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Dynamics at Classical Distribution

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Abstract: Classical distribution is the most used in rigid memory mechanisms adapted to four-stroke internal combustion engines such as Otto or diesel, as it was designed by Otto more than 150 years ago, without essential changes from its conception and up today. Since it was not yet possible to introduce the electric car to the industrial scale and today we have these classic cars with their distribution still in operation, with a park that exceeds a billion cars and grows annually by another 70 million units. If we only take into account these aspects without taking into account the classical rigid mechanisms used in robotics and mechatronics, mechanical transmissions, automated processing machines, or medical devices and we are talking about a scale utilization billions of pieces, so it is justified to continue discussing how these mechanisms work and especially their dynamics, in order to permanently improve them to eliminate the noises and vibrations of these mechanics, but also to increase their power and reduce consumption motor fuel still equipped with classic engines.

Keywords: Robots, Mechatronic Systems, Structure, Dynamics, Dynamics Systems, Machines, Machine Motion Equations, Cams, Machines

Introduction

Classical distribution is the most used in rigid memory mechanisms adapted to four-stroke internal combustion engines such as Otto or diesel, as it was designed by Otto more than 150 years ago, without essential changes from its conception and up today. Since it was not yet possible to introduce the electric car to the industrial scale and today we have these classic cars with their distribution still in operation, with a park that exceeds a billion cars and grows annually by another 70 million units.

If we only take into account these aspects without taking into account the classical rigid mechanisms used in robotics and mechatronics, mechanical transmissions, automated processing machines, or medical devices and we are talking about a scale utilization billions of pieces, so it is justified to continue discussing how these mechanisms work and especially their dynamics, in order to permanently improve them to eliminate the noises and vibrations of these mechanics, but also to increase their power and reduce consumption motor fuel still equipped with classic engines.

Mechanisms with rigid memory along with gears and sometimes wired and other types of mechanisms are widely used in machine building, energy systems, mechanical clocks, micromechanics, medical devices, various robotic applications and in especially the anthropomorphic and humanoid robots. Also, such mechanisms are also mandatory for mechanical transmissions from road vehicles, gearboxes and speed reducers, which are also used additionally in the heavy industry in industrial halls. A continuous variable transmission is also mandatory in the component and such mechanisms.

Today, robots are increasingly present in the machine building industry, sometimes even in some sections, to replace workers altogether due to the high quality of their work, repetitive, without stopping or interrupting, without manufacturing and assembly.

In addition, robots do not get sick, do not need medical leave or rest, work faster and better than people and support dyers, general assemblies, etc.

Generally, robots have increased the quality and productivity of work and have not even created a union to defend their claims, demanding higher wages for them and larger holidays.

Interestingly, a robot works without pause, but unpaid, without breaks, without complaining about factory conditions.

Robots can work on three shifts, that is, permanently, but not by moving them as humans, but they always remain the same robots deployed on a day without interruptions, without pauses, without rest, without problems.

Robots are today highly valued by major carmakers which even build complete sections where only robots

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work because they do not have a trade union, they do not require increased salaries (they actually work without any salary), they do not have to leave on holidays, do not want free days and can even work on Saturdays and Sundays, without breaks, if necessary, on three exchanges, including in toxic, dangerous environments, or even in hard-to-reach areas.The importance of implementing robots can no longer be challenged. They have increased the quality of work and the production of an enterprise so that they can no longer give up their help.

Workers reclassified and worked only in more friendly jobs or other jobs, such as supermarkets, in better conditions, with higher wages, more days off and are satisfied with the production and sales gains due to robot work in large factories.

One can clearly state that our robots have considerably improved our lives. Thanks to them, a new free day for almost all working people was introduced on Friday, in addition to Saturday and we will soon be able to enter another free day, but we have to choose Monday or Thursday.

People were initially trained by trade union leaders to track and sabotage robots, destroy them and not accept them. Today things are clear and the robots work quietly in the big companies and factories for the good of all, so now we can accept the silence of automation, robotics, electronics, without letting us be fooled by the trade union leaders who slowly slow down and calm down.

Whether we like it or not, the robots have already stolen all their heavy jobs.

Certain anthropomorphic robots are, as we have already said, in most of the most widespread and widely used works around the world, due to their ability to adapt quickly to forced labor, working without breaks or 24 hours, air or salary. Anthropomorphic robots are thin, elegant, easy to configure and adapted to virtually any location, being the most flexible, useful, more penetrating, easier to install and maintain. For the first time, these robots affirmed themselves in the automotive industry and especially in the automotive industry, today they have penetrated almost all industrial fields, being easily adaptable, flexible, dynamic, resilient, cheaper than other models, occupying a workspace important. They can also work in toxic or hazardous environments used in dyeing, chemical cleaning, chemical or nuclear environments, dealing with explosive objects or military missions in land or sea mines, even if they are forbidden to use them. countries around the world that use them, such as Afghanistan.

The most used industrial robots today are built. The importance of studying anthropomorphic robots has also been signaled, being today the most widespread robots around the world, thanks to its simple design, construction, implementation, operation and maintenance. In addition, anthropomorphic systems are simpler and cheaper from a technological point of view, with consistent, demanding and repetitive work, with no major maintenance problems.

Considering the increased importance of robots nowadays, when no large factory or factory can work without robots, one wants to present in the work the motion equations of the machine in an original form, both in terms of aspect and their deduction. The machine's motion equations can be used in dynamic calculations at any type of machine, whether it be a motor, a compressor, a lucrative machine, a robot, a system, a mechanism, a vehicle, a mechanical transmission, or any other type of car. The dynamics of systems is their real movement, the dynamic movement, in which the influences of three main factors interfere, which modify the kinematics of the mechanism when it moves really, dynamic. The first dynamic factor is the forces of inertia or the effect of inertial masses. The second important dynamic factor is that of the couplings, of the linkages within the respective machine mechanisms. The latter and the third dynamic factor represents the influence of system elasticity on its dynamic functioning (Rulkov *et al*., 2016; Agarwala, 2016; Babayemi, 2016; Gusti and Semin, 2016; Mohamed *et al*., 2016; Wessels and Raad, 2016; Maraveas *et al*., 2015; Khalil, 2015; Rhode-Barbarigos *et al*., 2015; Takeuchi *et al*., 2015; Li *et al*., 2015; Vernardos and Gantes, 2015; Bourahla and Blakeborough, 2015; Stavridou *et al*., 2015; Ong *et al*., 2015; Dixit and Pal, 2015; Rajput *et al*., 2016; Rea and Ottaviano, 2016; Zurfi and Zhang, 2016 a-b; Zheng and Li, 2016; Buonomano *et al*., 2016 a-b; Faizal *et al*., 2016; Ascione *et al*., 2016; Elmeddahi *et al*., 2016; Calise *et al*., 2016; Morse *et al*., 2016; Abouobaida, 2016; Rohit and Dixit, 2016; Kazakov *et al*., 2016; Alwetaishi, 2016; Riccio *et al*., 2016 a-b; Iqbal, 2016; Hasan and El-Naas, 2016; Al-Hasan and Al-Ghamdi, 2016; Jiang *et al*., 2016; Sepúlveda, 2016; Martins *et al*., 2016; Pisello *et al*., 2016; Jarahi, 2016; Mondal *et al*., 2016; Mansour, 2016; Al Qadi *et al*., 2016b; Campo *et al*., 2016; Samantaray *et al*., 2016; Malomar *et al*., 2016; Rich and Badar, 2016; Hirun, 2016; Bucinell, 2016; Nabilou, 2016b; Barone *et al*., 2016; Chisari and Bedon, 2016; Bedon and Louter, 2016; Santos and Bedon, 2016; Minghini *et al*., 2016; Bedon, 2016; Jafari *et al*., 2016; Chiozzi *et al*., 2016; Orlando and Benvenuti, 2016; Wang and Yagi, 2016; Obaiys *et al*., 2016; Ahmed *et al*., 2016; Jauhari *et al*., 2016; Syahrullah and Sinaga, 2016; Shanmugam, 2016; Jaber and Bicker, 2016; Wang *et al*., 2016; Moubarek and Gharsallah, 2016; Amani, 2016; Shruti, 2016; Pérez-de León *et al*., 2016; Mohseni and Tsavdaridis, 2016; Abu-Lebdeh *et al*., 2016; Serebrennikov *et al*., 2016; Budak *et al*., 2016; Augustine *et al*., 2016; Jarahi and Seifilaleh, 2016; Nabilou, 2016a; You *et al*., 2016; AL Qadi *et al*., 2016a; Rama *et al*., 2016; Sallami *et al*., 2016; Huang *et al*., 2016; Ali *et al*., 2016; Kamble and Kumar, 2016; 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Sylvester *et al*., 2015a; Ab-Rahman *et al*., 2009; Abdullah and Halim, 2009; Zotos and Costopoulos, 2009; Feraga *et al*., 2009; Bakar *et al*., 2009; Cardu *et al*., 2009; Bolonkin, 2009 a-b; Nandhakumar *et al*., 2009; Odeh *et al*., 2009; Lubis *et al*., 2009; Fathallah and Bakar, 2009; Marghany and Hashim, 2009; Kwon *et al*., 2010; Aly and Abuelnasr, 2010; Farahani *et al*., 2010; Ahmed *et al*., 2010; Kunanoppadon, 2010; Helmy and El-Taweel, 2010; Qutbodin, 2010; Pattanasethanon, 2010; Fen *et al*., 2011; Thongwan *et al*., 2011; Theansuwan and Triratanasirichai, 2011; Al Smadi, 2011; Tourab *et al*., 2011; Raptis *et al*., 2011; Momani *et al*., 2011; Ismail *et al*., 2011; Anizan *et al*., 2011; Tsolakis and Raptis, 2011; Abdullah *et al*., 2011; Kechiche *et al*., 2011; Ho *et al*., 2011; Rajbhandari *et al*., 2011; Aleksic and Lovric, 2011; Kaewnai and Wongwises, 2011; Idarwazeh, 2011; Ebrahim *et al*., 2012; Abdelkrim *et al*., 2012; Mohan *et al*., 2012; Abam *et al*., 2012; Hassan *et al*., 2012; Jalil and Sampe, 2013; Jaoude and El-Tawil, 2013; Ali and Shumaker, 2013; Zhao, 2013; El-Labban *et al*., 2013; Djalel *et al*., 2013; Nahas and Kozaitis, 2014; Petrescu and Petrescu, 2014 a-i, 2015 a-e, 2016 a-d; Fu *et al*., 2015; Al-Nasra *et al*., 2015; Amer *et al*., 2015; Sylvester *et al*., 2015b; Kumar *et al*., 2015; Gupta *et al*., 2015; Stavridou *et al*., 2015b; Casadei, 2015; Ge and Xu, 2015; Moretti, 2015; Wang *et al*., 2015; Antonescu and Petrescu, 1985; 1989; Antonescu *et al*., 1985a; 1985b; 1986; 1987; 1988; 1994; 1997; 2000a; 2000b; 2001; Aversa *et al*., 2017a; 2017b; 2017c; 2017d; 2017e; 2016a; 2016b; 2016c; 2016d; 2016e; 2016f; 2016g; 2016h; 2016i; 2016j; 2016k; 2016l; 2016m; 2016n; 2016o; Cao *et al*., 2013; Dong *et al*., 2013; Comanescu, 2010; Franklin, 1930; He *et al*., 2013; Lee, 2013; Lin *et al*., 2013; Liu *et al*., 2013; Padula and Perdereau, 2013; Perumaal and Jawahar, 2013; Petrescu, 2011; 2015a; 2015b; Petrescu and Petrescu, 1995a; 1995b; 1997a; 1997b; 1997c; 2000a; 2000b; 2002a; 2002b; 2003; 2005a; 2005b; 2005c; 2005d; 2005e; 2011a; 2011b; 2012a; 2012b; 2013a; 2013b; 2013c; 2013d; 2013e; 2016a; 2016b; 2016c; Petrescu *et al*., 2009; 2016; 2017a; 2017b; 2017c; 2017d; 2017e; 2017f; 2017g; 2017h; 2017i; 2017j; 2017k; 2017l; 2017m; 2017n; 2017o; 2017p; 2017q; 2017r; 2017s; 2017t; 2017u; 2017v; 2017w; 2017x; 2017y; 2017z; 2017aa; 2017ab; 2017ac; 2017ad; 2017ae; 2018a; 2018b; 2018c; 2018d; 2018e; 2018f; 2018g; 2018h; 2018i; 2018j; 2018k; 2018l; 2018m; 2018n).

Materials and Methods

The momentum of mechanical (massic) inertia of the mechanism, reduced to the rotating element, ie to the cam (the kinetic energy conservation is used, system 1) is determined first:

$$\begin{cases} J_{cama} = \frac{1}{2}\cdot M_c \cdot R^2 \\ R^2 = \left(R_0 + s\right)^2 + s'^2 \\ J_{cama} = \frac{1}{2}\cdot M_c \cdot \left[\left(R_0 + s\right)^2 + s'^2\right] \\ J^* = \frac{1}{2}\cdot M_c \cdot \left[\left(R_0 + s\right)^2 + s'^2\right] + m_T \cdot s'^2 \\ J^* = \frac{1}{2}\cdot M_c \cdot R_0^2 + \frac{1}{2}\cdot M_c \cdot s^2 + M_c \cdot R_0 \cdot s + \\ \frac{1}{2}\cdot M_c \cdot s'^2 + m_T \cdot s'^2 \\ J^* = J_{constant} + J \\ J \equiv J_{variabil} = \frac{1}{2}\cdot M_c \cdot s^2 + M_c \cdot R_0 \cdot s + \\ \frac{1}{2}\cdot M_c \cdot s'^2 + m_T \cdot s'^2 \end{cases} \tag{1}$$

The mean reduced inertia moment is calculated with relation (2):

$$J_m^* = \frac{J_{\min}^* + J_{\max}^*}{2} = \frac{1}{2}\cdot M_c \cdot R_0^2 + \frac{J_{\max}}{2} \tag{2}$$

The expression (2) (practically J_{max}) depends on the type of cam-stick mechanism, but also on the motion law used both for climbing and descending.

Angular velocity is a function of the position of the cam (φ) but also of its speed (3); (see also chapter 10):

$$\omega^2 = \frac{J_m^* \cdot \omega_m^2}{J^*} \tag{3}$$

In order to determine ω^2 (with relation 3) J^* must be found and more precisely J_{max}.

And to the classical distribution that this chapter deals with, that is to say, in the rotating cam (rotating) cam with flat soles, the relationship that determines J_{max} depends also on the motion law.

We will start the simulation with a classical movement law, namely cosinusoid law. Upon climbing cosine law is expressed through system relationships (4):

$$\begin{cases} s = \frac{h}{2} - \frac{h}{2}\cdot\cos\left(\pi\cdot\frac{\varphi}{\varphi_u}\right) \\ s' \equiv v_r = \frac{\pi\cdot h}{2\cdot\varphi_u}\cdot\sin\left(\pi\cdot\frac{\varphi}{\varphi_u}\right) \\ s'' \equiv a_r = \frac{\pi^2\cdot h}{2\cdot\varphi_u^2}\cdot\cos\left(\pi\cdot\frac{\varphi}{\varphi_u}\right) \\ s''' \equiv \alpha_r = -\frac{\pi^3\cdot h}{2\cdot\varphi_u^3}\cdot\sin\left(\pi\cdot\frac{\varphi}{\varphi_u}\right) \end{cases} \tag{4}$$

where, φ takes values from 0 to φ_u. Jmax occurs for $\varphi = \varphi u/2$.

$$J_{\max} = M_c\cdot\left[\frac{h^2}{8} + R_0\cdot\frac{h}{2} + \frac{1}{8}\cdot\frac{\pi^2\cdot h^2}{\varphi_u^2}\right] + m_T\cdot\frac{\pi^2\cdot h^2}{4\cdot\varphi_u^2} \tag{5}$$

Expression (3) takes now the form (6):

$$\begin{cases} \omega^2 = \omega_m^2\cdot\frac{A}{B} \\ A = M_c\cdot R_0^2 + M_c\cdot\frac{h^2}{8} + \frac{1}{2}\cdot M_c\cdot R_0\cdot h + \\ +\frac{1}{8}\cdot M_c\cdot\frac{\pi^2\cdot h^2}{\varphi_u^2} + \frac{1}{4}\cdot m_T\cdot\frac{\pi^2\cdot h^2}{\varphi_u^2} \\ B = M_c\cdot R_0^2 + M_c\cdot s^2 + 2\cdot M_c\cdot R_0\cdot s + M_c\cdot s'^2 + 2\cdot m_T\cdot s'^2 \\ \omega = \omega_m\cdot\sqrt{\frac{A}{B}} \end{cases} \tag{6}$$

where, ω_m represents the mean nominal speed of the cam and is expressed in the distribution mechanisms according to the engine shaft speed (7):

$$\omega_m = 2\cdot\pi\cdot\nu_c = 2\cdot\pi\cdot\frac{n_c}{60} = \frac{2\cdot\pi}{60}\cdot\frac{n_{motor}}{2} = \frac{\pi\cdot n}{60} \tag{7}$$

By deriving formula (6), by time, the expression of the angular acceleration (8) is obtained:

$$\varepsilon = -\omega^2\cdot\frac{\left(M_c\cdot s + M_c\cdot R_0 + M_c\cdot s'' + 2\cdot m_T\cdot s''\right)\cdot s'}{B} \tag{8}$$

For a classic cam and push mechanism mechanism (without valve) the dynamic displacement of the stem is expressed by the relation (9), which is customized by canceling the valve mass, reaching the shape below (9):

$$x = s - \frac{(K+k)\cdot m_T\cdot\omega^2\cdot s'^2 + (k^2 + 2k\cdot K)\cdot s^2 + 2k\cdot x_0\cdot(K+k)\cdot s}{2\cdot(K+k)^2\cdot\left(s + \frac{k\cdot x_0}{K+k}\right)} \tag{9}$$

where, x represents the dynamic movement of the stick, while s is its normal movement (kinematic). K is the elastic constant of the system and k represents the elastic constant of the spring that holds the stick. It is noted with x_0 the pretension of the stem spring, with m_T the rod weight, with ω the angular velocity of the cam (or the camshaft), s' being first derived according to φ of the stroke displacement s. Twice, successively, the expression (9) in relation to the angle φ, obtains the reduced speed (10) and the smaller throttle acceleration (11) respectively:

$$\begin{cases} N = (K+k)\cdot m_T\cdot\omega^2\cdot s'^2 + (k^2 + 2k\cdot K)\cdot s^2 + 2k\cdot x_0\cdot(K+k)\cdot s \\ M = \left[(K+k)m_T\omega^2\cdot 2s's'' + \left(k^2 + 2kK\right)\cdot 2ss' + 2kx_0\left(K+k\right)\cdot s'\right]\cdot \\ \cdot\left(s + \frac{kx_0}{K+k}\right) - N\cdot s' \\ x' = s' - \frac{M}{2\cdot\left(K+k\right)^2\cdot\left(s + \frac{kx_0}{K+k}\right)^2} \end{cases} \tag{10}$$

$$\begin{cases} N = (K+k)\cdot m_T\cdot\omega^2\cdot s'^2 + (k^2 + 2k\cdot K)\cdot s^2 + 2k\cdot x_0\cdot(K+k)\cdot s \\ M = \left[(K+k)m_T\omega^2\cdot 2s's'' + \left(k^2 + 2kK\right)\cdot 2ss' + 2kx_0\left(K+k\right)\cdot s'\right]\cdot \\ \cdot\left(s + \frac{kx_0}{K+k}\right) - N\cdot s' \\ O = \left(K+k\right)\cdot m_T\cdot\omega^2\cdot 2\cdot\left(s''^2 + s'\cdot s'''\right) + \\ +\left(k^2 + 2\cdot k\cdot K\right)\cdot 2\cdot\left(s'^2 + s\cdot s''\right) + 2\cdot k\cdot x_0\cdot\left(K+k\right)\cdot s'' \\ x'' = s'' - \frac{\left[O\cdot\left(s + \frac{kx_0}{K+k}\right) - N\cdot s''\right]\cdot\left(s + \frac{kx_0}{K+k}\right) - M\cdot 2\cdot s'}{2\cdot\left(K+k\right)^2\cdot\left(s + \frac{kx_0}{K+k}\right)^3} \end{cases} \tag{11}$$

Next, the actual (dynamic) throttle acceleration can be directly determined using the relationship (12):

$$\ddot{x} = x''\cdot\omega^2 + x'\cdot\varepsilon \tag{12}$$

Results and Discussion

The following values are required:

φ_u = π/2 [rad] = 90 [*deg*]; φ_{ss} = 0 [*rad sau deg*]; φ_c = π/2 [rad] = 90 [*deg*]; φ_{si} = π [rad] = 180 [*deg*]; *legea de mişcare cos atât la urcare câtşi la coborâre*.

The movement laws are imposed (13):

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$$\begin{cases} s=\frac{h}{2}-\frac{h}{2}\cdot\cos\left(\pi\cdot\frac{\alpha_u}{\varphi_u}\right) \quad s_c=\frac{h}{2}+\frac{h}{2}\cdot\cos\left(\pi\cdot\frac{\alpha_c}{\varphi_c}\right) \\ s'\equiv v_r=\frac{\pi\cdot h}{2\cdot\varphi_u}\cdot\sin\left(\pi\cdot\frac{\alpha_u}{\varphi_u}\right) \quad s_c'=-\frac{\pi\cdot h}{2\cdot\varphi_c}\cdot\sin\left(\pi\cdot\frac{\alpha_c}{\varphi_c}\right) \\ s''\equiv a_r=\frac{\pi^2\cdot h}{2\cdot\varphi_u^2}\cdot\cos\left(\pi\cdot\frac{\alpha_u}{\varphi_u}\right) \quad s_c''=-\frac{\pi^2\cdot h}{2\cdot\varphi_c^2}\cdot\cos\left(\pi\cdot\frac{\alpha_c}{\varphi_c}\right) \\ s'''\equiv \alpha_r=-\frac{\pi^3\cdot h}{2\cdot\varphi_u^3}\cdot\sin\left(\pi\cdot\frac{\alpha_u}{\varphi_u}\right) \quad s_c'''=\frac{\pi^3\cdot h}{2\cdot\varphi_c^3}\cdot\sin\left(\pi\cdot\frac{\alpha_c}{\varphi_c}\right) \end{cases} \tag{13}$$

Here are the diagrams s = s(φ); s' = s'(φ); s'' = s''(φ), similar to the model in Fig. 1.

A quick method of geometric synthesis is that of Cartesian coordinates.

In the fixed system xOy, the cartesian coordinates of the contact point (belonging to the stick) are given by the projections of the position vector rA on the axes Oxy respectively Oy and have the analytical expressions expressed by the relational system (14):

$$\begin{cases} x_T=r_A\cdot\cos\left(\phi+\tau+\frac{\pi}{2}-\varphi\right)=r_A\cdot\cos\left(\frac{\pi}{2}+\tau\right)=-r_A\cdot\sin\tau \\ =-r_A\cdot\frac{s'}{r_A}=-s' \\ y_T=r_A\cdot\sin\left(\varphi+\tau+\frac{\pi}{2}-\varphi\right)=r_A\cdot\sin\left(\frac{\pi}{2}+\tau\right)=r_A\cdot\cos\tau \\ =r_A\cdot\frac{r_0+s}{r_A}=r_0+s \end{cases} \tag{14}$$

In the x'Oy 'mobile system, the cartesian coordinates of the point A of contact (belonging to the cam profile that rotated with the angle φ) are given by the system relations (15-16):

$$\begin{cases} x_C=r_A\cdot\cos\left(\varphi+\tau+\frac{\pi}{2}-\varphi+\varphi\right) \\ =r_A\cdot\cos\left(\frac{\pi}{2}+\tau+\varphi\right) \\ =r_A\cdot\sin(-\varphi-\tau)=-r_A\cdot\sin(\varphi+\tau) \\ =-r_A\cdot(\sin\varphi\cdot\cos\tau+\sin\tau\cdot\cos\varphi) \\ =-r_A\cdot\frac{r_0+s}{r_A}\cdot\sin\varphi-r_A\cdot\frac{s'}{r_A}\cdot\cos\varphi \\ =-(r_0+s)\cdot\sin\varphi-s'\cdot\cos\varphi \\ y_C=r_A\cdot\sin\left(\varphi+\tau+\frac{\pi}{2}-\varphi+\varphi\right) \\ =r_A\cdot\sin\left(\frac{\pi}{2}+\tau+\varphi\right) \\ =r_A\cdot\cos(-\varphi-\tau)=r_A\cdot\cos(\varphi+\tau) \\ =r_A\cdot(\cos\varphi\cdot\cos\tau-\sin\tau\cdot\sin\varphi) \\ =r_A\cdot\frac{r_0+s}{r_A}\cdot\cos\varphi-r_A\cdot\frac{s'}{r_A}\cdot\sin\varphi \\ =(r_0+s)\cdot\cos\varphi-s'\cdot\sin\varphi \end{cases} \tag{15}$$

$$\begin{cases} x_C=-s'\cdot\cos\varphi-(r_0+s)\cdot\sin\varphi \\ y_C=(r_0+s)\cdot\cos\varphi-s'\cdot\sin\varphi \end{cases} \tag{16}$$

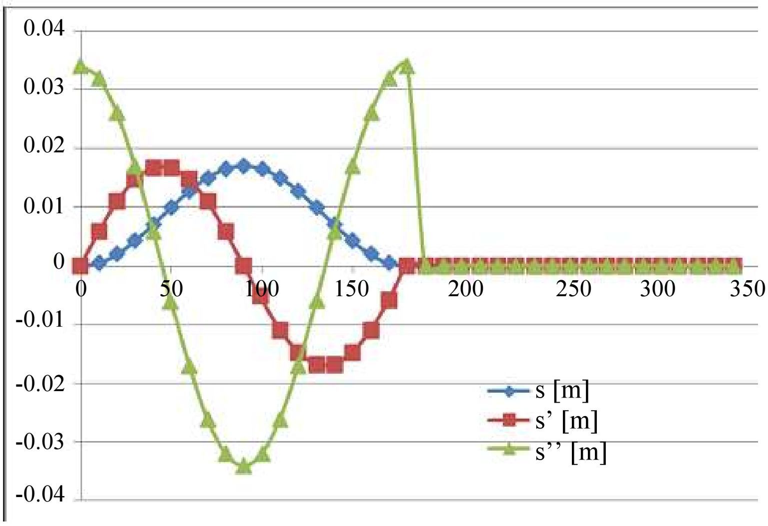

Fig. 1: Diagram of motion laws of the stick: s = s(φ); s' = s'(φ); s'' = s''(φ)

Drawing the cam profile (Fig. 2) is done in Cartesian coordinates, xOy, they are determined for a whole kinematic cycle (360 deg); the relationships (3) are used.

Dynamic synthesis of cam can be made with all relations shown and with the below data.

R_0 = [m]; h = [m]; x_0 = 0.03 [m]; $\varphi_u = \pi/2$; $\varphi_c = \pi/2$; K = 5000000 [N/m]; k = 20000 [N/m]; m_T = 0.1 [kg]; M_c = 0.2 [kg]; n_{motor} = 5500 [rot/min].

The dynamic diagram may be seen in the Fig. 3.

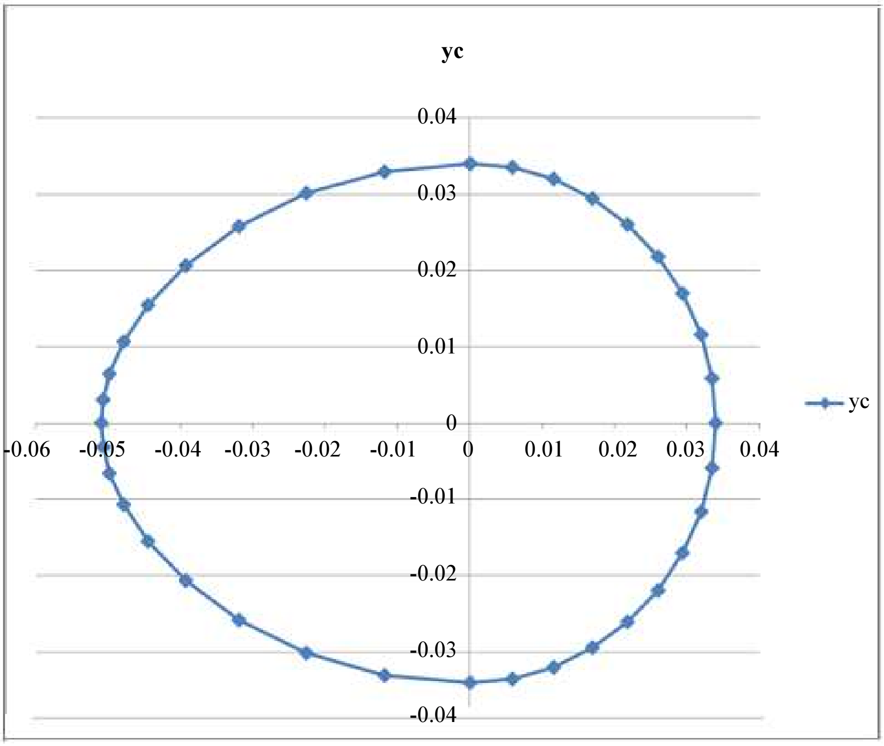

Fig. 2: Diagram of the cam profile, dynamic synthesized

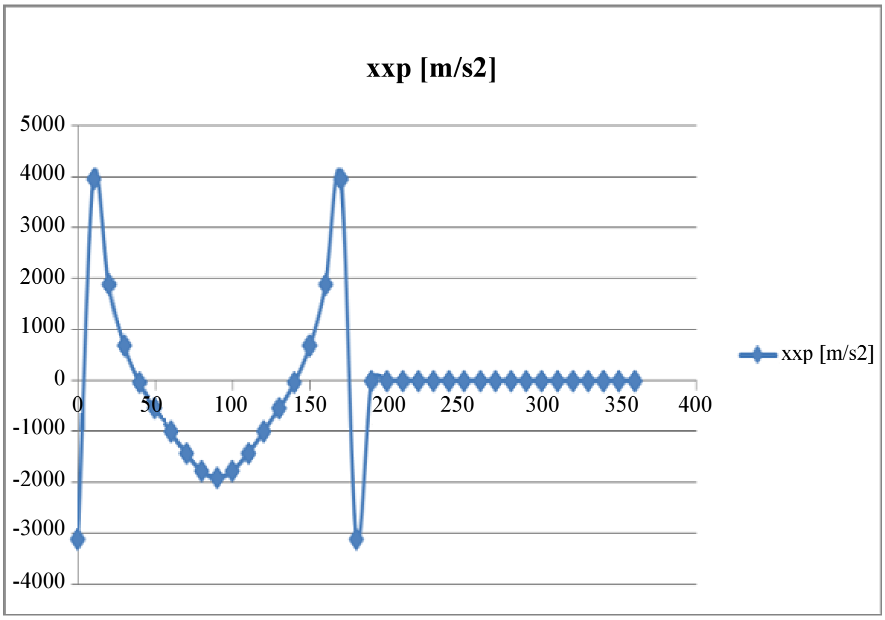

Fig. 3: Dynamic analysis

Conclusion

Classical distribution is the most used in rigid memory mechanisms adapted to four-stroke internal combustion engines such as Otto or diesel, as it was designed by Otto more than 150 years ago, without essential changes from its conception and up today.

Since it was not yet possible to introduce the electric car to the industrial scale and today we have these classic cars with their distribution still in operation, with a park that exceeds a billion cars and grows annually by another 70 million units.

If we only take into account these aspects without taking into account the classical rigid mechanisms used in robotics and mechatronics, mechanical transmissions, automated processing machines, or medical devices and we are talking about a scale utilization billions of pieces, so it is justified to continue discussing how these mechanisms work and especially their dynamics, in order to permanently improve them to eliminate the noises and vibrations of these mechanics, but also to increase their power and reduce consumption motor fuel still equipped with classic engines.

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2-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.

3-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.

Ethics

This article is original and contains unpublished material. Authors declare that are not ethical issues and no conflict of interest that may arise after the publication of this manuscript.

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