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Method of non-contact remote determination of the current functional state of the athlete

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Purpose: *development of a non-contact method for monitoring the current functional state in the process of the direct implementation of professional activities.*
Materials & Methods: *analysis of scientific and methodological literature; biomechanical analysis of kinematic, dynamic and static characteristics of motor activity; computer simulation of the dynamics of interaction of controlled indicators; methods of mathematical statistics.*
Results: *based on the results, their analytical dependencies were determined, on the basis of which the corresponding mathematical models were built. They allow you to study the dynamics of the interdependence of controlled parameters in the expected modes of their interaction without the participation of the object of study.*
Conclusions: *analytical patterns that describe the interdependence of the biomechanics of motor activity and mathematical models of reflection, as well as modern means of video recording and computer processing, provide an advantage for an effective assessment of the motor activity of an individual.*

Keywords*:* *contactless control, fatigue, mathematical modeling, rationalism method.*

Introduction

Kinematic and dynamic characteristics of body motion obey physical laws. The difficulty of using them directly in studying the biomechanics of the movement of a "living" body lies in the multicomponent structure of the body, which suggests the need to consider the entire interdependence of the kinematic elements of the body in the movement [10].

Any performed motor action, which is associated with the displacement of the common center of mass (CCM) and is interdependent with the displacement of all biokinematic parts of the body involved in its implementation. One of the most important components in the implementation of the movement is the provision of a working posture. It is characterized by static stress with a certain ratio of the work of synergists and antagonists. Using video control of a moving object allows you to track the kinematic movements of both a single element of the body and its center of mass, and the total center of mass of the whole body.

Purpose of the study: to develop a non-contact method for monitoring the current functional state in the process of the direct implementation of professional activities.

Material and Methods of the research

Methods: analysis of scientific and methodological literature on the research problem; biomechanical analysis of kinematic, dynamic and static characteristics of motor activity; high-speed video recording of movements; computer simulation of the dynamics of interaction of controlled indicators; integration of empiricism and rationalism.

Results of the research

A detailed analysis of the biomechanical fundamentals of sprinting techniques based on high-speed video recording revealed that start and start acceleration have a decisive influence on the final result of running [4; 7]. According to the results of research by domestic and foreign authors, it was found that the contribution of these parameters reaches 64% of the total result in running 100 meters and significantly more at a shorter distance [5; 9]. An important conclusion is that the authors divide the running step into phases of support and supportless movement. In the reference phase, in the process of accelerating the movement of body mass, the depreciation phase and the repulsion phase are distinguished. In sprinting, acceleration is such a part of it, in which the kinematic characteristics in each step are the most dynamic. In the process of acceleration, changes occur in the ratio of the frequency and length of steps, the duration of the support and flight phases, the position of the athlete's body at the time of the support phase. To assess the dynamics of changes in the marked parameters during acceleration, a dimensionless activity index was introduced, which represents the ratio of flight time to support time $\frac{t_n}{t_o}$. The determining factor in the development of speed in running and characterizing this process are the actions of kinematic units in the support phase. In the stage of acceleration of the body, the sequence of relations $\frac{t_n}{t_o}$ is changing. Support time is reduced, and flight is increased and activity index (I_a) as a function of these relations tends to 1, i.e. $I_a=\frac{t_n}{t_o}$ and its value changes at the initial stage of acceleration from 0 to 1 (therefore, $0 \le I_a \le 1$). With further acceleration, the support time becomes shorter, and the flight time increases. In this case, the activity index becomes more than one $0 \le I_a \le (1+\alpha)$. The value of α is an indicator of the effectiveness of the acceleration of the movement of the body's CCM and reflects the individual's ability to high-speed actions. This value depends on the inborn phylogenetic predisposition and the level of its development, as well as on the current functional state (measures of fatigue). In this regard, the activity index with further continuation of the run has the opposite tendency to change, which returns it to unity and a subsequent decrease. This information is not given for the purpose of further improving the kinematics of start and acceleration in sprinting, but in order to show the possibilities of non-contact remote evaluation in real time of the athlete's current functional state.

The peculiarity of this method is that the assessment is carried out not by monitoring the operation of individual functional systems, but by the final equifinal result of their joint provision. This justification was based on the principle of statistical construction of the final equifinal result in any multiparameter system of its support [2; 6].

In turn, [8] indicate that the integral indicator of fatigue is manifested in a decrease in perceptibility. This leads to an increase in inaccuracy in perception and an increase in the tolerance of environmental influences. In accordance with the theory of behavior in a system of tolerant spaces and the first theorem of V.N. Samsonkin, it follows that the complexity of the organization of behavior is significantly reduced [8].

Thus, monitoring the magnitude of the increase in error during the reproduction of standard motor actions is an objective indicator of the development of fatigue. In this case, variants of the manifestation of this process are possible, associated only with an increase in "fuzziness" relative to the stationary average value, or a simultaneous increase in "fuzziness" and transgression of the average value itself. This allows you to determine the individual characteristics of the integral indicator of the flow of functional processes that lead to the development of fatigue [1; 3].

However, without sufficient attention there were such characteristics of motor activity: static stress; dynamic efforts; static tension of a working pose; the relationship of the working pose with the kinematic movements available to it; dynamic efforts that ensure their implementation; the ratio of the magnitude of static stress to the magnitude of dynamic efforts in connection with the energy consumption of the potential reserve of the body.

It is known that the greater the angle of extension of the legs in the knee joint, the more effort is noted on the dynamograph (Figure 1).

The use of dynamographs made it possible to determine the duration of the conservation of static effort, the speed of its development, and to determine the maximum developed force. Simultaneous separate measurement of the strength of the legs with a fixed position of the angle of extension of the knee joint with different effort, specified as the initial condition of static stress, allows you to set the duration of its conservation. After a certain period of time, a clearly pronounced oscillating asymmetry of the efforts of the left and right legs is observed. This is observed for the entire range of changes in the angle of extension of the legs in the knee joint (Figure 2).

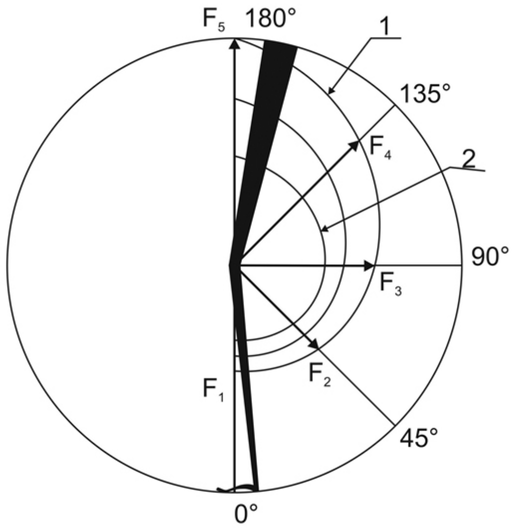

Fig. 2. Increment dependency $\frac{dF}{d\varphi}$ from the angle of extension of the biokinematic pair "drumstick-thigh":

1 – logarithmic spiral, reflecting changes $\frac{dF}{d\varphi}$ at a high level of performance; 2 – logarithmic spiral, reflecting changes $\frac{dF}{d\varphi}$ with extremely high fatigue.

The combination of all intermediate values of the given initial conditions allows us to note the regularity of the preservation of the strength of static voltage and the duration of its reduction. By setting separately for each leg a different extension angle in the knee joint, it is possible to empirically establish the consistency of the jointly developed efforts of each of the legs, which is observed under conditions of low start. Similarly in any other case, when the working pose has support with different position of the legs (when throwing).

The combination of all these characteristics into a single complex of interdependent relationships in ensuring the performed motor activity expresses a certain dependence of the magnitude of the effort on the extension angle between the biokinematic links and the rate of its change over time. In an analytical form it can be represented:

$$\frac{dF}{dt} = \frac{dF}{d\varphi} \cdot \frac{d\varphi}{dt} \quad (1),$$

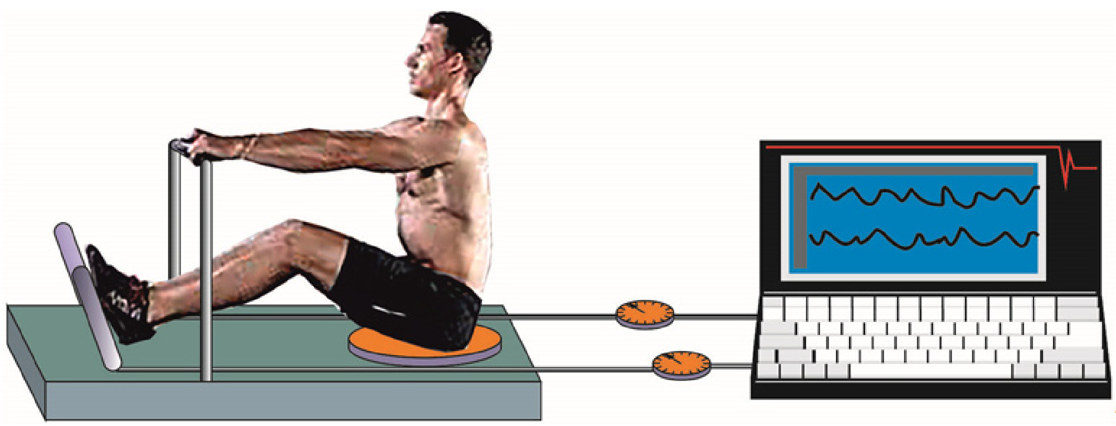

Fig. 1. Dynamography to record leg muscle strength

where $\frac{dF}{d\varphi}$ – boundary conditions of static tension of muscles of a working pose; $\frac{d\varphi}{dt}$ – initial conditions of the movement; $\frac{dF}{dt}$ – the speed of development of effort under given boundary and initial conditions of motion.

It should be noted that the quantity $\frac{dF}{d\varphi}$ includes the boundary value from which the movement begins. This is the basic value of static voltage, which is not reflected in the kinematics of the motion of the body's CCM, but requires a significant expenditure of energy potential. By controlling the movement of the body's CCM in space, we can calculate the total amount of work done to move it and highlight the amount of perfect useful work. Their ratio shows the efficiency coefficient of the technique of the performed movement. The value of these indicators reflects the potential reserve for improving the technique of the movement in motion. The first characteristic of the relationship between the quantities of work is connected with the regularity of the behavior of geometric progression, where the ratio of ratios acts as its denominator. The second characteristic of the difference in the values of the perfect work is associated with the behavior of arithmetic progression and reflects how much the energy expenditure changes with each completed movement cycle.

Using the example of determining the maximum deadlift with different values of the angle of extension in the knee joint, it is possible to assess the functional state of the individual's neuromuscular apparatus. The change in the angle of extension can be set with any accuracy, while observing the increment of the dead force (values $\frac{dF}{d\varphi}$). This dependence of the change in magnitude is expressed in the polar system by a logarithmic spiral. When incrementing the magnitude of the angle of extension in the knee joint in arithmetic progression, the magnitude of the application of force along the radius of the vector of rotation of the angle of extension changes. It is logical to single out a spiral that reflects the most excited state and utter fatigue. All other states are intermediate. Among them there is an optimal condition.

An individual feature of the manifestation of this pattern is the curvature of the spiral, which does not depend on the functional state of the individual.

This process can be most clearly represented as the path of the end of the radius vector, which, with successive uniform rotation moving along the vertical axis, describes a spiral on a cone that determines the direction of sliding of the end of the radius of the vector. The cone angle determines the coefficient of curvature of the logarithmic spiral in the perpendicular plane to the axis of its formation. The analytical description of this process is called the "cone of distinguishability" and has the features of its construction, revealing the boundaries of an extremely high level of working capacity and extremely low, arising from severe fatigue. This kind of mathematical model is based on the method of constructing the Apollonius circle and the principle of stability of dichotomous interdependent relationships. To maintain the equilibrium relationship of two opposing processes (dichotomies), their coefficient of "active" interdependent relationship should be equal to 1, which ensures the preservation of their full stability of relations. Otherwise, the dichotomy is destroyed.

The definition of the Apollonius circle, which is given to them, is the geometrical location of the points, the ratio of the distances of which from these two points is a constant value (λ). If A, B are the given points, C, D are the intersection points of the line AB with the circle (Figure 3), then since the points C and D by definition belong to the circle, for them, as for all points of this circle, the equality conditions $\frac{AC}{BC}=\lambda$, $\frac{AD}{BD}=\lambda$, from here $\frac{AC}{BC}=\frac{AD}{BD}$. This means that the four points of ABCD are harmonic.

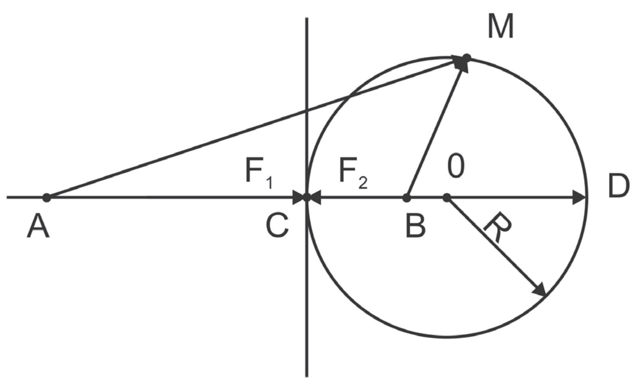

Fig. 3. Circum Apollonius

The Apollonius circle represents a zone of equal relations between two opposing forces, which in this case will be AC = F_1, BC = F_2 in the presented drawing. From any point and circle, by definition, the ratio of the distances AM / BM = λ. Therefore, the change in the length of the AC vector and all AM1, AM2 ... AD reflect the change in the direction of action of the force F1 and its magnitude from AC (F_1 = min) to AB (F_1 = max). In accordance with the change in the values of the force F1, the force of the vector F_2 will change from its minimum value BC (F2 = min) to BD (F_2 = max). At all points of relationship $\frac{F_1}{F_2}=\lambda$.

Due to the fact that the construction of the "cone of distinguishability" will be carried out in three-dimensional space of Cartesian coordinates, a perpendicular line is drawn in Figure 3, which acts as the Y axis. Its intersection with the line AB at point C corresponds to the origin, and the line AD, being a continuation, is X axis. In this case, given: AM=F_1; BM=F_2; $\frac{AC}{BC}=\lambda$; $\frac{F_1}{F_2}=\lambda$. AB is divided by point C in relation to λ. For convenience, let us designate further entries AC = a, BC = b. Need to find: the geometrical location of the ends of the radius of the vectors F_1 and F_2, preserving $\frac{F_1}{F_2}=\lambda$.

From geometric constructions in Cartesian $F_1=\sqrt{y^2+(a+x)^2}$ $F_2=\sqrt{y^2+(x-b)^2}$; from conditions $\frac{F_1}{F_2}=\lambda \Rightarrow \frac{y^2+(a+x)^2}{y^2+(x-b)^2}=\lambda^2$;

$y^2+a^2+2ax+x^2=\lambda^2y^2+\lambda^2b^2-2bx\lambda^2+\lambda x^2$; $\lambda^2y^2-y^2+\lambda^2x^2-x^2-2bx\lambda^2-2ax=a^2-\lambda^2b^2$;

as $a=\lambda b \Rightarrow a^2-\lambda b^2=0$ in this case $y^2(\lambda^2-1)+x^2(\lambda^2-1)-2x(\lambda^2b+a)=0$;

$y^2+x^2-2x\frac{(\lambda^2b+a)}{(\lambda^2-1)}=0$; $y^2+x^2-2x\frac{a(\lambda+1)}{(\lambda^2-1)}=0$; $y^2+x^2-2x\frac{a}{\lambda-1}=0$;

$y^2+x^2-2\frac{a}{x-1}+\frac{a^2}{(a-1)^2}=\frac{a^2}{(\lambda-1)^2}$; $y^2+(x-\frac{a}{\lambda-1})^2=\frac{a^2}{(\lambda-1)^2}\Rightarrow$

which in the Cartesian coordinate system represents the center (O) of the circle of Apollonius shifted by $\frac{a}{\lambda-1}$, therefore, CO=R=$\frac{a}{\lambda-1}$.

Thus, if you make an offset by R=$\frac{a}{\lambda-1}$, then the center of the circle coincides with the origin and the ratio $\frac{F_1}{F_2}=\lambda$ will be true for any values of F_1 and F_2, the ratio of which gives the value λ. This relation represents the control of a line passing through the center of coordinates, where λ=tg*L*, or the angle of inclination of the line, which can be graphically represented as Figure 4.

This indicates that practically a set of values of F_1 and F_2 as a pair of numbers, the ratio of which is equal to λ represents an infinite number.

In turn, the attitude $\frac{F_1}{F_2}=\lambda$ can be represented as the equation of a circle, which indicates a limited interval in the values of F_1 and F_2, which can satisfy the ratio $\frac{F_1}{F_2}=\lambda$. If we define these relations as the possible lengths of the vectors

F_1 and F_2, fixed at the beginning at the fixed points, and their ends touching at some point M, then this point will describe the circle, which was shown in Figure 3.

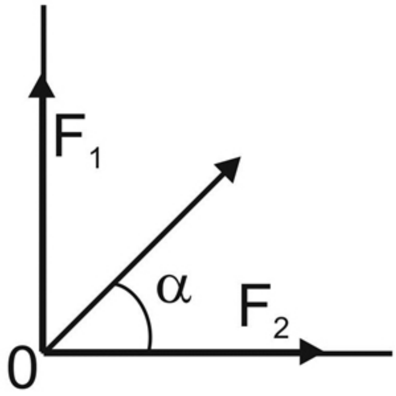

Fig. 4. The equation of a line passing through the center of coordinates

These vectors are represented in the Cartesian coordinate system and have a numerical value in the coordinates (x, y). Since the basic requirement is that the relation $\frac{F_1}{F_2}=\lambda$, then we can construct a sequence of decreasing values of F_1 and F_2 while maintaining the value λ. This sequence of circles decreasing in their diameter, whose centers lie on one straight line, representing the third Z axis of Cartesian coordinates and generate a "cone of distinguishability". In its construction, the reasons limiting the interval of changes in the values of F_1 and F_2 are revealed.

The main essence of this phenomenon lies in the structure of the construction of the circle of Apollonius. The vector F_2, whose origin lies at point B (Fig. 3), is at a distance from the center of the circle $a/_{\lambda-1}$, where *a* reflects the initial value of F_2, which has a minimum value in the range of its change in the construction of each circle of Apollonius. Thus, at point C, the force vector F1 and F_2 meeting, has the smallest value. At point D, their values reach their maximum size, after which the reverse process occurs in the construction of the Apollonius circle. In the sequence of arrangement of decreasing Apollonius circles, when constructing the "cone of distinguishability" taking into account the uniform step of their distance from each other, a constant value of the vector F_2 will be encountered in its minimum manifestation of the first circle, which is the basis of the "cone of distinguishability". Therefore, for each step of the displacement of the subsequent circle, a constant value F_2 in its minimum value will make a rotation by a certain angle *L*. This process will continue until it reaches a 180˚ turn in the last circle and in it its minimum value in the first circle, which is the base of the cone, becomes the minimum value in the last circle. This ends the first half-cycle of the motion of the vector F_2 in the construction of the upper half of the "cone of distinguishability".

The construction of the lower half of the "cone of distinguishability" has several options for solving this problem, but it is not the subject of this article, despite its exceptional importance.

In the construction of the "cone of distinguishability" (upper part), a number of determining components of its structure are distinguished. These include: the diameter of the base of the cone, or the initial circle of Apollonius, on which the points C are determined, at which the vectors F_1 and F_2 come into contact at their minimum values. Point B, which is the beginning of the vector F_2, point O is the center of the Apollonius circle with its radius R. Point D, at which the ends of the vectors F_1 and F_2 meet at their maximum value. All points lie on the coordinate axis X. Outside of the circle on the X axis lies point A, which is the beginning of the vector F_1. As noted above, points A, C, B, D are a harmonic four.

The diameter of the truncation of the cone by the circle of Apollonius, on which all the points mentioned are determined in their multiple reduction. The distance A between the circles of the base and the truncation, which determines the length of the line passing along the Z axis through all the circles from the base of the cone, at which the maximum values of the vectors F_1 and F_2 meet at point D. The relationship of these characteristics in the structure of the construction of the distinguishability cone is shown in Figure 5.

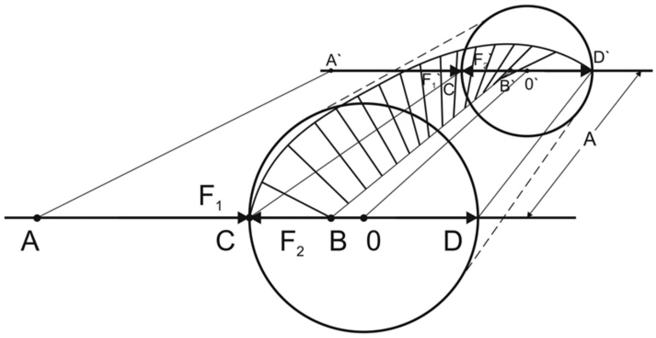

Fig. 5. Cone of legibility perceptions

Where A defines the range of F_2 in Apollonius circles in the corresponding section of the "cone of distinguishability". At the base of the cone, F_2 = min and F_2 = max comprise the diameter of the circumference of the base. In the final, last, smallest circle of Apollonius, the vector F_2 in the size of its minimum value represents the largest part of its diameter, being in this case the maximum of F_2 at its previous value. Thus, A is the range of distinguishability of perceptual states.

The diameter of the base circle represents the sum (F_2min + F_2max) and acts as a range of perceptibility distinguishability within the state.

Projection of each *Mi* Apollonius circle points on its diameter is an assessment of perception within the state. This estimate is measured in degrees of inclination of the vector F_2 to the diameter, which allows us to introduce the commensurability of the sensitivity of perception in different states in the same parts of the distinguishability scale within each state.

Constant $\lambda=\frac{F_1}{F_2}$ reflects the value of the share of perception in the redistribution of each *(i)* state where F_1*i* defines the upper limit of sensitivity, F_2 – reflects the lower limit, beyond which the measurement assessment is not available.

On condition $F_1>F_2$ the basis of the construction of the sensitivity measure is the Fibonacci numbers, since F_1min + F_2min represent an integer from point A to point B. The ratio of the whole (F_1min + F_2min) to the majority (F_1min) with the ratio of the majority (F_1min) to the smaller part (F_2min) gives the "golden section" and point C belonging to the circle of Apollonius, in which $\frac{F_1}{F_2}=\lambda$ determines the most effective structure for constructing a cone of distinguishability".

In each individual state, we can talk about the maximum manifestation of opportunities and the minimum sufficient. Between them there is a regime of optimal sufficient activity, which is most characteristic and most often occurs according to all three criteria for its evaluation: duration, intensity, volume of morphofunctional structures involved.

Similarly, from the entire range of functional states, one can select the optimal one that is adequate to the environment of staying along the boundaries of the variation in the required activity, short duration, and the total volume of the request for potential opportunities for its occurrence.

Regardless of the level, the processes of morphofunctional activity, which proceeds according to a uniform pattern for a given individual, are considered; one can distinguish the corresponding logarithmic spiral with a constant coefficient of its curvature. In this case, it is necessary to take into account the level of organization of the processes under consideration, especially when the absolute values of the considered characteristics are compared.

Due to the fact that the potential energy reserve of the body in the process of performing professional activity is spent on static stresses, emotional state, a method for the overall assessment of the fatigue index, which is the "cone of distinguishability" of the functional state described above, is needed. This will allow us to differentiate the energy consumption for static stresses and the level of emotional stress.

When analyzing the kinematic displacements of the centers of mass of the parts and the body's CCM, an important component is their trajectories, which minimize energy consumption when a positive final equifinal result is achieved. Such trajectories are parabola in unsupported motion, cycloid and brachistochron in the supporting position. In some cases, this trajectory is a straight line, if an additional mass is included in the movement of the body's CCM, which is part of the general structure of the performed motor act. In addition to these trajectories, as generators, circles: helicoid, ellipse, logarithmic spiral, chain line, are important in the analysis of motor activity.

In most cases, movements that are performed under natural conditions are carried out with the participation of all elements of the body with a different share contribution to the equifinal end result. In this case, it is necessary to take into account the various ratios of the parts of the body that comprise the two-link pendulums. The two-link pendulum is the lower limbs and the trunk. All the two-link monuments involved in organizing the movement can work simultaneously or sequentially. They constitute the kinematics of motion at a fixed static voltage of other links, which provide a working pose for the current moment of organization of the kinematics of the movement of the body's CCM. A common unifying feature of their movement in providing complex-coordinated movements is that they carry out their movement around the circle. The compatible movement of each link of the two-link pendulum ensures the movement of the CCM around the circumference, which creates a lifting force.

The most thoroughly studied movement of a falling body with the support search at the moment of its fall is a low start when accelerating the center of gravity and raising it to the height of movement along the distance. The most effective trajectory of the body's CCM movement is a parabola with an initial departure angle of 45˚. In most cases, this requirement is not implemented. As an example of the performance of this movement, high-speed video recording of the first low-start step of the ex-world record holder in the 100 m race of Asafa Powell can be used (Figure 6).

When ordering the placement of frames of video recordings of the first step of low start relative to the projection of the body CCM perpendicular to the axis of the start line on the last frame and based on the pattern of movement of the body MSC along the parabola, it does not make it difficult to calculate the components of the vertical velocity of the body MSC to reach the required height in distance running and acceleration horizontal running speed. The peculiarity of this task is that it is necessary to determine the starting position of the start and location of the CCM to calculate the departure path along a parabola with an angle of 45˚, given that the starting point of departure is the location of the CCM. In the case under consideration, the axial straight line passes through the start line, and the CCM moves along the parabola path with a departure angle of 40 ˚ at the CCM point, the angle is 32.5˚, which significantly redistributes the decomposition of the total speed in the direction of the horizontal component. But at the same time, the body's CCM output to the height of its necessary movement to the "smooth" run distance is reached only by the fifth step. Under the condition that the body's CCM departures in a parabola at an angle of 45˚, reaching this altitude is already achieved in the second step, but with a lower horizontal component, the speed continues to increase to its maximum activity index, which reaches its value more than 1, when the flight phase of the CCM body exceeds the phase of the support and the speed of horizontal movement reaches its maximum.

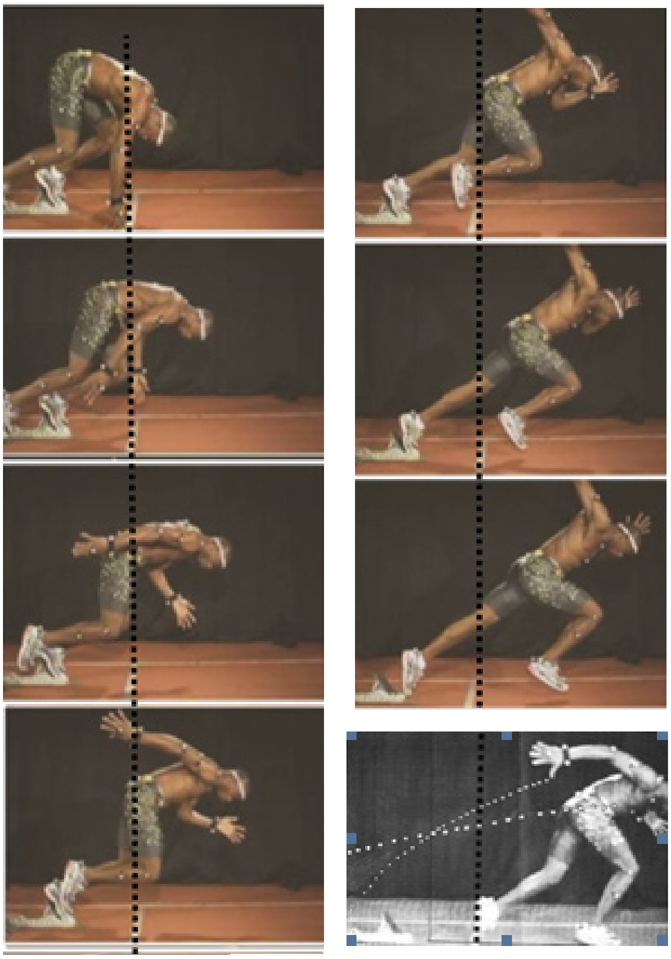

Fig. 6. First step of the crouch start rt in the 100 m run

Optimal, in the energy consumption of the potential reserve, is the trajectory of the parabola, which ensures the departure of the body's CCM and its horizontal acceleration at an angle of 45°.

When considering the trajectory of the body's CCM in the frontal plane, its movement in the longitudinal-transverse direction and stepwise rise to the required running distance along the distance are observed. The movement of the body's CCM in the longitudinal transverse direction resembles rolling during acceleration in the ridge race. In the considered technique of performing a crouch start, these fluctuations have a sufficiently large amplitude of movement with a corresponding energy consumption, which reduces the endurance of the athlete and, as a consequence, worsens the final result. The observed oscillations of the body's CCM in three directions give rise to a helicoid trajectory in the space of movement (Figure 7).

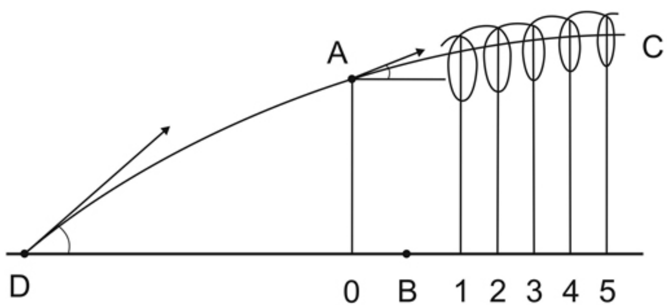

Fig. 7. Trajectory of the body CCM at the stage of starting acceleration:

1) Point A – the initial position of the body's CCM in front of the "attention" command; Point B -s the start line; Point O is the projection of the CCMB in the starting position on the plane; AS – the asymptotic line of motion of the CCMB; A 1.2.3.4.5 is the helicoid of the real movement of the body's CCM. 2) 0, 1, 2, 3, 4, 5 – the fulcrum of the running steps in the starting acceleration of the CCMB.

Thus, having a video recording of the athlete's body movement, it is possible to establish the economics of the technique of the performed motor actions with any required accuracy, focusing on the generalizing component characterizing its effectiveness. A decrease in the efficiency of performing motor activity is associated with a decrease in potential energy in the current state of the body, which is observed in a change in dependence when observing the kinematics of the movements performed, which are available at possible dynamics of the developed efforts.

Conclusions / Discussion

Based on these provisions, various manifestations of the activity of a functional state were presented as a mutual opposition of endurance and fatigue. The intensity of the work performed and its duration in Cartesian coordinates are interdependent by an exponential dependence, which in polar coordinates is represented by a logarithmic spiral.

If we imagine a certain state of equilibrium endurance relations as potential opportunities for doing work of the corresponding intensity and fatigue as a phenomenon associated with a violation of homeostasis, then a purely theoretical description of this phenomenon and analysis of the obtained mathematical model allows us to reveal those laws that cannot be detected by empirical methods in any way. The Apollonius circle reveals the peculiarities of the behavior of the "endurance – fatigue" dichotomous pair in one of the states, and the set of states gives rise to a "cone of distinguishability", covering the full range of various possible states.

The presence of established patterns and their analytical description, determination of the individual characteristics of their course, as well as modern technical means of video recording and computer processing of the information received allow us to talk about the presence of a dynamic computer simulation method, which not only solves the issue of contactless remote real-time determination of the athlete's current state, but predicting the subsequent state with the determination of optimal modes of its stabilization.

The reflection of the total volume of energy potential consumption on the surface of the "cone of distinguishability" will be reflected in a certain region of the state range corresponding to the zone of these states. When monitoring and evaluating the work associated with moving the body in space and the dynamics of changes in the working posture in the observed movements, one can judge the profitability and effectiveness of the activity carried out, or in general its availability for this individual in his current state.

On the whole, this nature of organization underlies interdependent relationships in the process of adaptation of an organism to its environment. The lack of the necessary accuracy of control in this process limits the level of complexity and cost-effectiveness of the organization, and in some cases leads to a quick «burnout» of potential opportunities and the unsuitability of further high-quality implementation of professional activities.

Any interaction with the environment entails the consumption of potential opportunities and manifests itself in fatigue. Monitoring its level is an effective means of optimizing the process of interaction with the environment in the optimal mode of its course. Evaluation of the optimality of the performance of any activity is determined by the number of errors and their «rudeness», which in turn requires a certain standard of comparison and the availability of correction tools.

For motor activity, such comparison standards are the most economical trajectories of body movement in space, taking into account the specific structure and conditions of the activity. In this case, we can talk about optimizing the kinematics of body motion in its support and supportless movement.

Prospects for further research. In the future, the developed control technique will be tested in the training and competitive process of athletes of various specializations.

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