 \cdot \cos^2 \phi_{20} = d^2 \cdot \cos^2 \hat{O}_2 \\ + y_M^2 \cdot \sin^2 \phi_{20} \\ - 2 \cdot y_M \cdot d \cdot \cos \hat{O}_2 \cdot \sin \phi_{20} \\ x_M^2 - x_M^2 \cdot \sin^2 \phi_{20} \\ = d^2 \cdot \cos^2 \hat{O}_2 + y_M^2 \cdot \sin^2 \phi_{20} \\ - 2 \cdot y_M \cdot d \cdot \cos \hat{O}_2 \cdot \sin \phi_{20} \\ (x_M^2 + y_M^2) \cdot \sin^2 \phi_{20} \\ - 2 \cdot y_M \cdot d \cdot \cos \hat{O}_2 \cdot \sin \phi_{20} \\ - (x_M^2 - d^2 \cdot \cos^2 \hat{O}_2) = 0 \\ d^2 \cdot \sin^2 \phi_{20} - 2 \cdot y_M \cdot d \cdot \\ \cdot \cos \hat{O}_2 \cdot \sin \phi_{20} - (x_M^2 - d^2 \cdot \cos^2 \hat{O}_2) = 0 \end{cases} \quad (20)$$

Discriminant of the Equation 20 of second degree in cos takes the form (21):

$$\begin{cases} \Delta = y_M^2 \cdot d^2 \cdot \cos^2 \hat{O}_2 \\ + d^2 \cdot (x_M^2 - d^2 \cdot \cos^2 \hat{O}_2) \\ = d^2 \cdot (x_M^2 + y_M^2 \cdot \cos^2 \hat{O}_2 \\ - x_M^2 \cdot \cos^2 \hat{O}_2 - y_M^2 \cdot \cos^2 \hat{O}_2) \\ = d^2 \cdot (x_M^2 - x_M^2 \cdot \cos^2 \hat{O}_2) \\ = d^2 \cdot x_M^2 \cdot \sin^2 \hat{O}_2 \end{cases} \quad (21)$$

Equation Solutions (20) shall be written in the form (22):

$$\begin{cases} \sin \phi_{20} = \frac{y_M \cdot d \cdot \cos \hat{O}_2 \pm x_M \cdot d \cdot \sin \hat{O}_2}{d^2} \\ = \frac{y_M \cdot \cos \hat{O}_2 \pm x_M \cdot \sin \hat{O}_2}{d} \\ = \frac{y_M}{d} \cdot \cos \hat{O}_2 \pm \frac{x_M}{d} \cdot \sin \hat{O}_2 \\ = \sin \phi \cdot \cos \hat{O}_2 \pm \cos \phi \cdot \sin \hat{O}_2 = \sin(\phi \pm \hat{O}_2) \end{cases} \quad (22)$$

Have been obtained relations (23), of which shall be deducted the basic relationship (24):

$$\begin{cases} \cos \phi_{20} = \cos(\phi \pm \hat{O}_2) \\ \sin \phi_{20} = \sin(\phi \pm \hat{O}_2) \end{cases} \quad (23)$$

$$\phi_{20} = \phi \pm \hat{O}_2 \quad (24)$$

Repeat the procedure and for determining  $\phi_{30}$  angle, starting again from the system (2), in which the first two equations transcendently are rewritten in the form (25), with a view to eliminating  $\phi_{20}$  angle at this time:

$$\begin{cases} d_2 \cdot \cos \phi_{20} + d_3 \cdot \cos \phi_{30} = x_M \\ d_2 \cdot \sin \phi_{20} + d_3 \cdot \sin \phi_{30} = y_M \\ \cos^2 \phi_{20} + \sin^2 \phi_{20} = 1 \\ \cos^2 \phi_{30} + \sin^2 \phi_{30} = 1 \end{cases} \quad (2)$$

$$\begin{cases} d_2 \cdot \cos \phi_{20} = x_M - d_3 \cdot \cos \phi_{30} \\ d_2 \cdot \sin \phi_{20} = y_M - d_3 \cdot \sin \phi_{30} \end{cases} \quad (25)$$

He stood up the two equations of the system (25) square and summed, resulting the equation of the form (26), which shall be made up in one of the forms easier (27) and (28):

$$\begin{cases} d_2^2 = x_M^2 + y_M^2 + d_3^2 \\ - 2 \cdot d_3 \cdot x_M \cdot \cos \phi_{30} \\ - 2 \cdot d_3 \cdot y_M \cdot \sin \phi_{30} \end{cases} \quad (26)$$

$$\begin{cases} x_M \cdot \cos \phi_{30} + y_M \cdot \sin \phi_{30} \\ = d \cdot \frac{d^2 + d_3^2 - d_2^2}{2 \cdot d \cdot d_3} \end{cases} \quad (27)$$

$$x_M \cdot \cos \phi_{30} + y_M \cdot \sin \phi_{30} = d \cdot \cos \hat{M} \quad (28)$$

We would like to determine the first shopping cart function, so we isolate for the start-up period of the term in sin, the Equation 28, by placing it in the form of (29), which by quadrature head coil generates the expression (30), which is made up into the form (31):

$$x_M \cdot \cos \phi_{30} - d \cdot \cos \hat{M} = -y_M \cdot \sin \phi_{30} \quad (29)$$

$$\begin{cases} x_M^2 \cdot \cos^2 \phi_{30} + d^2 \cdot \cos^2 \hat{M} \\ -2 \cdot d \cdot x_M \cdot \cos \hat{M} \cdot \cos \phi_{30} \\ = y_M^2 - y_M^2 \cdot \cos^2 \phi_{30} \end{cases} \quad (30)$$

$$\begin{cases} d^2 \cdot \cos^2 \phi_{30} - 2 \cdot d \cdot x_M \cdot \cos \hat{M} \cdot \cos \phi_{30} \\ -(y_M^2 - d^2 \cdot \cos^2 \hat{M}) = 0 \end{cases} \quad (31)$$

The Equation 31 is an equation of degree II in cos, with the solutions given by the expression (32).

Enter the following Equation 28 in the form of (33), where it is isolated from the moment the term to cart with a view to eliminating so it can be determined by the law of the sin:

$$\begin{cases} \cos \phi_{30} \\ = \frac{d \cdot x_M \cdot \cos \hat{M} \pm \sqrt{d^2 \cdot x_M^2 \cdot \cos^2 \hat{M} + d^2 \cdot (y_M^2 - d^2 \cdot \cos^2 \hat{M})}}{d^2} \\ = \frac{d \cdot x_M \cdot \cos \hat{M} \pm \sqrt{d^2 \cdot y_M^2 \cdot (1 - \cos^2 \hat{M})}}{d^2} \\ = \frac{d \cdot x_M \cdot \cos \hat{M} \pm d \cdot y_M \cdot \sin \hat{M}}{d^2} \\ = \frac{x_M}{d} \cdot \cos \hat{M} \pm \frac{y_M}{d} \cdot \sin \hat{M} \\ = \cos \phi \cdot \cos \hat{M} \pm \sin \phi \cdot \sin \hat{M} = \cos(\phi \mp \hat{M}) \\ \cos \phi_{30} = \cos(\phi \mp \hat{M}) \end{cases} \quad (32)$$

$$x_M \cdot \cos \phi_{30} = d \cdot \cos \hat{M} - y_M \cdot \sin \phi_{30} \quad (33)$$

The Equation 33 square and obtain the equation of the form (34), which shall be made up in the form convenient (35):

$$\begin{cases} x_M^2 \cdot (1 - \sin^2 \phi_{30}) \\ = d^2 \cdot \cos^2 \hat{M} + y_M^2 \cdot \sin^2 \phi_{30} \\ -2 \cdot y_M \cdot d \cdot \cos \hat{M} \cdot \sin \phi_{30} \end{cases} \quad (34)$$

$$\begin{cases} d^2 \cdot \sin^2 \phi_{30} - 2 \cdot y_M \cdot d \cdot \cos \hat{M} \cdot \sin \phi_{30} \\ -(x_M^2 - d^2 \cdot \cos^2 \hat{M}) = 0 \end{cases} \quad (35)$$

The expression (35) is an equation of degree II in sin, which allowed some solutions given by the relationship (36):

$$\begin{cases} \sin \phi_{30} \\ = \frac{d \cdot y_M \cdot \cos \hat{M} \mp \sqrt{d^2 \cdot y_M^2 \cdot \cos^2 \hat{M} + d^2 \cdot (x_M^2 - d^2 \cdot \cos^2 \hat{M})}}{d^2} \\ = \frac{d \cdot y_M \cdot \cos \hat{M} \mp \sqrt{d^2 \cdot x_M^2 \cdot (1 - \cos^2 \hat{M})}}{d^2} \\ = \frac{d \cdot y_M \cdot \cos \hat{M} \mp d \cdot x_M \cdot \sin \hat{M}}{d^2} \\ = \frac{y_M}{d} \cdot \cos \hat{M} \mp \frac{x_M}{d} \cdot \sin \hat{M} = \sin \phi \cdot \cos \hat{M} \mp \cos \phi \cdot \sin \hat{M} \\ = \sin(\phi \mp \hat{M}) \\ \sin \phi_{30} = \sin(\phi \mp \hat{M}) \end{cases} \quad (36)$$

Are retained relations (37) of which shall be deducted and the expression (38):

$$\begin{cases} \cos \phi_{30} = \cos(\phi \mp \hat{M}) \\ \sin \phi_{30} = \sin(\phi \mp \hat{M}) \end{cases} \quad (37)$$

$$\phi_{30} = \phi \mp \hat{M} \quad (38)$$

## Velocities Determination

In the system (1) derived be retained only relations (39), necessary in the study of the inverse kinematics of system. Start at the relationship linking cosine  $\hat{O}_2$  angle to the sides of the triangle, which is derived with respect to time and is given the value  $\dot{\hat{O}}_2$ , writing simpler  $\dot{O}_2$  (relations 40):

$$\begin{cases} \dot{\phi} = \frac{\dot{y}_M \cdot \cos \phi - \dot{x}_M \cdot \sin \phi}{d} \\ \dot{d} = \frac{x_M \cdot \dot{x}_M + y_M \cdot \dot{y}_M}{d} \end{cases} \quad (39)$$

$$\begin{cases} 2 \cdot d_2 \cdot d \cdot \cos O_2 = d_2^2 - d_3^2 + d^2 \\ 2 \cdot d_2 \cdot \dot{d} \cdot \cos O_2 - 2 \cdot d_2 \cdot d \cdot \sin O_2 \cdot \dot{O}_2 = \\ 2 \cdot d \cdot \dot{d} \Rightarrow \\ \Rightarrow \dot{O}_2 = \frac{d_2 \cdot \dot{d} \cdot \cos O_2 - d \cdot \dot{d}}{d_2 \cdot d \cdot \sin O_2} \end{cases} \quad (40)$$

Is derived relationship (24) and obtain angular speed (the relationship 41):

$$\phi_{20} = \phi \pm \hat{O}_2 \quad (24)$$

$$\omega_{20} \equiv \dot{\phi}_{20} = \dot{\phi} \pm \dot{O}_2 \quad (41)$$

To determine  $\omega_{20}$  (the relationship 41) we need  $\dot{\phi}$  which is calculated from (39) and  $\dot{O}_2$  which is to be determined from (40).

In turn  $\dot{O}_2$  requires for its calculation  $\dot{d}$  who is still determined from the system (39) as well.

Input speeds  $\dot{x}_M$  and  $\dot{y}_M$  are known, are imposed in input data, or choose convenient, times can be calculated on the basis of such criteria as required. Similarly shall be determined and angular speed  $\omega_{30} \equiv \dot{\phi}_{30}$ :

$$\begin{cases} 2 \cdot d_3 \cdot d \cdot \cos M = d_3^2 - d_2^2 + d^2 \\ 2 \cdot d_3 \cdot \dot{d} \cdot \cos M - 2 \cdot d_3 \cdot d \cdot \sin M \cdot \dot{M} = \\ = 2 \cdot d \cdot \dot{d} \Rightarrow \\ \Rightarrow \dot{M} = \frac{d_3 \cdot \dot{d} \cdot \cos M - d \cdot \dot{d}}{d_3 \cdot d \cdot \sin M} \end{cases} \quad (42)$$

It derived relationship (38) in order to obtain angular speed  $\omega_{30} \equiv \dot{\phi}_{30}$ , (the expression 43).  $\dot{\phi}$  shall be calculated with the expression already known from the system (39) and  $\dot{M}$  shall be determined from the system (42) and with the aid of (39) that it determines and on the  $\dot{d}$ :

$$\phi_{30} = \phi \mp \hat{M} \quad (38)$$

$$\omega_{30} \equiv \dot{\phi}_{30} = \dot{\phi} \mp \dot{M} \quad (43)$$

### Accelerations Determination

The relations in the system (39) derived, are obtained (44), as referred to in the study of acceleration of the system in the reverse cinematic. The relationship of the system (40) is derived a second time, with time and to obtain the system (45):

$$\begin{cases} \ddot{\phi} = \frac{\ddot{y}_M \cdot \cos \phi - \ddot{x}_M \cdot \sin \phi - \dot{y}_M \cdot \sin \phi \cdot \dot{\phi} - \dot{x}_M \cdot \cos \phi \cdot \dot{\phi} - \dot{d} \cdot \dot{\phi}}{d} \\ \ddot{d} = \frac{\dot{x}_M^2 + x_M \cdot \ddot{x}_M + \dot{y}_M^2 + y_M \cdot \ddot{y}_M - \dot{d}^2}{d} \end{cases} \quad (44)$$

$$\begin{cases} 2 \cdot d_2 \cdot d \cdot \cos O_2 = d_2^2 - d_3^2 + d^2 \\ 2 \cdot d_2 \cdot \dot{d} \cdot \cos O_2 - 2 \cdot d_2 \cdot d \cdot \sin O_2 \cdot \dot{O}_2 = 2 \cdot d \cdot \dot{d} \Rightarrow \\ \Rightarrow d_2 \cdot d \cdot \sin O_2 \cdot \dot{O}_2 = d_2 \cdot \dot{d} \cdot \cos O_2 - d \cdot \dot{d} \\ \ddot{O}_2 = \frac{\ddot{d} d_2 \cos O_2 - \ddot{d} d - 2 \dot{d} d_2 \sin O_2 \cdot \dot{O}_2 - d \dot{d}_2 \cos O_2 \cdot \dot{O}_2 - \dot{d}^2}{d_2 \cdot d \cdot \sin O_2} \end{cases} \quad (45)$$

The following is derived expression (41) and obtain the relationship (46), which generates an absolute angular acceleration  $\varepsilon_2 \equiv \varepsilon_{20}$ , which can be calculated with  $\ddot{\phi}$  deducted from the system (44) and with  $\ddot{O}_2$  obtained from the system (45) and for its determination ( $\ddot{O}_2$  determination) it is necessary and  $\ddot{d}$  calculated all from (44):

$$\omega_{20} \equiv \dot{\phi}_{20} = \dot{\phi} \pm \dot{O}_2 \quad (41)$$

$$\varepsilon_2 \equiv \varepsilon_{20} = \dot{\omega}_{20} \equiv \ddot{\phi}_{20} = \ddot{\phi} \pm \ddot{O}_2 \quad (46)$$

Now derived a second time expression (42) and obtain the system (47):

$$\begin{cases} 2 \cdot d_3 \cdot d \cdot \cos M = d_3^2 - d_2^2 + d^2 \\ 2 \cdot d_3 \cdot \dot{d} \cdot \cos M - 2 \cdot d_3 \cdot d \cdot \sin M \cdot \dot{M} = 2 \cdot d \cdot \dot{d} \Rightarrow \\ \Rightarrow d_3 \cdot d \cdot \sin M \cdot \dot{M} = d_3 \cdot \dot{d} \cdot \cos M - d \cdot \dot{d} \\ \ddot{M} = \frac{\ddot{d} d_3 \cos M - \ddot{d} d - 2 \dot{d} d_3 \sin M \cdot \dot{M} - d \dot{d}_3 \cos M \cdot \dot{M} - \dot{d}^2}{d_3 \cdot d \cdot \sin M} \end{cases} \quad (47)$$

Is derived again with time relationship (43) and obtain the expression (64) of the absolute angular acceleration  $\varepsilon_3 \equiv \varepsilon_{30}$  which is to be determined with  $\ddot{\phi}$  and  $\ddot{M}$ .

$\ddot{\phi}$  is obtained from the system (44) and  $\ddot{M}$  shall be calculated from the system (47) and also needs  $\ddot{d}$  obtain all of the system (44):

$$\omega_{30} \equiv \dot{\phi}_{30} = \dot{\phi} \mp \dot{M} \quad (43)$$

$$\varepsilon_3 \equiv \varepsilon_{30} = \dot{\omega}_{30} \equiv \ddot{\phi}_{30} = \ddot{\phi} \mp \ddot{M} \quad (48)$$

### Discussion

Researchers need to understand the structure of the human body and behavior (biomechanics) to build and to study robots humanoids. On the other hand the attempt simulation of the human body leads to a greater

understanding of it. Human knowledge is a field of study, which is focused on the way in that people learn from sensory information in order to acquire the skills and insightful motor. Such knowledge is used to develop models for the calculation of human behavior and has been the improvement in time.

It has been suggested that robotics highly advanced will facilitate the increase in ordinary people.

With all that the original purpose of humanoid research has been to build a better orthosis and prosthesis for human beings, knowledge has been transferred between the two disciplines. Some examples are: Prosthesis footswitch with electrical adjustment for impaired neuromuscular, orthosis ankle-foot, biological realistic prosthesis leg and forearm prosthesis (Aversa *et al.*, 2016a; 2016b; 2016c; 2016e; 2016f).

In addition to the research, robots humanoids are developed to perform human activities, such as personal assistance, where they would be able to help places of work diseased and the elderly and dirty or dangerous. Work places ordinary, such as to be a yacht or a worker of a production line of cars are also suitable for the humanoids." In essence, as they can use tools and operate the equipment and vehicles designed to human form, those humanoids could carry out, theoretically, any load a human being may, as long as they have the software itself. However, the complexity to do this is deceptively big.

They are more popular for the provision of entertainment too. For example, Ursula, food Sex Female, sing, play music, dances and speaks to the public her from Universal Studios. More highlights Disney hire the use of animatrons, robots that looks, moves and speaking in the same way as human beings, in some thematic shows the parking brake.

These animatrons look so realistic that it can be difficult to decipher the remote whether or not they are in fact they are human. Though they look realistic, they do not have any cognitive autonomy or natural. Various robots humanoids and possible their applications in everyday life are presented in a documentary film independently, called Plug and Pray, which has been launched in 2010.

Robots humanoids, in particular with the algorithms of artificial intelligence, could be useful for future dangerous mission and/or at a distance of the spatial scan without the need to turn around again and to get back on the ground once the mission is completed.

A sensor is a device which measures some attribute of the world. As one of the three primitives of robotics (apart from the planning and control), detection plays an important role in the fault finding sequential paradigms.

Sensors can be classified on the basis of the physical process which works with or, depending on the type of

metering information which they give that output. In this case, was used by the second approach.

Proprioceptive sensors sense the position, the orientation and speed of the body and the rubber humanoid him.

Human beings otoliths channels and the semi-circular (in his ear internal) are used to maintain balance and orientation. In addition, people do not use their own proprioceptive sensors (e.g., to the touch, muscular extension, limb position) to help with robots humanoid orientation. Their uses accelerometers to measure the acceleration, from which the speed can be calculated by means of the integration; tilt sensors to measure the tilt sensor; of force placed in her arms and legs to measure the force of contact with the robot environment; position sensors, which indicates the actual robot position (from which the speed can be calculated by the derivation) or even the speed sensors.

The arrays tactile can be used to provide data on what has been reached.

The shadow of the Hand uses an array of 34 tactile arranged under the skin of polyurethane on each finger. Touch sensors also provide information about the forces and the torques transferred between the robot and the other objects.

The vision refers to the processing of data from any way that uses the electromagnetic spectrum to produce an image. In the robots humanoids is used to recognize the objects and determine their properties (The sensors to the works at more than in a similar way with the eyes of human beings). Most robots humanoids use CCD cameras that the sensors.

Sensors allow sound robots humanoids to hear the speech and the sounds of the environment and to carry out that the ears of the human being. Microphones are usually used for this task.

Actuators are the motors responsible for the movement in the robot.

Robots humanoids are constructed in such a way that they mimics the human body, so that they can use the actuators which carried out such as the muscles and joints, though with a different structure.

To obtain the same effect as the human movement, robots humanoids use actuator in rotating main.

They may be either electrical wiring, pneumatic, hydraulics, piezoelectric ultrasound or

Actuators hydraulic and electrical have a behavior very rigid and may be made only to act in a manner consistent with the, through the use of strategies relatively complex for the control of the feedback.

While the electrical components of the motor actuation using cored are more suited for high speed and low load, hydraulic works well at low speed and high load.

Elements of the piezoelectric actuator generate a movement with a large capacity of force, when it is

applied to the voltage. They can be used for positioning the ultra-fine and for generating and handling large forces or pressure in situations static and dynamic.

Elements of the actuator with ultrasound are designed to produce movements in an order micrometer at frequencies ultrasound (over 20 kHz). They are useful for vibration control applications, positioning and fast switching.

Elements of the pneumatic actuator operate based on the compressibility of gas. As they are inflated, extend along the axis and how to deflate, contracts. In the case where an end is fixed, the other will move in a linear trajectory.

These components are intended for low speed and low load/average. Between the components of the pneumatic actuator are: Cylinders the gaiter, motors pneumatic, stepper motors gauge and of the artificial muscles pneumatic.

In the planning and control, the essential difference between the humanoids and other types of robots (such as industrial), is the fact that the robot move must be human consumption as it may be, using locomotion with feet, in particular lever biped.

Planning the ideal for the movements of the humanoids during the normal course should lead to a minimal power consumption, as it happens in the human body. For this reason, the studies on the dynamics and control of these types of structures are becoming increasingly important.

The problem of walking the stabilization scythe robots on the surface is of great importance. Maintenance of the center of gravity of the robot over the center of the camp in order to ensure a stable position can be chosen as an objective of the control.

In order to maintain the dynamic balance during their walk and a robot needs information on the contact force and the movement to the actual and desired.

The solution to this problem is based on a major concept, Zero Point Time (ZMP).

Another feature of the robots humanoids is that moves, gather information (using sensors) on "real world and to interact with her.

They do not remain as other manipulators robots who works in environments very structured. In order to enable the humanoids to move in complex environments, planning and control must focus on the detection of self-collision, planning and the way of avoiding obstacles.

The humanoids have not yet been some features of the human body. These include structures with variable flexibility to provide a fuse (to the robot in itself and for the people) and redundancy movements, i.e., more degrees of freedom and availability task, therefore, at the level.

With all that these features are desirable for the robots humanoids, they will bring more complexity and new problems of planning and control.

The field of dealing with the control of the whole body with these problems and to address proper coordination of many degrees of freedom, for example in order to carry out more tasks simultaneously control, while in the following an order given of priority.

Robotic screwing unit with automatic feeding of screws, are automatic machines with anthropomorphic arms: Extremely flexible in all aspects.

They allow to screw on different planes and have a high reconversion factor: In case of change of product or mode of production, the arm can be used in the most diverse applications (Fig. 4).

Anthropomorphic industrial robots have become the most prevalent and most used.

They are most prevalent across the planet because they were very well put in place and are more easily designed, manufactured and implemented, compared to other types of robots and manipulators.

The most common is the structure of Fig. 1, with a base made up of three rotating elements, 3R.

It is a mechanical structure, furniture, with three degrees of mobility, easy designed, with a high mobility and a large work space.

They are big advantages, that it has established itself in the world of industrial robots and was generalized.

Like all industrial robots and this anthropomorphic structure, it was launched on the auto industry, which commissioned and produced almost all modern industrial robots.

The main advantages of a structure of this kind are great mobility, a wider working space, a good dynamic, fast moving and acceptable accuracy for industrial operations daily conjunction with most common.

When it comes to reliability and stability excessive anthropomorphic structure can't cope, she successfully being replaced by parallel structures.

Even if parallel or mixed platforms are more accurate and more stable than an anthropomorphic structure, yet they can't be used everywhere, is more expensive, more difficult designed, built and implemented.

However anthropomorphic mechanical structures have a high mobility, good dynamics and a low complexity, which has imposed in industrial robotic almost everyone, except for some special cases, the necessary structures are parallel or mixed ones.

Anthropomorphic industrial robots have become the most prevalent and most used.

They are most prevalent across the planet because they were very well put in place and are more easily designed, manufactured and implemented, compared to other types of robots and manipulators.

The most common is the structure of Fig. 4, with a base made up of three rotating elements, 3R.

It is a mechanical structure, furniture, with three degrees of mobility, easy designed, with a high mobility and a large work space.

They are big advantages, it has established itself in the world of industrial robots and was generalized.

Like all industrial robots and this anthropomorphic structure, it was launched on the auto industry, which commissioned and produced almost all modern industrial robots.

The main advantages of a structure of this kind are great mobility, a wider working space, a good dynamic, fast moving and acceptable accuracy for industrial operations daily conjunction with most common.

When it comes to reliability and stability excessive anthropomorphic structure can't cope, she successfully being replaced by parallel structures.

Even if parallel or mixed platforms are more accurate and more stable than an anthropomorphic structure, yet they can't be used everywhere, is more expensive, more difficult designed, built and implemented.

However anthropomorphic mechanical structures have a high mobility, good dynamics and a low complexity, which has imposed in industrial robotic almost everyone, except for some special cases, the necessary structures are parallel or mixed ones.

In this study has been presented the basis of an anthropomorphic structure, in terms of construction, geometric and kinematic.

This article presents an original method to determine the speeds and accelerations to structures MP R-3 The structure of the 3R (space) are known (required) rotation speeds of the triggers and must be determined speeds and accelerations of the endeffector M.

Starting from the positions of direct kinematic system MP R-3 deriving these systems of relations in depending on the time, once and then a second time (the second derivation) is first obtains the speeds of the system and for the second time the accelerations endeffector point M.

System on which must be resolved has three equations and three independent parameters to determine.

Constructive basis is represented by a robot with three degrees of freedom (a robot with three axis of rotation).

In the case where a study (analysis) a robot anthropomorphic with three axis of rotation (which represents the main movements, it is absolutely necessary), already has a system of the basis on which it can add other movements (secondary).

## Applications

The technique of determining the velocities and accelerations depending on the position is extremely useful in the study of system dynamics, vibration and noise caused by the system.

This technique is common in the study of vibration system. Scaling vibrations known positions of point O3

and then easily determine the vibration velocities and accelerations that point and other points of the system all the functions of positions scaling known point O<sub>3</sub>.

Also by this technique can calculate local noise levels at various points in the system and the overall level of noise generated by the system to the nearest large enough compared to the noise produced by experimental measurements, with adequate equipment. Studying the dynamics of the system can be developed by this technique.

An industrial robot Kawasaki FS-03N, welding robot, can be seen in the Fig. 6.

Industrial robotics is officially defined by ISO as an automatic control, reprogrammable, versatile manipulator programmable in three or more axes.

Typical applications include welding, painting and assembly robots. Industrial robotics inspects products quickly and accurately.

Industrial robots are widely used in cars. Their design requires a good knowledge and a very high level in the field of engineering.

An industrial robot is a system with several arms in the image of a human arm often composed of 6 degrees of freedom, 3 axes for positioning and 3 axes (for orientation to move and orient a tool in a given workspace).

One can distinguish: Assembly robots of often smaller dimensions, mobile robots intended for inspection often associated with artificial intelligence and capable, in some cases, of taking into account the environment.

A robot consists of a mechanical part, the arm itself, of a control unit composed of a central unit which controls the control electronics of one or more axes which ensures the control thereof, Speed and a specialized programming language that allows to control the robot (LM1 developed by the Ensimag Grenoble, language Adept type basic) that integrates a coordinate transformer to transform a Cartesian value into engine encoder data.

Some robots have a learning mode which allows to repeat the movements performed freely by hand, the essential element being the fidelity the robot's ability to successively reach the same position within a defined tolerance, a calibration procedure allows To resume the zero of each of the axes. They can be associated with an artificial vision system that allows them to correct the displacements.

For safety reasons, these robots are protected by cages or casings to prevent the man from approaching them too closely.

The diffusion and improvement of robotic techniques makes it possible to operate factories in the dark.

An industrial robot Motoman SDA10, assembly robot, can be seen in the Fig. 7.





Fig. 6. An industrial robot Kawasaki FS-03N, welding robot

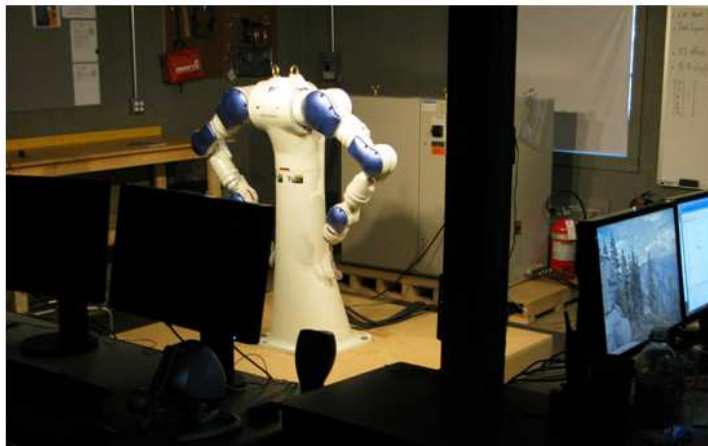


Fig. 7. An industrial robot Motoman SDA10, assembly robot



Fig. 8. Industrial robots working at a factory

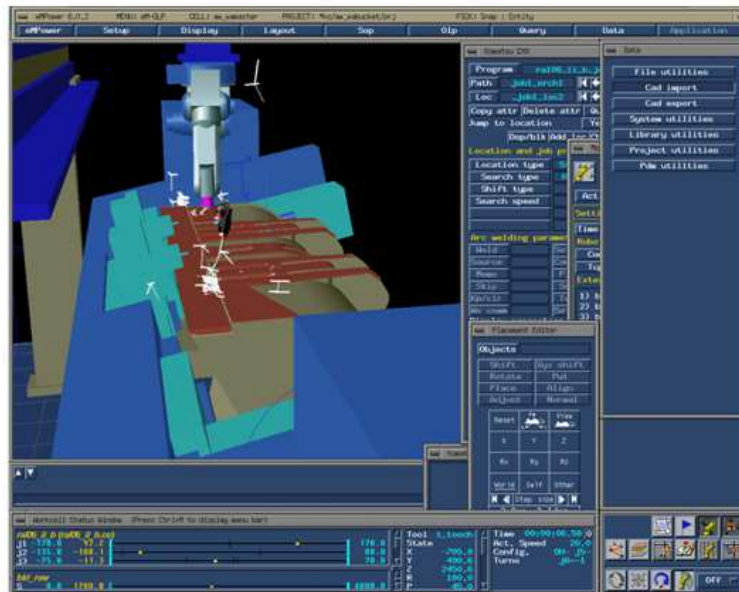


Fig. 9. Programming the movements of a robot on a computer

According to the Ministry of Industry, the total number of industrial robots in the world may be estimated to be at least 1.15 million in 2010 and 3.58 million in 2017. These estimates are based on the assumption Average operating life of 12 years. With an average duration of 15 years, there would be 1.4 million industrial robots in 2011.

Approximately 69000 industrial robots were produced worldwide in 1998, 120000 in 2005, but 113000 in 2008. Production dropped sharply in 2009 (60000) and resumed strongly (120600 in 2010, 166000 in 2011 and 207500 scheduled for 2015).

In 2011, sales of industrial robots amounted to \$ 9.5 billion. Including software, peripherals and systems engineering, the market for industrial robotic systems is estimated at \$ 28.5 billion in 2011; it is expected to increase in the future, but at lower rates than in the past.

Some robots are programmed to faithfully perform specific repetitive actions. They are programmed with a high degree of accuracy. Other robots are much more flexible.

They are used, for example, in painting. Artificial intelligence is becoming an important factor in industrial robotics.

Some industrial robots working at a factory may be seen in the Fig. 8.

## Programming

The movements of an industrial robot are programmed through 2 major methods.

The method by learning is the first historically appeared. It consists in creating the trajectories by causing the robot to

memorize points corresponding to Cartesian coordinates and which will determine its position.

This is done directly on the robot using the control box. The second, more recent method is offline programming.

On a dedicated work computer, the operator can program the next task via offline programming software by importing a CAD model to generate the movements. It will then be able to visualize the result of its programming thanks to an integrated simulator which is a virtual representation of the working environment of the robot with all its components (Fig. 9):

- Move to P1
- Move to P2
- Move to P3
- Close the clamp
- Move to P2
- Move to P4
- Move to P5
- Open the clamp
- Move to P4
- Move to P1 and Finish

## Conclusion

Constructive basis is represented by a robot with three degrees of freedom (a robot with three axis of rotation).

In the case where a study (analysis) a robot anthropomorphic with three axis of rotation (which represents the main movements, it is absolutely necessary), already has a system of the basis on which it can add other movements (secondary).

All calculations have been arranged and in the form of the array.

Robots anthropomorphic include a structure flat 2R, which is a structure of the base.

In the reverse direction (vice versa) drive train, known cinematic parameters  $x_m$  and  $Y_m$ , which represents the coordinates of the pixel scales M endeffector (M) and must be determined by the analytical calculation parameters  $\varphi_{20}$  and  $\varphi_{30}$ .

For the purpose of determining angles can be used for various methods (Trigonometric, geometric transformations, etc.), of which has been submitted to the trigonometric method, which is a direct method and fast.

This method has the great advantage to be easier to understand. With it you can avoid the spatial methods of calculation.

The proposed method in this study has the advantage of simplifying the very much of everyday computing systems design for Mechatronics and robotics. Win Time, Saves, it is possible to develop systems for the direct synthesis easier in series, without the need for experimental testing.

For the method of teaching is a total simplification of the design, thus increasing the understanding of this phenomenon.

## Acknowledgement

This text was acknowledged and appreciated by Assoc. Pro. Taher M. Abu-Lebdeh, North Carolina A and T State University, United States, Samuel P. Kozaitis, Professor and Department Head at Electrical and Computer Engineering, Florida Institute of Technology, United States, whom we thank and in this way.

## Funding Information

Research contract: Contract number 36-5-4D/1986 from 24IV1985, beneficiary CNST RO (Romanian National Center for Science and Technology) Improving dynamic mechanisms.

Contract research integration. 19-91-3 from 29.03.1991; Beneficiary: MIS; TOPIC: Research on designing mechanisms with bars, cams and gears, with application in industrial robots.

Contract research. GR 69/10.05.2007: NURC in 2762; theme 8: Dynamic analysis of mechanisms and manipulators with bars and gears.

4-Labor contract, no. 35/22.01.2013, the UPB, "Stand for reading performance parameters of kinematics and dynamic mechanisms, using inductive and incremental encoders, to a Mitsubishi Mechatronic System" "PN-II-IN-CI-2012-1-0389".

All these matters are copyrighted! Copyrights: 394-qodGnhhtej, from 17-02-2010 13:42:18; 463-vpstuCGsiy, from 20-03-2010 12:45:30; 631-

sqfsgqvutm, from 24-05-2010 16:15:22; 933-CrDztEfqow, from 07-01-2011 13:37:52.

## Author's Contributions

All the authors contributed equally to prepare, develop and carry out this manuscript.

## Ethics

This article is original. Authors declare that are not ethical issues that may arise after the publication of this manuscript.

## References

- Aversa, R., D. Parcesepe, R.V.V. Petrescu, G. Chen and F.I.T. Petrescu *et al.*, 2016a. Glassy Amorphous Metal Injection Molded Induced Morphological Defects. *Am. J. Applied Sci.*, 13: 1476-1482. DOI: 10.3844/ajassp.2016.1476.1482
- Aversa, R., F.I. Petrescu, R.V. Petrescu and A. Antonio, 2016b. Biomimetic finite element analysis bone modeling for customized hybrid biological prostheses development. *Am. J. Applied Sci.*, 13: 1060-1067. DOI: 10.3844/ajassp.2016.1060.1067
- Aversa, R., R.V. Petrescu, F.I. Petrescu, A. Apicella, 2016c. Smart-factory: Optimization and process control of composite centrifuged pipes. *Am. J. Applied Sci.*, 13: 1330-1341. DOI: 10.3844/ajassp.2016.1330.1341
- Aversa, R., F. Tamburrino, R.V. Petrescu, F.I. Petrescu and M. Artur *et al.*, 2016d. Biomechanically inspired shape memory effect machines driven by muscle like acting NiTi alloys. *Am. J. Applied Sci.*, 13: 1264-1271. DOI: 10.3844/ajassp.2016.1264.1271
- Aversa, R., F.I.T. Petrescu, R.V.V. Petrescu and A. Apicella, 2016e. Biofidel FEA modeling of customized hybrid biological hip joint prostheses, part I: Biomechanical behavior of implanted femur. *Am. J. Biochem. Biotechnol.*, 12: 270-276. DOI: 10.3844/ajbbsp.2016.270.276
- Aversa, R., F.I.T. Petrescu, R.V.V. Petrescu and A. Apicella, 2016f. Biofidel FEA modeling of customized hybrid biological hip joint design part II: Flexible stem trabecular prostheses. *Am. J. Biochem. Biotechnol.*, 12: 277-285. DOI: 10.3844/ajbbsp.2016.277.285
- Aldana, N.D., C.L. Trujillo and J.G. Guarnizo, 2013. Active and reactive power flow regulation for a grid connected vsc based on fuzzy controllers. *Revista Facultad Ingenieria*, 66: 118-130.
- Dong, H., N. Giakoumidis, N. Figueroa and N. Mavridis, 2013. Approaching behaviour monitor and vibration indication in developing a General Moving Object Alarm System (GMOAS). *Int. J. Adv. Robotic Syst.* DOI: 10.5772/56586

- Flavio de Melo, L., S.F. Reis Alves and J.M. Rosário, 2012. Mobile robot navigation modelling, control and applications. *Int. Rev. Modell. Simulat.*, 5: 1059-1068.
- Lee, B.J., 2013. Geometrical derivation of differential kinematics to calibrate model parameters of flexible manipulator. *Int. J. Adv. Robotic Syst.*  
DOI: 10.5772/55592
- Garcia, E., M.A. Jimenez, P.G. De Santos and M. Armada, 2007. The evolution of robotics research. *IEEE Robot. Automat. Magazine*, 14: 90-103.  
DOI: 10.1109/MRA.2007.339608
- He, B., Z. Wang, Q. Li, H. Xie and R. Shen, 2013. An analytic method for the kinematics and dynamics of a multiple-backbone continuum robot. *IJARS*. DOI: 10.5772/54051
- Liu, H., W. Zhou, X. Lai and S. Zhu, 2013. An efficient inverse kinematic algorithm for a PUMA560-structured robot manipulator. *IJARS*.  
DOI: 10.5772/56403
- Garcia-Murillo, M., J. Gallardo-Alvarado and E. Castillo-Castaneda, 2013. Finding the generalized forces of a series-parallel manipulator. *IJARS*.  
DOI: 10.5772/53824
- Padula, F. and V. Perdereau, 2013. An on-line path planner for industrial manipulators. *Int. J. Adv. Robotic Syst.* DOI: 10.5772/55063
- Perumaal, S. and N. Jawahar, 2013. Automated trajectory planner of industrial robot for pick-and-place task. *IJARS*. DOI: 10.5772/53940
- Petrescu, F.I. and R.V. Petrescu, 2013. Cinematics of the 3R dyad. *Engevista*, 15: 118-124.
- Petrescu, F.I. and R.V. Petrescu, 2012a. Kinematics of the planar quadrilateral mechanism. *Engevista*, 14: 345-348.
- Petrescu, F.I. and R.V. Petrescu, 2012b. *Mecatronica-Sisteme Seriale si Paralele*. 1st Edn., Create Space Publisher, USA,  
ISBN-13: 978-1-4750-6613-5, pp: 128.
- Petrescu, F.I. and R.V. Petrescu, 2011. *Mechanical Systems. Serial and Parallel-Course* (in romanian), LULU Publisher, London, UK,  
ISBN-13: 978-1-4466-0039-9, pp: 124.
- Petrescu, F.I., B. Grecu, A. Comanescu and R.V. Petrescu, 2009. Some mechanical design elements. *Proceedings of the 3rd International Conference on Computational Mechanics and Virtual Engineering, (MEC' 09), Braşov*, pp: 520-525.
- Reddy, P., K.V. Shihabudheen and J. Jacob, 2012. Precise non linear modeling of flexible link flexible joint manipulator. *Proceedings of the International Review on Modelling and Simulations, (RMS' 12)*, pp: 1368-1374.
- Tang, X., D. Sun and Z. Shao, 2013. The structure and dimensional design of a reconfigurable PKM. *IJARS*. DOI: 10.5772/54696
- Tong, G., J. Gu and W. Xie, 2013. Virtual entity-based rapid prototype for design and simulation of humanoid robots. *Int. J. Adv. Robotic Syst.*  
DOI: 10.5772/55936
- Wang, K., M. Luo, T. Mei, J. Zhao and Y. Cao, 2013. Dynamics analysis of a three-DOF planar serial-parallel mechanism for active dynamic balancing with respect to a given trajectory. *Int. J. Adv. Robotic Syst.* DOI: 10.5772/54201
- Wen, S., J. Zhu, X. Li, A. Rad and X. Chen, 2012. End-point contact force control with quantitative feedback theory for mobile robots. *IJARS*.  
DOI: 10.5772/53742

## Nomenclature

- $\varphi_{10}$ : Rotation  $\varphi_{10}$  carried out by the first actuator, is and relative (between items 1 and 0) and absolute (between elements 1 and 0);
- $\varphi_{20}$ : Rotation  $\varphi_{20}$  carried out by the second actuator, is and relative (between items 2 and 1) and absolute (between items 2 and 0), due to the arrangement;
- $\varphi_{30}$ : Rotation  $\theta = \varphi_{32}$  carried out by the third actuator, is only relative (between items 3 and 2); the corresponding absolute (between items 3 and 0) as a function of  $\theta = \varphi_{32}$  and  $\varphi_{20}$ ;
- Drive-train 2-3: The drive train 2-3 (consisting of kinematic elements 2 and 3) is a kinematic chain plan, which fall within a single plane or in one or more of the other plane parallel to each other;
- d1, d2, d3: The lengths of robot 3R arms;
- a1, a2, a3: Misalignments;
- $\varphi$ : The angle that positions helper variable length vector d;
- $\varphi_{20}$ : The angular velocity of the second actuator of a 3R robot;
- $\varphi_{30}$ : The angular velocity of the third actuator of a 3R mechanical structure (system);
- $\varepsilon_{20}$ : The angular acceleration of the second actuator;
- $\varepsilon_{30}$ : The angular acceleration of the third actuator.