ISSN 2664-9969

UDC 620.01
DOI: 10.15587/2706-5448.2020.220515

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JUSTIFICATION OF THE PRINCIPLES OF COORDINATE THEORY BASED ON THE D'ALEMBERT'S PRINCIPLE AND SMALL MOVEMENTS

The work is a continuation of a number of author's studies devoted to the accuracy of determining the coordinates of an abstract object in technological space. So, since any object is in two coordinate systems, there is a problem of compatibility of these systems. It is this compatibility of coordinate systems that causes stability of motion and location of an abstract object in space. Now the stability of the movement or location of an object in space is taken as its frame of reference, that is, the zero point of any device or object. This is especially true for machine tools with numerical control (CNC). In order to solve the problem of compatibility of the coordinate system of the machine and the part, it is necessary to create a basic theory of coordinates, which will solve the problems of coordinating coordinate systems. The presence of an imaginary coordinate system in the CNC memory and the process of its implementation in a real machine coordinate system are shown. There is a need to investigate the physical and mathematical properties of a point, a dash, an error field structure and the relationship between all these field elements. The research proposed by the authors is devoted to the interpretation of ordinary natural phenomena by the physicochemical laws of interaction between abstract entities. Thus, the object of research is the relationship between imaginary and real coordinates. One of the most problematic places is the spatial reference of abstract space, that is, functional movement or stationary state. Analytical studies based on field affine transformations are used in this research. As a result, the possibility of creating a theory of coordinates of abstract objects in general, regardless of their physicochemical and medico-biological properties, has been theoretically substantiated. So, if to consider the processes of interaction between abstract objects, then it is possible to state the fact that such interaction has a very specific character. As a result, let's obtain a lot of sciences that give a similar description of the processes around us and their branches. It should be emphasized that there is a fairly clear distinction between the main scientific areas at the initial stage. The research carried out is useful in the development of metrological instruments and standard measuring instruments in assessing their stability.

Keywords: *theory of coordinates, abstract object, zone of presence, technological object.*

Received date: 07.08.2020
Accepted date: 21.09.2020
Published date: 31.12.2020

1. Introduction

Zones of presence are formed from the surface of the abstract object and, thus, depend on the coordinates of the location in space, as well as on the internal structure of the object. In this case, secondary zones are a consequence of the existence of primary zones, and parasitic zones of existence arise as derivatives of the interaction of existing abstract objects and their functioning. So, for example, the properties of parasitic zones, both biological and biological bone, with some zones of secondary importance are considered. At the same time, the interaction of internal and external field structures with respect to the object's coordinate system in space leads to the fact that this object needs to react in a certain way to changes in the external field structures of other factors. So, all objects are in the presence of the globe and, as a result, interact with its field structures. Thus, taking these parameters into account affects the metrological characteristics of devices for recording, monitoring and measuring technical parameters of abstract objects.

Thus, if more or less true research is carried out, then let's find that the basis of all natural phenomena and, as a consequence, sciences is a physical force, which should have been explained by classical physics as a phenomenon. Nevertheless, there is no such clear formulation as such [1–3]. In most cases, all explanations tthrhend to interpret this phenomenon as an interaction, which lends itself to mathematical description, for example, Newton's law. The second version is Newton's version, force must be perceived as Newton's postulate, that is, this property of any mass of matter. So, any object that has a mass of matter and, as a result, volume has the property of any force. Now this phenomenon is confirmed by research physics and its mathematical description. In this case, there is a clear factor-effect chain mass→volume→force. So, if to conduct research in this direction, then it is necessary to consider the typical interaction of two objects either in direct contact or through field structures. In general, there are quite a few such cases in the environment.

So, for example, the movement of any object in the environment occurs according to Newton's third law. If the medium is isotropic and static, then the object is in a state of rest or uniform motion. When the environment is excited, the coordinates of the object in space are violated and, accordingly, it creates new energetic forces for the corresponding rest in space [4, 5].

Consideration of the problem provided grounds to propose the principles of functioning of new automated complexes that increase the productivity of technological metalworking equipment in modern instrument-making production. Therefore, it is relevant to consider the basic laws of the appearance of objects, their properties and principles of interaction in a single biotechnical complex. Formalized analytical models of the internal structure of an abstract biotechnical object based on its physical properties are proposed, which determines a new approach to the registration of dynamic processes and the creation of control systems for them. Thus, *the object of research* is the relationship between imaginary and real coordinates.

The aim of research is to provide a mathematical basis for formalized analytical models of the stability of an object and its response to stimuli. This will make it possible to determine the conditions for registering the spatio-temporal coordinates of the object surface during the life cycle.

2. Methods of research

As mentioned above, in measurement systems such technological elements as point, point and risk play a very important role [6, 7]. The essence of this influence lies in the fact that these elements are part of the general coordinate system in the space of any workspace. This is especially true for machine tools with numerical control (CNC), where there are two coordinate systems. The first is the imaginary, technologically phantom coordinate system of the machine tool together with the part. The second is the real coordinate system of the machine tool with a part made of metal, which is controlled by an imaginary one. Of course, with this method of reproducing a part, there are certain errors that affect the quality of the final product. In order to maximize the accuracy of the real coordinate system, so-called constants are introduced into the CNC memory, which partially reduce the errors of the real coordinate system. But the problem lies in the fact that the number of constants must be extremely large, since it is necessary to give a correction for each cubic positioning step. So, for example, with a positioning step of one micrometer for one cubic centimeter of the working space, it is necessary to memorize 1,012 constants, in addition to the fact that each of them has its own values, and service systems.

Moreover, this case is more complicated than the case of interaction of an abstract entity with an ordinary potential field, even when the abstract entity does not move. The first thing it is necessary to pay attention to is the different types of fields. In this case, it is necessary to pay attention not only to such common known fields as magnetic, gravitational, electric, but also such concepts as air, water, sound field, and the like. In order to consider all these things, it will be necessary to think about a number of properties of the field, and abstract objects that let's use in modeling [6, 7] are also considered. So, for the field under consideration, let's accept the following conditions:

– field as a material object has a very specific mass within the space considered;
– boundaries of a part of the space of the field under consideration have quite specific dimensions;
– field properties within the selected space are constant regardless of coordinates and direction of movement;
– specific density and weight of the field are the same regardless of the selected coordinate;
– interaction between the environment and an abstract object can occur only according to the main TOHTOP theorem of tangency [6, 7].

An abstract object that falls into this field has the following properties:

– form of an abstract object for a simplified description of physical processes is taken in the form of a ball without geometric deviations;
– properties of matter within the sphere are the same in all coordinates and directions;
– specific density and weight are the same in all coordinates within the volume of the object;
– abstract object has the ability to create a zone of presence of various types, regardless of its structure;
– interaction with the environment and surrounding abstract objects occurs in accordance with the main TOHTOP theorem about contact [6, 7];
– substance of an abstract object does not have the property of movement within the specified volume.

The geometric shape in the form of a ball is accepted, because in this case all the physical and geometric centers of the object coincide. This means that the center of gravity, the center of hydroaerostatic and dynamic pressure coincide with the geometric center. In addition, let's stipulate the coincidence of the center of symmetry with other centers of physical forces and physical effects. A special condition is the stability of the coordinate systems of all physical effects. The directions of action of all forces pass through the geometric center.

The introduction of such restrictions allows to formulate the concept of a coordinate as a physical phenomenon. Unlike the usual concept of a coordinate, let's consider a coordinate as a force vector containing an abstract object in space. Now there are a number of forces that stabilize motion or a static position in space no worse than [*S*].

Since in the models under consideration there will be forces acting, which in the end are considered as mechanical interaction, now Newton's laws will be used.

3. Research results and discussion

So, according to Newton's first law, any abstract object maintains a state of rest or uniform motion until an external influence changes this state. In fact, this law is the law of inertia [2, 8, 9], which underlies kinetostatics. In this case, the sum of all forces acting on the object is considered equal to zero. This thesis is considered an axiom, although it is not fully justified. Now, to get the effect that the lowest of several forces is zero is impossible. It is enough to recall the usual scales, when it is necessary to achieve a certain balance, but this never succeeds, since the balance obtained is just an illusion. In fact, this Newton's law can be written as a general equation of dynamics, which unites D'Alembert's principle according to the principle of possible displacements of Lagrange:

$$F_i + R_i + \Phi_i = 0, \quad i = 1,2,3,\dots n, \tag{1}$$

where F_i – resultant of active forces applied to the i-th point of the system; R_i – resultant reaction of connections; Φ_i – phantom force of inertia of the i-th point ($\Phi = m_0 a_0$).

Now dependence (1) will be further used in modeling the processes of basing coordinates, which is shown in Fig. 1.

 ISSN 2664-9969

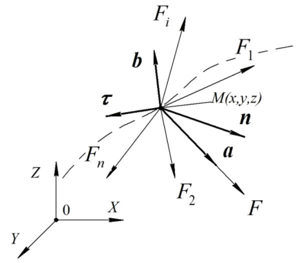

Fig. 1. Coordinate forces of holding an object in space

The next law that will be used in modeling is Newton's second law: the acceleration that material mass receives in the inertial frame of reference, which acts directly on the body to the force and is inversely proportional to its mass, and coincides in direction with the force that is:

$$a=\frac{F}{m}. \quad (2)$$

Law (2) apart from this name is called the basic law of dynamics. In addition to writing the law in the form (2), it has a record through a change in the body's momentum (Δp). In this case, the law is written in the form:

$$F\Delta t=\Delta p=\Delta\left(mv\right), \quad (3)$$

where F – acting force; Δt – time of force action; v – speed of movement; m – mass.

That is, the product of the force F by the time interval Δt during which the force acted on the object is called the impulse of force. Newton's second law is interesting because, on its basis, it can be concluded that the change in the velocities of bodies connected with each other does not occur instantly, but over a certain period of time. So, for example, from the equations of Newton's second law (2) and (3) for objects with constant mass $F\Delta t=m\Delta v$, whence let's get the conclusion that at $\Delta v\neq 0$ cannot $\Delta t\neq 0$. This remark is very important regarding the content of the distance between bodies and especially their interaction in time. This now leads to the formulation of Newton's third law.

So, Newton's third law says: the forces of interaction of two material bodies in the inertial reference frame are equal in magnitude and have the opposite direction:

$$F_{ik}=-F_{ki}, \quad (4)$$

where F_{ik} – force acting on the i-th point from the side of the k-th point, and F_{ki} – force acting on the k-th point from the i-th point.

The subtraction sign in equation (4) indicates the opposite direction of forces.

So, Newton's third law indicates the equality of interacting material objects. In this case, the forces applied to different points can be mutually balanced only in the case when they belong to the same absolutely rigid body. In the case when bodies do not have direct contact, then the application of this law is extremely limited. Nevertheless, such an interaction exists and can be adequately described using a mathematical apparatus.

Newton's fourth law is the relationship between the coordinates of the content of an object in space.

In addition to the three laws of Newton, widely known to all three, there is a fourth. This law is associated with the independence of the action of forces. It is little known, since it was not specifically formulated by Newton himself. Therefore, in most works on theoretical mechanics, it is not mentioned. As a separate law, it follows from the generalized rule of the parallelogram of forces [8, 9]. The essence of this law is that if a number of forces $F_1, F_2, F_3, ..., F_n$ act on a material point, then, as a result, each of them separately creates a corresponding acceleration $a_1, a_2, a_3, ..., a_n$. This acceleration according to the second law is defined as:

$$F_1=ma_1,\ F_2=ma_2,\ F_3=ma_3,\ ...,\ F_n=ma_n. \quad (5)$$

According to the fourth law of acceleration of a material point under the action of these forces (5) is determined by the equation:

$$ma=F_1+F_2+F_3+...+F_n, \quad (6)$$

and is called the basic equation of dynamics. If in (6) to substitute the values of forces from (5) and divide by m, then let's obtain:

$$a=a_1+a_2+a_3+...+a_n. \quad (7)$$

So, the law of independence of the action of forces is the statement that the acceleration of an object, and from the simultaneous action of a number of forces on it, is equal to the vector sum of the acceleration from extraneous forces. Moreover, each force acts separately, independently of the others. Thus, if to imagine that there are a number of field structures that create a chain of acting forces (6), then there is an opportunity to use the laws of fields and assert that [8]:

$$m\cdot \mathrm{div}a=F_1+F_2+F_3+...+F_n. \quad (8)$$

So, as a consequence, any object in space is supported by a number of forces independent of each other. It is this Newton's law that underlies the theory of coordinates. So, let's pay attention to those aspects of the interaction of matter where Newton's laws are fulfilled only partially.

So, the first law has a significant limitation, since it concerns only a free (isolated) body, which is not affected by external objects or fields. That is, if such forces exist, then they are balanced. In this case, a rather logical question arises: if the body is at a certain point of coordinates, then this can still be explained, but if it moves, then it is necessary to balance the system all the time, and this requires spending time and energy. This situation can be solved with a system of dynamic equations. The second situation that arises is related to the specific geometry of the object. When any object moves in a certain environment, distortions of this environment occur, which leads to the interaction of the object and the environment. In this case, Newton's first law ceases to apply at all. As already mentioned, the main problems of the second law are that the rate of change of the same object does not occur instantly, but slowly over some time. In this regard, the value Δt in expression (3) is determined not as a Δ-function, but as a function according to the law e^{kt}, that is, gradually according to the exponential law. Now the value of the dynamic error in determining the coordinate [S] is based on this [3, 10]. As a consequence, this uncertainty turns into uncertainty when applying the third law.

So, in dynamics the influence of interaction between bodies and their mechanical movement is considered. Thus, the main task of the dynamics is to determine the coordinates of the location of the object from an arbitrary moment in time with a known location of the body, initial velocity and forces acting on the body [2, 9]. So, from the previous analysis of the shortcomings of Newton's laws, the problem arises for studying the state and coordinates of an abstract object. In this case, it is believed that an object in its location in space can move despite the action or not doing any extraneous forces (fourth law).

So, while it is about the forces due to which an abstract entity is contained in space in such a way that it satisfies the conditions of Newton's first law, and not vice versa. This means that Newton's law must be read as follows: the body is in a state of rest or uniform rectilinear motion only when this state is supported by external forces, that is, beyond the fourth law. In this case, the expression of the D'Alembert's principle takes the following form:

$$F_i+R_i+\Phi_i\neq 0, \text{ at } i=1,2,3,...,n. \quad (9)$$

Equation (9) justifies itself for some i-th object in a system with n parts. However, this inequality is not in conflict with the expression of the D'Alembert's principle. All quantities in expression (9) are vector, which have a finite motion and therefore their vector sum, even in principle, can't equal zero, since this would contradict the fundamental laws of physics, for example, the Earnshaw's theorem etc. [8, 9].

In general, the vector as a spatial geometric quantity is a purely irrational concept. Equation (9) can be in the extreme case equal to $[S]$ or less. In this case, it is possible to talk about the reality of equation (1).

Thus, the irrationality of the vector motion does not allow full confidence in the D'Alembert's equation. But the results are always obtained, as in (1). Now there is a very simple explanation, since there is a barrier in the form of the quantity $[S]$, that is, if the sum with n-equations (9) gives the accumulation of the result, as $[S]<0$, then all processes in the system are according to equation (1), although for each i-th object, there is equation (9). Since the sum for each i-th object is an arbitrary spatial vector, the sum of such equations (9) as a vector will be less than $[S]$ [5]. As a consequence, the system for a number of bodies is mechanically neutral within its volume. If there are oscillations, then they do not exceed the $[S]$ value in all coordinates, for example, at the atomic level.

In general, the vector as a spatial geometric quantity is a purely irrational concept. For further research, let's refer to this topic from time to time. Equation (9) can be, in the extreme case, equal to $[S]$ or less. In this case, it is possible to talk about the reality of equation (1).

4. Conclusions

Thus, the irrationality of the vector motion does not allow full confidence in the D'Alembert's equation. But it is always get the results as in (1). There is now a simple explanation, because there is a barrier in the form of value $[S]$. That is, if the sum with n-equations (9) gives the accumulation of the result, as in $[S]\prec 0,$ then all processes are perceived as in the system according to equation (1), although for each i-th object there is equation (9). Since the sum for each i-th object is an arbitrary spatial vector, the sum of such equations (9) as a vector will be less $[S]$. As a consequence, the system for a number of bodies is mechanically neutral within its volume. If there are oscillations, then they do not exceed values $[S]$ in all coordinates, for example, at the atomic level.

So, on the basis of what is considered, it is possible to conclude that any abstract entity, and even more so a biotechnical object, has its own zone of presence, and not one, but several. In the case of a multistage structure of zones of presence, it is the zone that will be the main carrier of the zone of presence, according to which certain parameters of the biotechnical object are determined. The aforementioned theses formed the basis of the theory of coordinates of an abstract entity and the TOHTOP technology.

The general concept of interaction of biological and biotechnical objects has been substantiated on the basis of a spectral analysis of the zones of their presence. The theoretical foundations for the construction of analytical models of the existence and vital activity of biological and biotechnical objects have been created, which provides an opportunity to formulate the physicochemical and technical aspects of the existence of an abstract entity.

Thus, this research is the basis for the creation of new information technologies for ultra-precise instrumentation. Based on the above evidence, it is possible to develop new control and measuring systems designed to increase the reliability and reliability of technological diagnostic processes in various fields of technology.

Since this topic has not been covered in modern literature, it is promising today, since it will explain a number of physical phenomena of the interaction of the imaginary and real coordinate systems of abstract objects. Thus, the proposed comprehensive measures and recommendations make it possible to modernize the existing technological equipment for metal processing in order to achieve higher accuracy parameters for the manufacture of precision products of instrument-making enterprises.

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