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2) Name of the technical solution

Program package **SMOWIND – OW**, (**SMO**oth **WIND**ing for **O**ne **W**inch)

3) Key Words

Analysis, kinematics of smooth cable winding/unwinding, novel construction of the winch, simulations.

4) For whom the solution was done (legal entity or industries)

Scientific Research for the purpose of validation of theoretical assumptions

5) The year when the solution was completed

2017.

6) Year when it began to be implemented and by whom

The program package **SMOWIND – OW** was implemented in

1. published paper [2], in the journal FACTA UNIVERSITATIS, Series: Mechanical Engineering, 2017, appropriate category **M24**. We present the confirmation of theoretical contributions in the subtitle 3. "THE PROGRAM PACKAGE SMOWIND – OW" using software package **SMOWIND – OW** in paper [2].
2. registered patent at the national level [3], appropriate category **M92**.

On this basis the software package **SMOWIND – OW** acquires the right to be ranked in the category **M82, a new technical solution (method) applied at the national level,** because it meets open source criteria (registered patent [3]).

7) The area and the scientific field, which the technical solution refers to

One of areas where this solution can be used is robotics CPR (Cable-suspended Parallel Robot).

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However, robotics is not the only scientific area where program package **SMOWIND – OW** can be used. There are a lot of these systems in different areas of science and engineering. Some of these systems are: measuring mechanism, machines in textile industry, cable logging systems in civil engineering and forestry, cranes, systems in shipping industry, and other complex cable driven systems.

8) Problem solved by technical solution

New constructive solutions of winches for single-row radial multi-layered cable smooth winding/unwinding on a winch are solved. It's model was presented in [2] and in this paper simulation results were achieved by using the program package **SMOWIND – OW**.

9) State of the problem solution in the world

The analysis of the behavior of a circular winch intended for single-row radial multi-layer cable winding/unwinding system indicated that this system was far from ideal and contained a series of constructive problems. This simple construction of the winch has caused abrupt changes of important variables of this system: radius of cable winding/unwinding, cable length, and inclination of the cable with respect to vertical axis. Detailed description of this problem is given in [1].
The concept of nonlinear smooth cable winding/unwinding process on a winch has been first defined, analyzed and solved in [2] and by registered patent [3].

10) Description of the technical solution

This program system **SMOWIND – OW,** was generated in MATLAB. Technical solution came out as a result of analyzing the standard winch for single - row radial multilayered cable winding (unwinding) from Fig. 1. The analysis of the behavior of a circular winch intended for single-row radial multi-layer cable winding/unwinding system indicated that this system was far from ideal and contained a series of constructive problems. This simple construction of the winch has caused abrupt changes of important variables of this system: radius of cable winding/unwinding: R_i, cable length: lw_i, and inclination of the cable with respect to y_i axis: angle γ_i, but it should be emphasized that this problem is present in other systems form cable winding/unwinding, for example: cable winding/unwinding system for multi-row radial and axial cable winding/unwinding process. See [1]. Because of the described effects, it is required to find a solution in the form of a new construction of the winch. Constructively, only a winding/unwinding system which does not generate abrupt changes of the variables involved presents a good system for this purpose.
The main point of this research is geometric and mathematic definition of cable winding/unwinding process on a novel shape of winch intended for smooth rope (cable) winding/unwinding. The new constructive solution of the winch is presented in Fig. 2. To achieve smooth cable winding/unwinding process, two new constructive solutions of the winch have been designed:

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1) The first, consists of two semi cylindrical bodies of different radii, as shown in Fig. 2a). It has been named two-cylinder winch. Two-cylinder winch will be presented in this paper in detail, and

2) The second, has a spiral shape, as shown in Fig. 2b). It has been named spiral winch.

Similar effects of smooth cable winding/unwinding process are achieved for both, the spiral and two-cylinder winches.

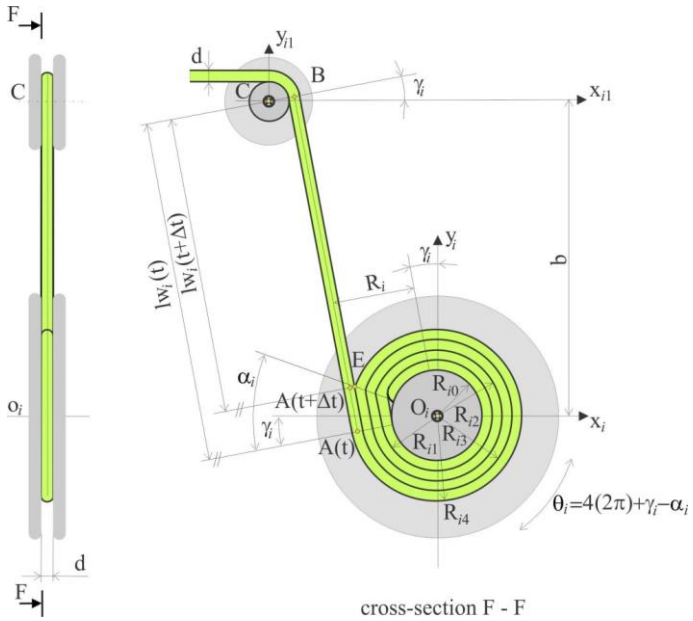

Fig. 1 Standard winch for cable winding/unwinding system

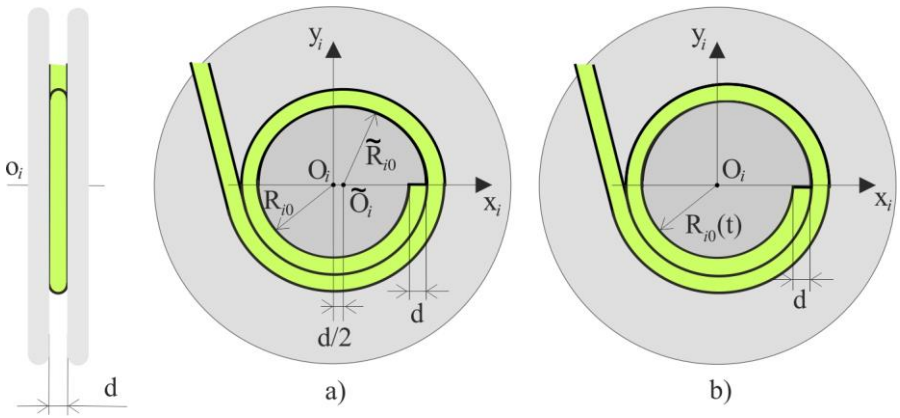

Fig. 2 Winch for the smooth cable winding/unwinding process: a) two-cylinder winch, b) spiral winch

The two – cylinder winch will be used for performing the corresponding theoretical analysis. The geometry of the cable smooth winding/unwinding process on one winch will be shown and analyzed in detail. The cable is mounted so that it emerges from the winch at a place where there is a joint of two semi cylindrical bodies. See Fig. 3. The starting position was systematically (by calibration) defined to be at the direction of the negative part of x_i axis and affects to further kinematics of the process. A more detailed look at the starting position of the system for cable winding/unwinding is shown in Fig. 4a). In order to

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facilitate understanding of the kinematics of the cable smooth winding/unwinding process on a winch, the geometry of this complex process will be shown.

Defining the geometry of the cable smooth winding/unwinding process is needed for specifying the kinematic and dynamic models of this process. Also, for a good understanding it is sufficient only to analyze the winding process of a cable on a winch, thus the analysis of the process of unwinding will be omitted since the phenomena are the same but occur in the reverse order compared to winding.

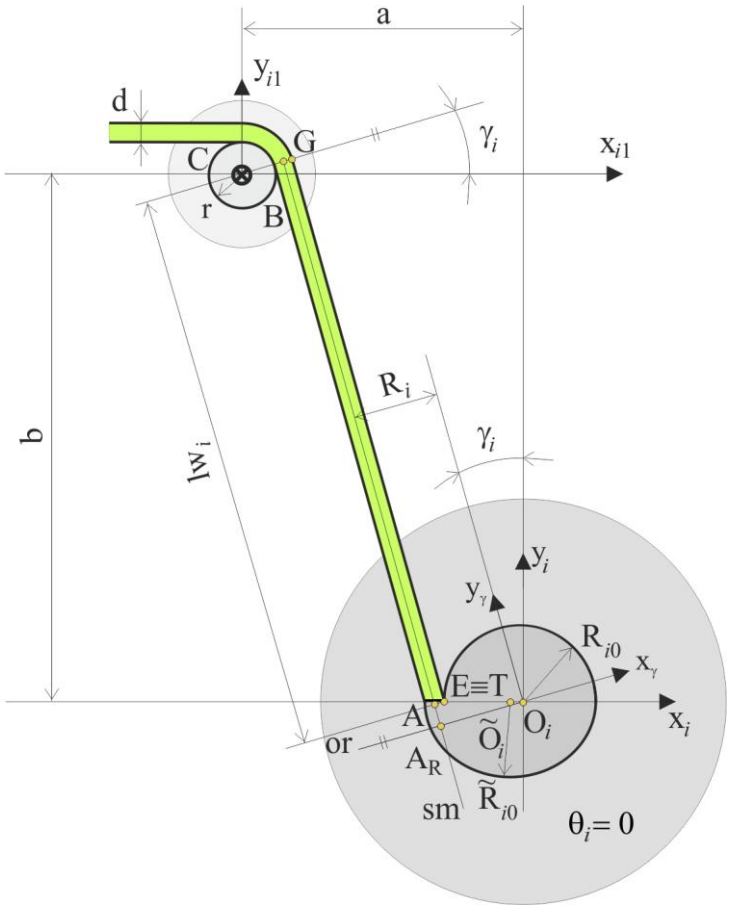

Fig. 3 The starting position of the winding/unwinding system

The newly shaped motorized winch is positioned along one axis of the $x_i - y_i$ coordinate system. This winch (winds up)/unwinds a cable of diameter $d = 0.0008\text{m}$. From the other side this cable goes over a smaller pulley (which is not motorized) which has radius $r = 0.009\text{m}$. This pulley is positioned at the center of $x_{i1} - y_{i1}$ coordinate system, in point C. This point in relation to the $x_i - y_i$ coordinate system has coordinates $(-a = -0.045\text{m}, b = 0.524\text{m})$. The smaller semicylinder has a basis of radius $R_{i0} = 0.0136\text{m}$ with the center at point $O_i(0,0)$. Radius of the bigger semicylinder $\tilde{R}_{i0}$ is geometrically defined by the shape function of this winch in relation to the radius of the smaller semicylinder R_{i0}.

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The bigger semicylinder has a radius of basis $\tilde{R}_{i0} = R_{i0} + d/2 = 0.014\text{m}$ with the center at point $\tilde{O}_i(-d/2,0)$. Point $\tilde{O}_i$ is constantly rotating around point O_i at distance $d/2$. The two semicylinders will further on be referred simplify names as two semicircles. Point E belongs to the outer contour of the winch and it is positioned at the intersection of the smaller semicircle and flat part of the winch, see Fig. 4a). At the starting position, this point belongs to the negative part of x_i axis. This point has a stationary position in comparison with the winch during the whole of the cable winding/unwinding process on the winch. It is assumed that deflection angle between line O_iE and negative part of x_i axis defines the winding/unwinding process of the cable. This deflection is denoted as angle θ_i whose value at the starting position is: $\theta_i = 0$.

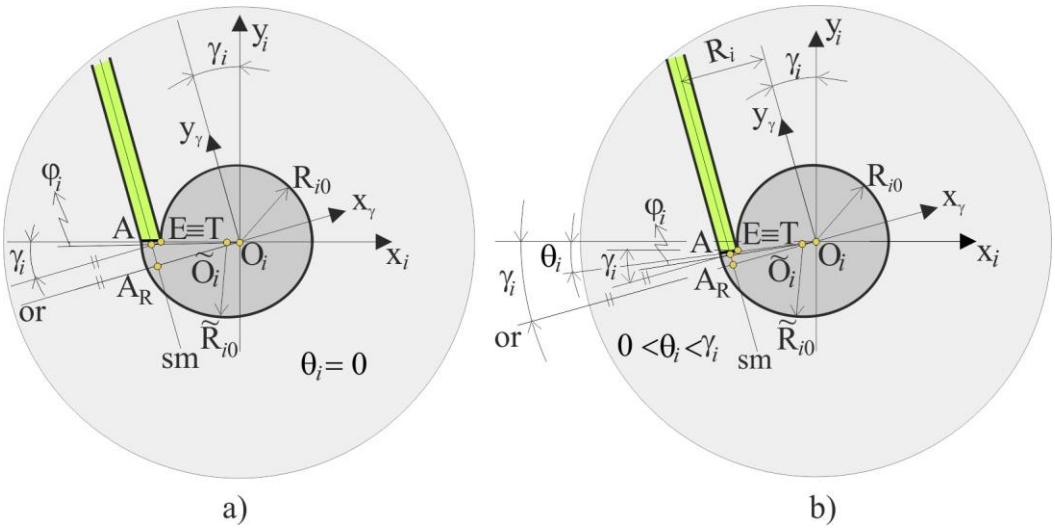

Fig. 4. a) The starting position of the winding/unwinding system – close-up, b) Position of the winding/unwinding system for $0 < \theta_i < \gamma_i$

Unlike point E, point T changes constantly its position on the winch. This point presents the place where the cable touches the winch or the cable wound so far. At the starting position, points E and T overlap. The winch and pulley are positioned so that angle γ_i has a positive value at any moment. Angle γ_i presents one of the variables of the system which characterize the cable winding/unwinding process. At the starting position, angle γ_i has the largest value of 0.04116rad, this is defined by the constructive solution of the mechanical part. This angle is defined as angle between the line *sm* and y_i axis.

It is presumed that the cable is wound with constant angular speed, i.e. $\dot{\theta}_i = \text{const}$. This presumption presents an idealized theoretical condition, which has been introduced for easier and clearer explanation of the smooth cable winding process on the winch.

It is assumed that the cable force acts through the central axis of the cable, i.e. along direction of the line *sm* (see Figs. 3 and 4a)). Usually, it is presumed that the winding/unwinding radius is calculated at the

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position where the force acts upon the winch. With this presumption and from Figs. 3 and 4a) it can be seen that this radius presents distance O_iA_R at the starting position.

The position of point A_R is at the intersection between lines *sm* and *or*. Point B is positioned at the intersection between line *sm* and the line which contains point *C* and which is parallel to line *or*. Distance AB labeled as lw_i presents a dynamic variable during the cable smooth winding/unwinding process on the winch. This variable has its dynamics of change and thus affects the dynamic response of the system (see Fig. 3).

As in the previous case (Figs. 3 and 4a)), point A_R is positioned at the intersection of lines *sm* and *or*, while point *A* is at the intersection of line *sm* and the line which contains point *T* and is parallel to line *or*. The system's position which is analyzed next is shown in Fig. 5a). This is the position when the following condition is satisfied $\theta_i = \gamma_i$.

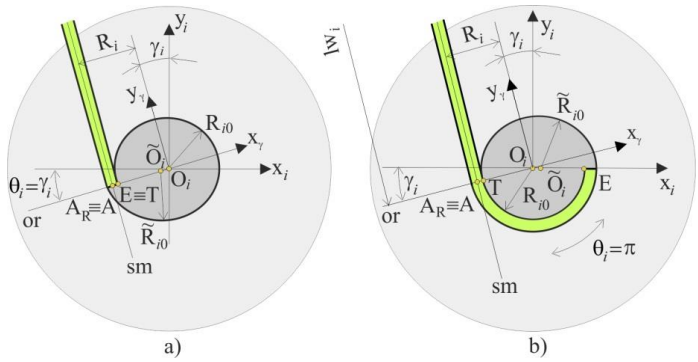

Fig. 5 Position of the system for a) $\theta_i = \gamma_i$ and b) $\theta_i = \pi$

At this moment, points A_R and A are at the same position and they are lying on line O_iT. From this moment on, point A is always on line O_iT during the winding process. In Fig. 5a), it can be seen that line O_iT is lying on x_γ axis (also line O_iE is lying on this axis) – axis x_γ presents the axis that is deflected by angle γ_i compared to the positive part of x_i axis. Coordinate system $x_\gamma - y_\gamma$ is always defined by angle γ_i. At this moment, the cable is tangential to the winch at point *T*. Also, it is the last moment when points E and T overlap. From that moment on, point E maintains its fixed position on the body of the winch, while point T follows winding dynamics of the cable. The winding/unwinding radius has the following value $R_i = O_iA = O_iA_R = R_{i0} + d/2$.

Also, at this moment, distance lw_i has the biggest value during the cable winding process on the winch.

The cable keeps on winding and angle θ_i takes values from the following range: $\gamma_i < \theta_i < \pi + \gamma_i$, named the *con* range (constant).

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Throughout this range, radius R_i length lw_i, and angle γ_i (important variables of the cable smooth winding/unwinding process) have constant values. An example of the position from this range is shown in Fig. 5b). In this example line O_iE overlaps with the positive part of x_i axis, i.e. $\theta_i = \pi$. From Fig. 5b) it can be seen that positions of points E and T are different.

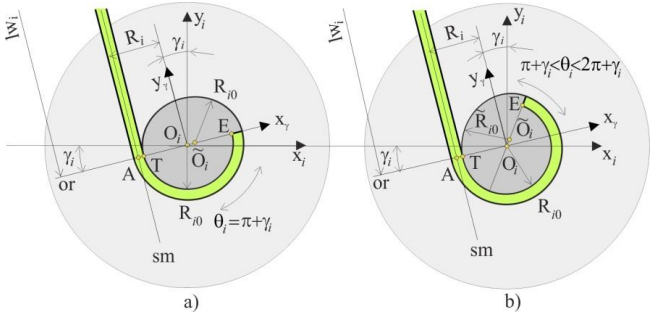

Fig. 6 Position of the system for: a) $\theta_i = \pi + \gamma_i$ and b) $\pi + \gamma_i < \theta_i < 2\pi + \gamma_i$

An important moment is when the following condition is satisfied: $\theta_i = \pi + \gamma_i$, because at that moment the system leaves *con* range and a new law of change of all relevant variables: winding/unwinding radius R_i length lw_i, and angle γ_i starts. It can be seen that at this moment line O_iE lies on x_γ axis (see Fig. 6a)), but, in comparison with the positions from Fig. 5a), this line is rotated about point O_i by angle π. After that moment, the cable is starting to wind smoothly on the part of the winch with the bigger radius, i.e. the bigger semicircle.

From that moment on, angle θ_i takes the values defined by the following equation: $\pi + \gamma_i < \theta_i < 2\pi + \gamma_i$.

The range when all the relevant variables are changing their values is named *smvar* (smooth variable) and one position of the system within this range is shown in Fig. 6b).

Angle θ_i is changing linearly during the cable winding process, i.e. angular speed of the winch rotation is constant, $\dot{\theta}_i = \text{const}$. The defined *smvar* range represents the period when cable winding/unwinding radius R_i changes its value. Upon entering this range, during the cable winding, this radius starts to grow from value $R_i = R_{i0} + d/2$ to value $R_i = R_{i0} + 3 \cdot d/2$ which is reached at the end of *smvar* range. For easier description of the change of radius R_i, two sub-ranges of *smvar* range will be considered:

1) The first sub-range is defined by the following change of angle θ_i: $\pi + \gamma_i < \theta_i < \pi + \gamma_i + \pi/2$. This period of winding is shown in Fig. 7a) and in this sub-range of *smvar* range, radius R_i is calculated by $R_i = R_T + d/2$. Radius R_T becomes a changing variable in *smvar* range, where at the beginning of the range it has value $R_T = R_{i0}$. During the first sub-range, the change of this variable is described by

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$$R_T = \sqrt{(R_{i0} + d/2)^2 - (d/2 \cdot \sin(\theta_i - \pi))^2} - d/2 \cdot \cos(\theta_i - \pi).$$

2) The second sub-range is defined by the following change of angle θ_i: $\pi + \gamma_i + \pi/2 < \theta_i < 2\pi + \gamma_i$. This period is shown in Fig. 7b) and in this sub-range of *smvar* range, radius R_i is calculated by $R_i = R_T + d/2$, but R_T is: $R_T = \sqrt{(R_{i0} + d/2)^2 - (d/2 \cdot \sin(\theta_i - \pi))^2} + |d/2 \cdot \cos(\theta_i - \pi)|$.

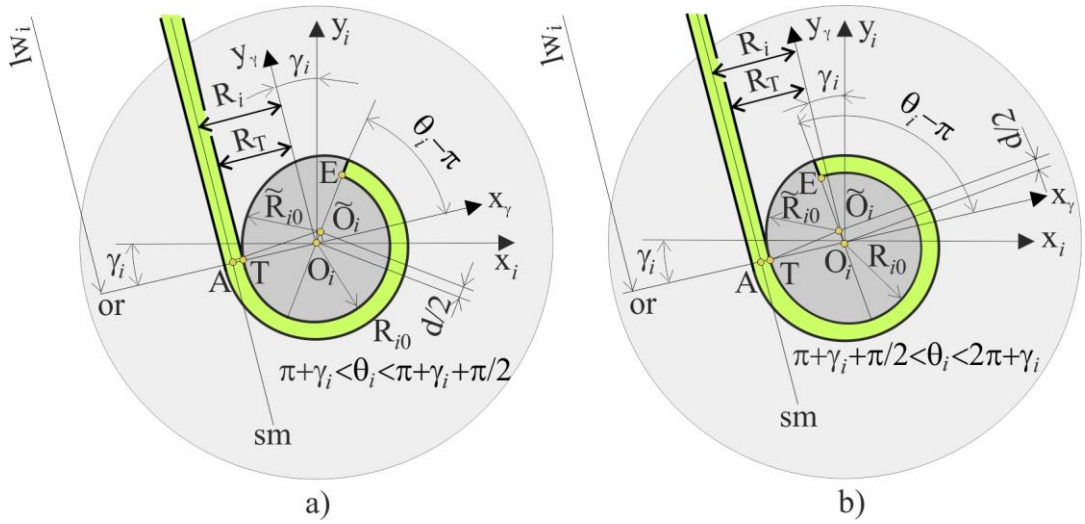

Fig. 7 Position of the system for: a) $\pi + \gamma_i < \theta_i < \pi + \gamma_i + \pi/2$, and b) $\pi + \gamma_i + \pi/2 < \theta_i < 2\pi + \gamma_i$

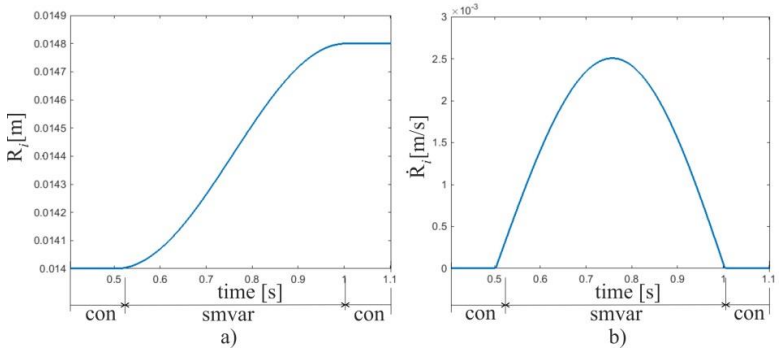

Fig. 8 a) Radius R_i and b) the first derivative of radius R_i over *smvar* range

Change of the winding/unwinding radius achieved in this fashion is smooth, as can be seen from Fig. 8a), Fig. 9a), Fig. 10a), where variation of radius R_i, distance lw_i, change of angle γ_i, over *smvar* region is presented, respectively. Fig. 8b) , Fig. 9b), Fig. 10b) shows the first derivative of this radius, i.e. variable $\dot{R}_i$, the change of first derivative $l\dot{w}_i$, the first derivative $\dot{\gamma}_i$, respectively, where one can see a smooth change of the winding/unwinding radius. Upon entering *smvar* range, points T and A are slowly changing their positions. At the moment when angle θ_i reaches the following value: $\theta_i = 2\pi + \gamma_i$, the system goes out of *smvar* range and enters the new *con* range. At this moment, the winding/unwinding radius $R_i = R_{i0} + 3 \cdot d/2$, the length lw_i, and angle γ_i have constant values, also. From this moment on, the

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system for smooth cable winding/unwinding on the winch enters the period when angle θ_i has values defined by: $2\pi+\gamma_i<\theta_i<3\pi+\gamma_i$. Fig. 11a) shows one example of the system during the new *con* range: position of the system for $\theta_i=3\pi$.

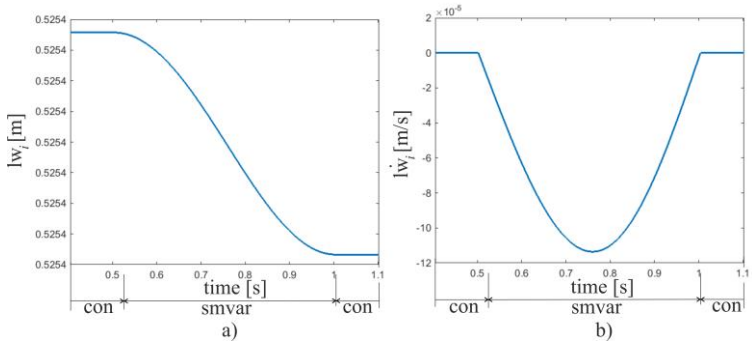

Fig. 9 a) Length lw_i and b) the first derivative of length lw_i over *smvar* range

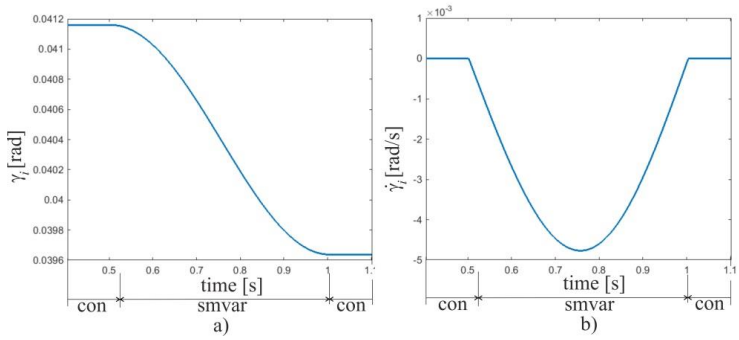

Fig. 10 a) Angle γ_i and b) the first derivative of angle γ_i over *smvar* range

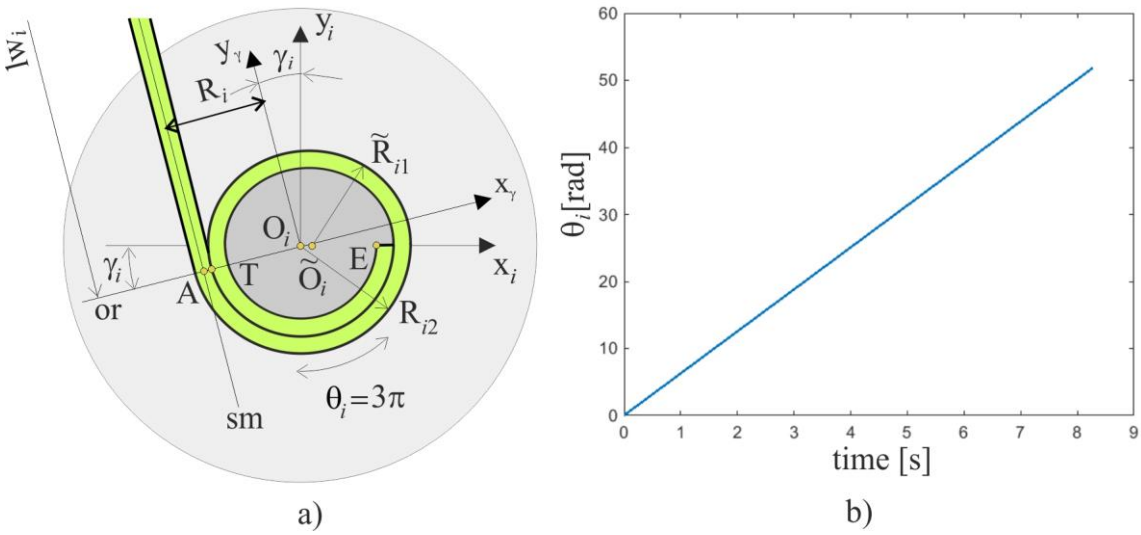

Fig. 11 a) Position of the system for $\theta_i=3\pi$ and b) Angle θ_i

Based on the process defined, it can be concluded that the smooth cable winding/unwinding process on the winch is accomplished by a cyclical alternation of the *con* and *smvar* ranges.

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A smooth trajectory of the winch is defined for the overall range of angle $\theta_i : 0 < \theta_i < 17\pi\, rad$. It is presumed that angular speed of this winch is constant. The program **SMOWIND – OW** is generated so that the motion takes place only in the direction of the cable winding on the winch. It is assumed that the cable unwinding takes place in the same way but in the opposite direction. The program package **SMOWIND – OW** presumes application of the two-cylinder winch (Fig. 2a)), but with small modifications this program package can be used for generation of the same results for the spiral winch (Fig. 2b)), if required. The cable winding process has been shown for the values of angle θ_i given by following inequality: $0 < \theta_i < 3\pi + \gamma_i$. See Fig. 11a).

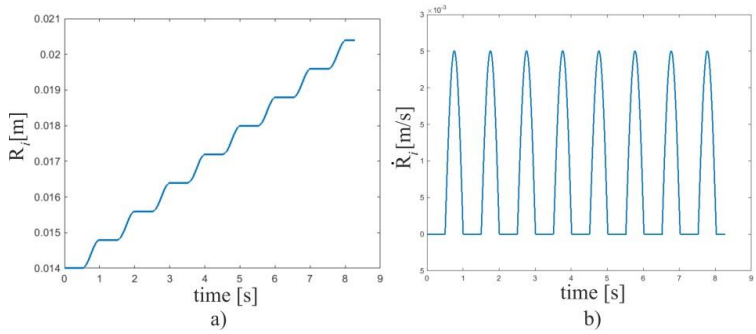

Fig. 12 a) Radius R_i, and b) The first derivative of radius R_i

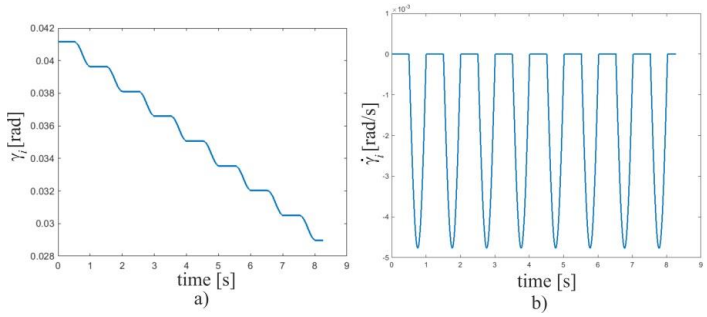

Fig. 13 a) Angle γ_i and b) The first derivative of angle γ_i

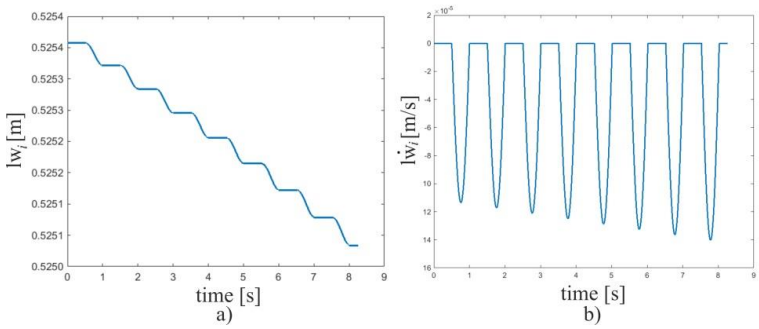

Fig. 14 a) Length lw_i and b) The first derivative of length lw_i

Based on this analysis, it is concluded that a smooth cable winding process involves cyclical alterations of *con* and *smvar* ranges. With a constant growth of angle θ_i, i.e. with a continuous cable winding, the previously defined principles of winding should be applied to achieve a smooth growth of radius R_i and a

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smooth decrease of the angle γ_i and length lw_i. By using the program package SMOWIND – OW, which was outlined, the simulation experiments for a linear full scale increase of angle θ_i, $0 < \theta_i < 17\pi$, have been generated. The change of angle θ_i is shown in Fig. 11b). From this figure it can be seen that this angle has a linear change, i.e. its first derivative is constant $\dot{\theta}_i = \text{const}$. During the winding period, a increasing of radius R_i (Fig. 12a)), decreasing of angle γ_i (Fig. 13a)), decreasing of length lw_i (Fig. 14a)), have cyclical character. It can be noticed that R_i, (γ_i, lw_i) have a constant and gradual growth (fall) in *smvar* ranges, while have a constant value during *con* ranges. Fig. 12b), Fig. 13b), Fig. 14b), shows the first derivative of variable R_i, γ_i, lw_i, respectively. From this figure, it can be seen that the first derivative of R_i, γ_i, lw_i, has a smooth and cyclical change with maximal value of $\dot{R}_{i\max} = 0.0025\text{m/s}$, $\dot{\gamma}_{i\max} = 0.0047\text{rad/s}$, $l\dot{w}_{i\max} = 1.4 \cdot 10^{-4}\text{m/s}$, respectively. Change of velocity of the cable movement is much smaller than change achieved with the standard winch from. This presents only one advantage of the novel winch in comparison with the standard winch. What is essentially important is that with the novel constructive solution of the winch abrupt changes of the cable length velocity have been avoided. It can be seen that first derivatives of all important variables $\dot{R}_i, l\dot{w}_i, \dot{\gamma}_i$ have small smooth changes and thus their effect on the whole system's dynamics is much better in terms of systems' dynamic response.

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[1] Ljubinko Kevac, Mirjana Filipović, and Aleksandar Rakic, "Dynamics of the process of the rope winding (unwinding) on the winch", Applied Mathematical Modelling 48, Elsevier, 2017, pp. 821-843, DOI: 10.1016/j.apm.2017.02.023.

[2] Mirjana Filipović, Ljubinko Kevac, "A new Winch Construction for Smooth Cable Winding/Unwinding", FACTA UNIVERSITATIS, Series: Mechanical Engineering, University of Niš, Vol. 15, No 3, 2017, pp. 367 – 381,DOI: 10.22190/FUME171002020F, ISSN: 0354-2025, COBISS.SR-ID 98732551, ZDB-ID: 2766459-4. UDC 531. https://doi.org/10.22190/FUME171002020F.

[3] Ljubino Kevac, Mirjana Filipović, Živko Stikić, Registered patent at the national level, Owner: Mihailo Pupin Institute, Čekrk sa profilisanim poprečnim presekom doboša za glatko jednoredno višeslojno namotavanje užeta, A winch with profiled drum section for smooth single rowed multilayered radial winding of the rope, IPC B66D 1/30; B66D 1/36, Application number П-2015/0598, Publication date of application (A1) 31 03 2017, number of gazette 3/2017, Registration number 57921, Number of decision to grant the right 2018/18117, date 21.12.2018. The Intellectual Property Office, Republic of Serbia, 2018.

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Subject: Opinion on meeting the criteria for recognition of the technical solution

According to the submitted material and in accordance with the provisions of The Rules of procedures and methods of evaluation and quantitative presentation of scientific research results of researchers, brought by the National Council for Scientific and Technological Development of Serbia ("Official Gazette of the Republic of Serbia", No. 38/2008) **reviewer: Prof. dr Ana Djuric, Wayne State University , 4855 Fourth St. Detroit, MI 48202, U.S.A.,** *has evaluated that conditions for the recognition of the properties of the technical solution are fulfilled for the following result:*

Title: **program system SMOWIND – OW,** (**SMO**oth **WIND**ing for **O**ne **W**inch), (*Projects:* Ambientally intelligent service robots of anthropomorphic characteristics, TR-35003 and "Dynamics of hybrid systems of complex structures" OI-174001*)*

Author: **Mirjana Filipovic, Ljubinko Kevac**

Category of technical solution: **M82** *„**A new technical solution (method) applied at the national level**", Program system***– Software.**

Explanation

Objective and significance: The new constructive solutions of winches for single-row radial multi-layered cable smooth winding/unwinding on a winch is defined and obtained theoretical contribution has been simulated and verified through software package **SMOWIND – OW**.

Proposed solution is done in: *2017.*

Area to which the technical solution refers is: *Robotics, Winding/unwinding, Winch, Kinematics, Dynamics.*

Problem that is being solved with this technical solution: *Technical solution came out as a result of analyzing the standard winch for single - row radial multilayered cable winding (unwinding). The analysis of the behavior of a circular winch intended for single-row radial multi-layer cable winding/unwinding system indicated that this system was far from ideal and contained a series of constructive problems. This simple construction of the winch has caused abrupt changes of important variables of this system: radius of cable winding/unwinding:* R_i*, cable length:* lw_i*, and inclination of the cable with respect to* y_i *axis: angle* γ_i*, but it should be emphasized that this problem is present in other systems form cable winding/unwinding, for example: cable winding/unwinding system for multi-row radial and axial cable winding/unwinding process. See [1].*

[1] Ljubinko Kevac, Mirjana Filipović, and Aleksandar Rakic, "Dynamics of the process of the rope winding (unwinding) on the winch", Applied Mathematical Modelling 48, Elsevier, 2017, pp. 821-843, DOI: 10.1016/j.apm.2017.02.023.

State of the problem solution in the world: *The behavior of a circular winch intended for single-row radial multi-layer cable winding/unwinding system is far from ideal and contained a series of constructive problems. This phenomenon was first analysed in detail in [1].*

Essence of technical solution. *The obtained variables which characterize the kinematics of the cable smooth winding/unwinding process on new constructive solutions of winches* [2], [3], *are nonlinear and smooth. This result is important because the systems for smooth cable winding/unwinding process on the winch could be parts of any cables driven mechanism.*

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Characteristics of the proposed technical solution are following: *Two new forms of winches for ensuring a single-row radial multi-layered cable smooth winding/unwinding have been constructed:*

a) is composed of two semicylindrical bodies of different radii: two-cylinder winch.
b) has a spiral shape: spiral winch.

Possibility of implementation of proposed technical solution: *Various complex mechatronic systems have cable (ropes as well) winding/unwinding systems as main sub-systems. There are a lot of these systems in different areas of science and engineering. Some of these systems are: measuring mechanism, machines in textile industry, cable logging systems in civil engineering and forestry, cranes, systems in shipping industry, CPR (Cable-suspended Parallel Robot) and other complex cable driven systems.*

On the basis of all above mentioned, the reviewer has concluded that the program system SMOWIND – OW includes the expert knowledge, the original scientific research contribution, and it is meeting the criteria for the recognition of the technical solutions.

Belgrade,
09.01.2019.

Reviewer:

Prof. dr Ana Djuric,
Wayne State University , 4855 Fourth St.
Detroit, MI 48202, U.S.A.

Subject: Opinion on meeting the criteria for recognition of the technical solution

According to the submitted material and in accordance with the provisions of The Rules of procedures and methods of evaluation and quantitative presentation of scientific research results of researchers, brought by the National Council for Scientific and Technological Development of Serbia ("Official Gazette of the Republic of Serbia", No. 38/2008) **reviewer: Dr Milovan Živanović, dipl.inž**, *Digital Control Systems Oziris, Kosmajska 32, 11450 Sopot, Belgrade, Serbia***,** *has evaluated that conditions for the recognition of the properties of the technical solution are fulfilled for the following result:*

Title: **program system SMOWIND – OW,** (**SMO**oth **WIND**ing for **O**ne **W**inch), (*Projects:* Ambientally intelligent service robots of anthropomorphic characteristics, TR-35003 and "Dynamics of hybrid systems of complex structures" OI-174001*)*

Author: **Mirjana Filipovic, Ljubinko Kevac**

Category of technical solution: **M82** *„**A new technical solution (method) applied at the national level**", Program system***– Software.***

Explanation

Objective and significance: The new constructive solutions of winches for single-row radial multi-layered cable smooth winding/unwinding on a winch is defined and obtained theoretical contribution has been simulated and verified through software package **SMOWIND – OW**.

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Area to which the technical solution refers is: *Robotics, Winding/unwinding, Winch, Kinematics, Dynamics.*

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On the basis of all above mentioned, the reviewer has concluded that the program system SMOWIND – OW includes the expert knowledge, the original scientific research contribution, and it is meeting the criteria for the recognition of the technical solutions.

Belgrade,
09.01.2019.

Reviewer:

Dr Milovan Živanović, dipl.inž,
Digital Control Systems Oziris, Kosmajska 32, 11450 Sopot,
Belgrade, Serbia

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DECLARATION

OF USING THE PROGRAM SYSTEM **SMOWIND – OW**

The program system: **SMOWIND – OW**, (**SMO**oth **WIND**ing for **O**ne **W**inch), *Projects:* "Ambientally intelligent service robots of anthropomorphic characteristics" TR-35003 and "Dynamics of hybrid systems of complex structures" OI-174001, whose authors are Mirjana Filipovic, Ph.D,El.Eng., and Ljubinko Kevac, Ph.D,El.Eng. presents a scientific and technical achievement in robotics which we, the below-signed, use in education and research purposes as well as during the realization of our theoretical and practical solutions. We, the below-signed, confirm that we have used the program system **SMOWIND – OW** since 2017.

15, January 2019.

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DIVISION OF ENGINEERING TECHNOLOGY
DATE 15.1.2019

DIVISION OF ENGINEERING TECHNOLOGY
WSU
APPROVED AND ENDORSED

ИНСТИТУТ МИХАЈЛО ПУПИН ДОО БЕОГРАД
Број: 3249/22 -18
23. јануар 2019. године
Б е о г р а д

На основу чл. 24. Статута Института „Михајло Пупин“ ДОО Београд – Пречишћен текст („Билтен“ бр.4/2016.), а у вези чл. 25. Закона о научноистраживачкој делатности („Сл. гласник РС“ бр. 110/2005, 50/2006-испр., 18/2010 и 112/2015) и Прилога 2 Правилника о поступку и начину вредновања и квантитативног исказивања научноистраживачких резултата истраживача („Сл. гласник РС“ бр. 24/2016, 21/2017 и 38/2017), Научно веће ИНСТИТУТА МИХАЈЛО ПУПИН ДОО БЕОГРАД доноси следећу:

О Д Л У К У

ПРИХВАТА СЕ **техничко решење под називом:** Program package **SMOWIND – OW**, (**SMO**oth **WIND**ing for **O**ne **W**inch).

Реализатор: authors.

Аутори: Mirjana Filipovic, Ljubinko Kevac.

Број аутора: **2**, Година када је комплетирано: **2017**, Пријављена категорија: **M82**, a new technical solution (method) applied at the national level, because it meets open source criteria (registered patent).

Техничко решење је рађено за: for scientific purposes, for the purpose of confirming scientific contributions.

Техничко решење користи: Wayne State University, 4855 Fourth St. Detroit, MI 48202, U.S.A. од: 2017.

Техничко решење је резултат рада на пројекту (ев.број):

- “Ambientally intelligent service robots of anthropomorphic characteristics” TR-35003,
- “Dynamics of hybrid systems of complex structures“ OI-174001.

Кратак опис решења:

This program system **SMOWIND – OW** was generated in MATLAB. New constructive solutions of winches for single-row radial multi-layered cable smooth winding/unwinding on a winch are described. Two new structural solutions of winches have been defined.

The nonlinear phenomenon of cable smooth winding/unwinding process on the winch by using one of the two proposed constructive solutions has been defined and analyzed. To facilitate understanding of this concept, the cable winding/unwinding process on only one winch has been analyzed. The obtained variables which characterize the kinematics of the cable smooth winding/unwinding process are nonlinear and smooth. This result is important because the systems for smooth cable winding/unwinding process on the winch could be parts of any cables driven mechanism. These systems can be used in various fields of human activity. For the verification of the presented theoretical contributions, a novel software package named **SMOWIND – OW** has been developed.

Рецензенти:

1. Prof. dr Ana Djuric, Wayne State University , 4855 Fourth St. Detroit, MI 48202, U.S.A.,
2. Dr Milovan Živanović, dipl.inž, Digital Control Systems Oziris, Kosmajska 32, 11450 Sopot, Belgrade, Serbia.

На основу позитивног мишљења два рецензента – експерта из области техничког решења, Научно веће је донело предметну одлуку и исту упућује надлежном Матичном научном одбору на Мишљење.

ИНСТИТУТ МИХАЈЛО ПУПИН ДОО БЕОГРАД
НАУЧНО ВЕЋЕ
П р е д с е д н и к

ИНСТИТУТ МИХАЈЛО ПУПИН БЕОГРАД

За

Проф. др Ђуро Кутлача*, дипл. инж.,*
Научни саветник

Достављено:

- ауторима
- Секретаријату Института