Original Research Paper

Geometry and Determining the Positions of a Plan Transporter Manipulator

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Abstract: The conveyor mechanism (working in a plan) to be presented in this study is a classic case of manipulating conveyor, simply with a single degree of mobility. It is a very common mechanism used in classical mechanics, being encountered at lifting platforms, at handicapped chairs, at cranes, forklifts, automatic machines and machines, or at older steam locomotives where it having the role of reversing the rotation-translation movement. Being a simple, common manipulator, he is also a good teaching example, much used in the student courses of mechanics, mechanisms, robotics-mechatronics. That is why we want to present in this study in a concise way the geometry and the kinematics of this mechanism. There will be a constructive and one kinematic scheme. The mechanism consists of a crank (a motor element 1), an RRR dyad composed of elements 2 and 3 and an RRT dyad formed by kinematic elements 4 and 5. The motor element 1 has a complete rotation (360 degrees) being the single driving feature of the entire mechanism. The element 3 is a bar that links the engine element 1 to the rocker element 2. From the rocker element 2, the movement is forwarded through the rod 4 to the final execution member 5, which is a slider (patina), having the role of oscillating linearly (it can also be a piston in a cylinder). The mechanism can also be used by changing the driving element to the driven one so as to become a motor mechanism with the leading element 5 and when the rotation element 1 to become a final driven element. Thus it can be used as a mechanism for producing the movement and transmitting it with the conversion from the rotation to translation movement. We intend to present this mechanism, in the present paper, when it functions as a manipulator, having the motor element 1 and the final element, the execution element, the patina 5. Special emphasis will be placed on the kinematics of the mechanism, studied on elements, but also on structural groups. Obviously there will be presented and some applications of the mechanism.

Keywords: Mechanism, Manipulator Plan, Transporter, Motor, Dyad, Geometry, Positions, Kinematics, Transporter Mechanism, Motor Mechanism, Robots, Mechatronics, Motor Element, Execution Element, Bar Element, Patina, RRR Dyad, RRT Dyad

Introduction

Robots and manipulators are now used in all industrial fields, instead of humans, taking heavy, repetitive, tedious operations into toxic, hazardous environments in heavy-duty industrial areas where there were dangers of manipulation of objects and people. Simple conveyors or manipulators have the role of moving an object from one place to another. It is then processed, processed, indiscriminately and ready for manufacturing and manufacturing. Between all the main operations, it is necessary that the piece in question be handled. Manipulating robots are generally used as simple as possible, the most common being the anthropomorphic. Very simple linear handling operations can be used but simplified manipulator robots. Such mechanisms have been used since ancient times in the mechanisms of steam locomotives, having the role of transforming the linear motion into a rotation or vice versa (Fig. 1).

In Fig. 2 shows the kinematic constructive schematic of a simple conveyor mechanism with various uses, such as transforming the rotation motion into a linear motion or vice versa, manipulating an object by sequentially moving it sequentially by means of an actuator or other positioning of the parts, sequencing some moves.

In the proposed study we will limit to a simple conveyor mechanism having the kinematic scheme given in Fig. 3. Only the geometry of the proposed conveyor mechanism and its kinematics will be studied in the present paper.

The conveyor mechanism (working in a plan) to be presented in this study is a classic case of manipulating conveyor, simply with a single degree of mobility. It is a very common mechanism used in classical mechanics, being encountered at lifting platforms, at handicapped chairs, at cranes, forklifts, automatic machines and machines, or at older steam locomotives where it having the role of reversing the rotation-translation movement.

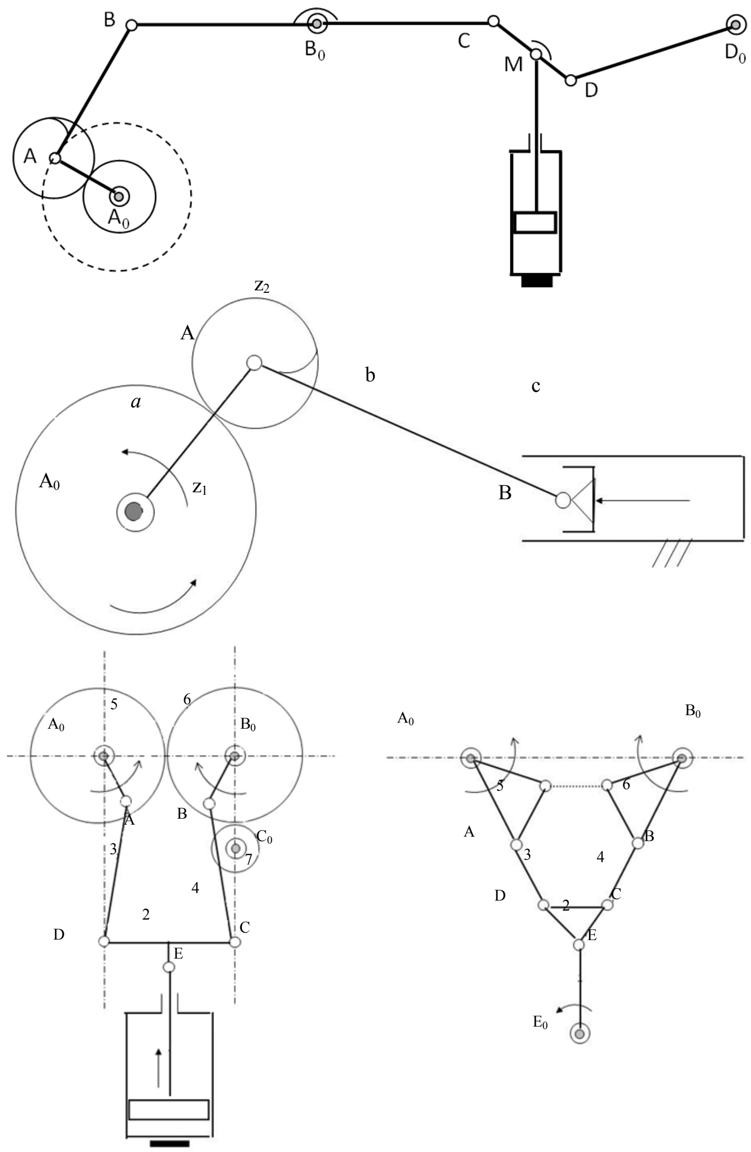

Fig. 1: Watt imagined a new mechanism, combining the crankshaft mechanism with a planetary gear with two gears

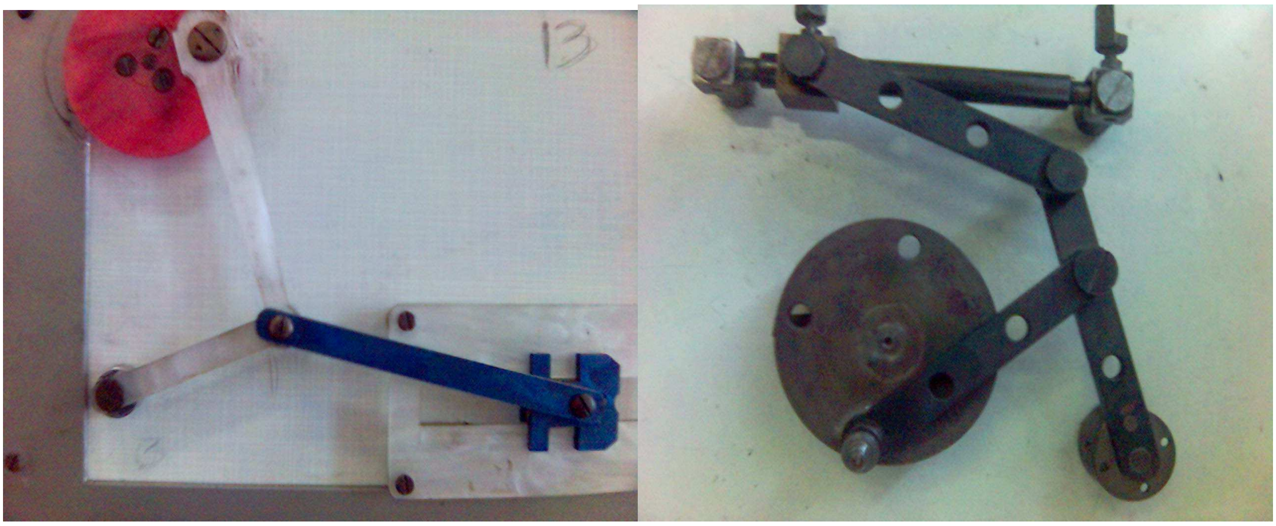

Fig. 2: The kinematic constructive schematic of a simple conveyor mechanism with various uses

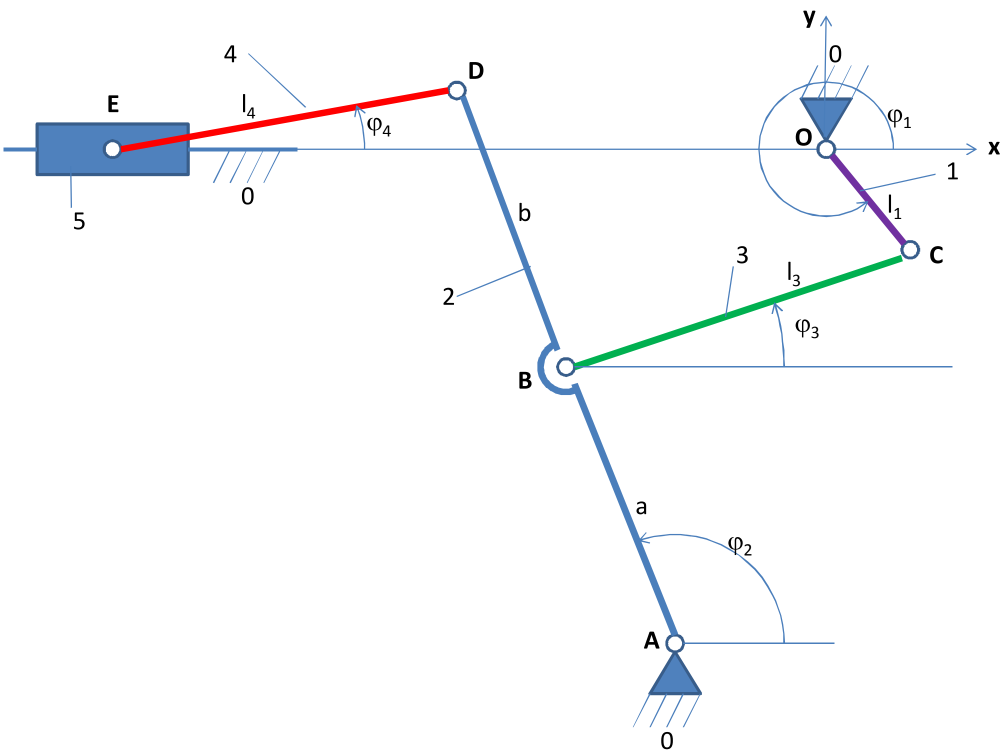

Fig. 3: The geometric-kinematic scheme of a planar manipulator

Materials and Methods

Being a simple, common manipulator, he is also a good teaching example, much used in the student courses of mechanics, mechanisms, robotics-mechatronics (Antonescu and Petrescu, 1985; 1989; Antonescu *et al.*, 1985a-b; 1986; 1987; 1988; 1994; 1997; 2000a; 2000b; 2001; Aversa *et al.*, 2017a-e; 2016a-o; Berto *et al.*, 2016a-d; Cao *et al.*, 2013; Dong *et al.*, 2013; Comanescu, 2010; Franklin, 1930; He *et al.*, 2013; Lee, 2013; Lin *et al.*, 2013; Liu *et al.*, 2013; Mirsayar *et al.*, 2017; Padula and Perdereau, 2013; Perumaal and Jawahar, 2013; Petrescu, 2011; 2015a-b; Petrescu and Petrescu, 1995a-b; 1997a-c; 2000a-b; 2002a-b; 2003; 2005a-e; 2011; 2012a-b; 2013a-b; 2016a-c; Petrescu *et al*., 2009; 2016; 2017a-l).

That is why we want to present in this study in a concise way the geometry and the kinematics of this mechanism. There will be a constructive and one kinematic scheme. The mechanism consists of a crank (a motor element 1), an RRR dyad composed of elements 2 and 3 and an RRT dyad formed by kinematic elements 4 and 5. The motor element 1 has a complete rotation (360 degrees) being the single driving feature of the entire mechanism.

The element 3 is a bar that links the engine element 1 to the rocker element 2. From the rocker element 2, the movement is forwarded through the rod 4 to the final execution member 5, which is a slider (patina), having the role of oscillating linearly (it can also be a piston in a cylinder).

The mechanism can also be used by changing the driving element to the driven one so as to become a motor mechanism with the leading element 5 and when the rotation element 1 to become a final driven element. Thus it can be used as a mechanism for producing the movement and transmitting it with the conversion from the rotation to translation movement. We intend to present this mechanism, in the present paper, when it functions as a manipulator, having the motor element 1 and the final element, the execution element, the patina 5. Special emphasis will be placed on the kinematics of the mechanism, studied on elements, but also on structural groups. Obviously there will be presented and some applications of the mechanism.

For the crank (element 1) of the mechanism the calculations are started with the relational system 1:

$$\begin{cases} x_C = x_O + l_1 \cdot \cos\phi_1 \\ y_C = y_O + l_1 \cdot \sin\phi_1 \end{cases} \tag{1}$$

Mechatronic Module 3R (RRR) calculations are performed with the system relationships 2 obtained from Fig. 4, corresponding to module 3R:

$$\begin{cases} e = x_C - x_A \\ f = y_C - y_A \\ l = \sqrt{e^2 + f^2} \\ \cos\phi = \dfrac{e}{l} \\ \sin\phi = \dfrac{f}{l} \\ \phi = \arccos(\cos\phi) \cdot sign(\sin\phi) \\ \cos A = \dfrac{l^2 + a^2 - l_3^2}{2a \cdot l} \\ \cos C = \dfrac{l^2 + l_3^2 - a^2}{2l \cdot l_3} \\ A = \arccos(\cos A) \\ C = \arccos(\cos C) \\ \phi_2 = \phi + A \\ \phi_3 = \phi - C \\ x_D = x_A + l_2 \cdot \cos\phi_2 \\ y_D = y_A + l_2 \cdot \sin\phi_2 \end{cases} \tag{2}$$

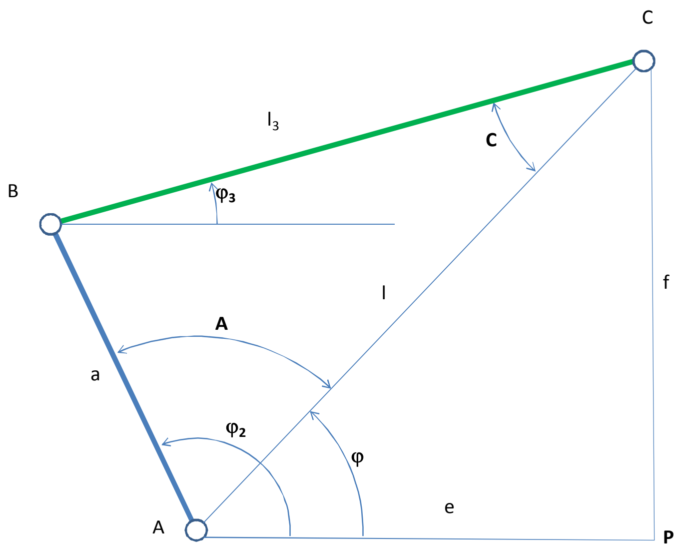

Fig. 4: Geometry and kinematics of 3R mechatronic module

Module 3R was also shown on other occasions, it being made up of two planar relative elements, joined by a flat rotation coupler, a C5 coupler (noted with B).

The module may still have two potential couplers, noted here with A and C.

We know the lengths of the two bars of the mechatronic module, denoted by l_3 and a, as well as the positions of the kinematic couplings C and A and the positional angles of the mechatronic module must be determined, Fi2 and Fi3.

All calculations are executed using the relationships in system 2.

Results

Follows the kinematic calculations for the RRT mechatronic module, having two rotation and one translational couplers (3).

$$\begin{cases} x_D = x_E + l_4 \cdot \cos\phi_4 \\ y_D = y_E + l_4 \cdot \sin\phi_4 \end{cases} \Rightarrow \begin{cases} x_D - x_E = l_4 \cdot \cos\phi_4 \\ y_D - y_E = l_4 \cdot \sin\phi_4 \end{cases}$$
$$(x_D - x_E)^2 + (y_D - y_E)^2 = l_4^2 \Rightarrow$$
$$\Rightarrow (x_D - x_E)^2 = l_4^2 - (y_D - y_E)^2 \Rightarrow x_E$$
$$\begin{cases} x_E = x_D - \sqrt{l_4^2 - (y_D - y_E)^2} \\ \cos\phi_4 = \dfrac{x_D - x_E}{l_4} \\ \sin\phi_4 = \dfrac{y_D - y_E}{l_4} \\ \phi_4 = \arccos(\cos\phi_4) \cdot semn(\sin\phi_4) \end{cases} \tag{3}$$

At the end, four results are tabulated: φ_2; φ_3; φ_4; x_E, calculated according to the input variable FI1.

Discussion

There will be a constructive and one kinematic scheme. The mechanism consists of a crank (a motor element 1), an RRR dyad composed of elements 2 and 3 and an RRT dyad formed by kinematic elements 4 and 5.

The motor element 1 has a complete rotation (360 degrees) being the single driving feature of the entire mechanism. The element 3 is a bar that links the engine element 1 to the rocker element 2. From the rocker element 2, the movement is forwarded through the rod 4 to the final execution member 5, which is a slider (patina), having the role of oscillating linearly (it can also be a piston in a cylinder).

Conclusion

The mechanism can also be used by changing the driving element to the driven one so as to become a motor mechanism with the leading element 5 and when the rotation element 1 to become a final driven element.

Thus it can be used as a mechanism for producing the movement and transmitting it with the conversion from the rotation to translation movement. We intend to present this mechanism, in the present paper, when it functions as a manipulator, having the motor element 1and the final element, the execution element, the patina 5.

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Author’s Contributions

This section should state the contributions made by each author in the preparation, development and publication of this manuscript.

Ethics

Authors should address any ethical issues that may arise after the publication of this manuscript.

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