16th International Research/Expert Conference
"Trends in the Development of Machinery and Associated Technology"
TMT 2012, Dubai, UAE, 10-12 September 2012

ALGORITHM FOR MECHANISMS DESIGN AND ITS APPLICATION AT COPIER-BLADE MECHANISM USING DUAL-VECTOR ALGEBRA IN TOPOLOGICAL SYNTHESIS

Dr. Sc. Kastriot A. Buza
Faculty of Education
Address: Agim Ramadani, nn 10000 Prishtina
Kosova

Dr.Sc.Ismajl Gojani, Dr.Sc.Arbnor Pajaziti, Dr.Sc.Fevzi Radoniqi
Faculty of Mechanical Engineering
Address: Kodra e Diellit, nn 10000 Prishtina
Kosova

ABSTRACT
The methodology of mechanisms design takes into consideration motion specifics, functional, topological and dimensional synthesis.
The algorithm presents the methodology for mechanism design using basic kinematics building blocks. In this paper the application of mechanisms design methodology for copier-blade mechanism is analysed using dual-vector algebra.
Copier-blade mechanism is combination of Cylindrical Cam-Follower and Six-Bar Dwell Linkage, transforming rotational motion at input to the translation at output. This mechanism was design selecting the basic kinematic building blocks from database, using the Motion Characteristic Code (MCC) for functional synthesis is uses and the dual-vector algebra for topological synthesis.
Key words: Algorithm, Basic Kinematics Building Blocks, Copier-Blade Mechanism, Dual –Vector Algebra.

1. INTRODUCTION
Mechanism design can be realised using several methodologies [1,2,9,10,11].
The methodology the algorithm that presents the mechanisms design using Basic Kinematics Blocks goes through four basic phases: (a) Motion Specifics, (b) Functional Synthesis, (c) Topological Synthesis and (d) Dimensional Synthesis [1,2]. In the motion specifics and functional synthesis the Motion Characteristic Code is taken into consideration, while at topological synthesis the methodology of dual-vector algebra is used [1].

2. METODOLOGY OF DUAL - VECTOR ALGEBRA
It is known that motion of any solid body in three-dimensional space can be represented through screw kinematic couples [1,4].
Screw can be defined by displacement and line. Line contains the information about position and direction of the motion. Displacement represents the transformation between rotational and translational motion. The motion transformation can be divided into a dual-number and dual-vector [1, 4, 7].
The final expression for screw motion for basic kinematics block is given as:

$$\hat{S} = (\alpha + \varepsilon a)\left[\begin{Bmatrix} l_x \\ l_y \\ l_z \end{Bmatrix} + \varepsilon \begin{Bmatrix} r_y l_z - r_z l_y \\ r_z l_x - r_x l_z \\ r_x l_y - r_y l_x \end{Bmatrix}\right] \qquad (1)$$

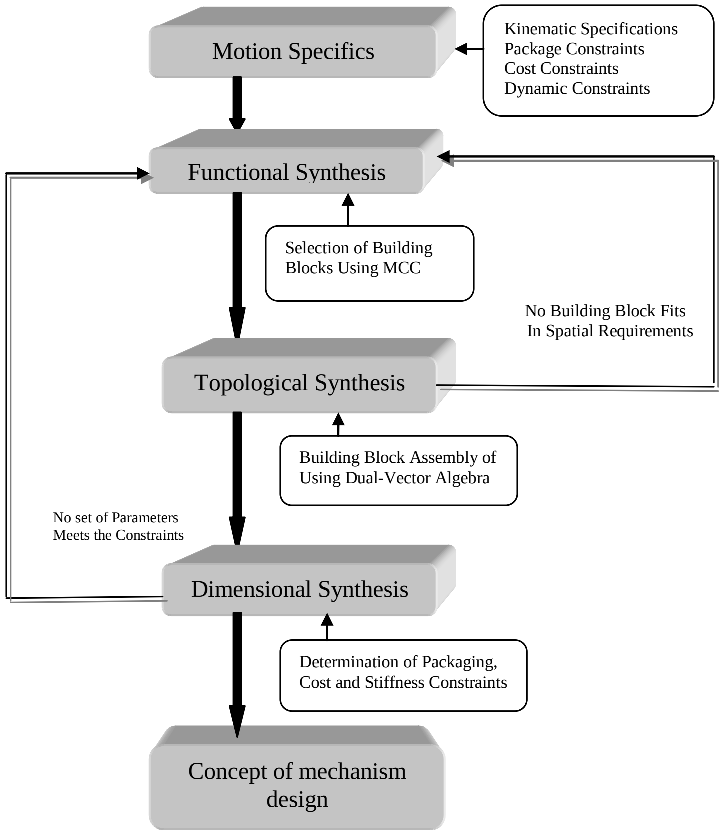

Figure 1. Algorithm for mechanism design

3. METODOLOGY OF MOTION CHARACTERISTIC CODE (MCC)

Some authors, the motion in input and output of the kinematics block have used Motion Transformation Matrices of First Level (MTL[1]) and Operational Constraint Vector (OCV) [2, 3, 6, 9]. Similarly, in this paper Motion Characteristic Code (MCC) including data is used to determine the type of motion, continuity, linearity and direction of building blocks [1].
Motion Characteristic Code from can be described by:

$$MCC = (MotionType, Continuity, Linearity, Direction) \qquad (2)$$

Kinematics function for each building block is presented correctly through two Motion Characteristic Codes: the first one represents characteristics of input motion and the second one characteristics at output.

4. MOTION CHARACTERISTIC CODE (MCC), SCREW MOTION AND SPATIAL PRESENTATION FOR BLADE-COPIER MECHANISM

Based on methodology for mechanisms design, fig.1, the algorithm for building the model of Multi-Linkage Blade-Copier Mechanism and Mechanism for Supply/Feeding with wire, fig.4 has been created.

For Blade-Copier Mechanism, analyzing all possible combinations functionally and constructively based on original mechanism fig.2, it was concluded that Mechanism with Cylindrical Cam-Follower and Six-Bar Dwell Linkage Mechanism fulfills the criteria, fig.3 [1,4,5,6,7].

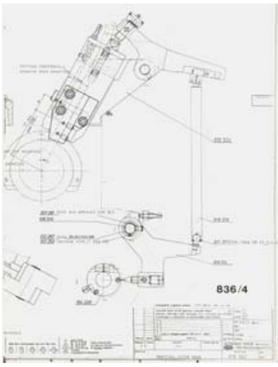

Figure 2. Lathe with copier-blade mechanism

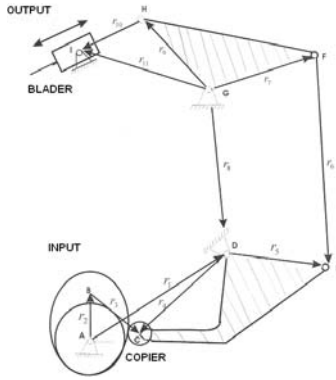

Figure 3. Vector loop for alternate multi linkage copier-blade mechanism

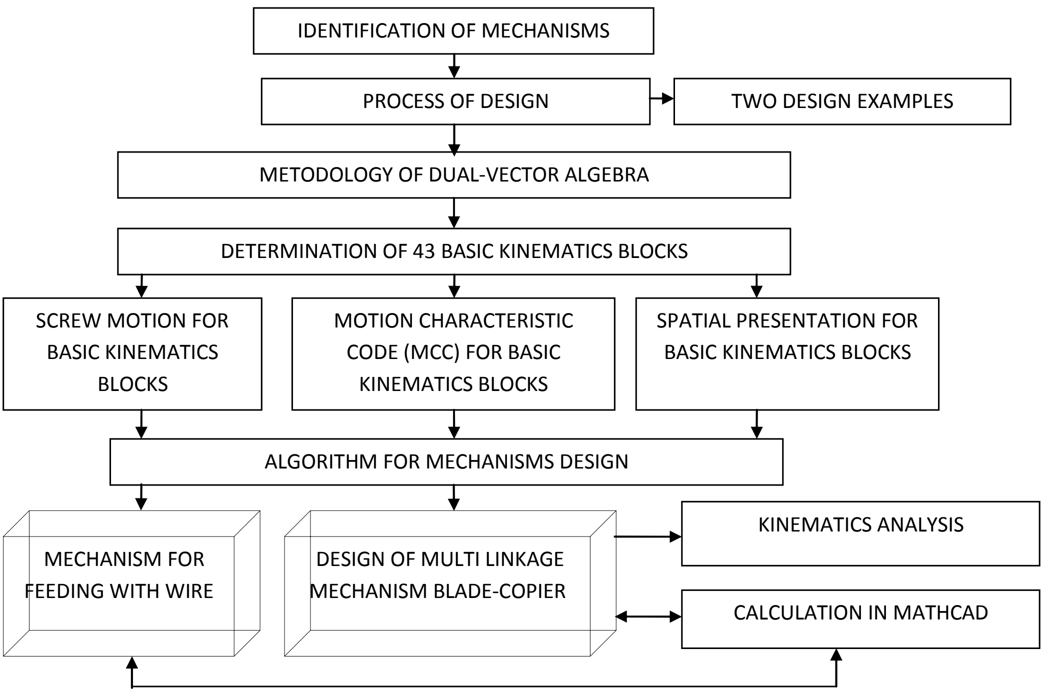

Fig. 4. Algorithm applied on Copier-Blade Mechanism design

5. CONCLUSIONS

Based on methodology for mechanisms design, the algorithm that uses Specific Motion, Functional Synthesis, Topological Synthesis and Dimensional Synthesis and was applied in this study case includes following phases:

- Building algorithm for Blade-Copier Mechanism;
- Topological Synthesis using Dual-Vector Algebra;
- Functional Synthesis using Motion Characteristic Code methodology;
- Spatial Presentation for 43 basic kinematic blocks and
- Design of different types of couples of mechanisms.

6. REFERENCES

[1] Buza K.: Kontribut sintezës së mekanizmave duke shfrytëzuar algjebrën e vektorit-dual, Disertacioni i doktoraturës (Doctorate thesis), Prishtina, 2006.

[2] Buza K.: Disajnimi automatik i mekanizmave me ndihmen e programeve aplikative, Punim magjistrature (Master work), Prishtina, 2003.

[3] Buza K., Pirraj B., Gojani I., Pajaziti A., Anxhaku A.: General Matrix Model at the Second Level of Automatic Synthesis Procedre of the Mechanisms, Proceedings of the 10th International Research/Expert Conference "Trends in the Development of Machinery and Associated Technology", TMT 2006, Barcelona –Lloret de Mar, Spain, 11-15 September, 2006, pp. 785-788.

[4] Buza K., Gojani I., Pajaziti A., Anxhaku A.: Screw Motion of Some Basic Kinematic Blocks Through Dual-Vector Algebra, Proceedings of the 11th International Research/Expert Conference "Trends in the Development of Machinery and Associated Technology", TMT 2007, Hammamet, Tunisia, 5-9 September, 2007, pp. 891-894.

[5] Buza K., Gojani I., Pajaziti A., Anxhaku A.: Motion Characteristic Code at the Screw Motion for Some Basic Kinematics Blocks Using Dual-Vector Algebra, Proceedings of the 12th International Research/Expert Conference "Trends in the Development of Machinery and Associated Technology", TMT 2008, Istambul, Turkey, 26-30 August, 2008, pp. 1005-1008.

[6] Buza K., Gojani I., Pajaziti A., Buza Sh., Anxhaku A.: Comparison of First Level Motion Transformation Matrix and Operational Constraint Vector with Motion Characteristic Code at the Mechanisms Design, Proceedings of the 13th International Research/Expert Conference "Trends in the Development of Machinery and Associated Technology", TMT 2009, Hammamet, Tunisia, 16-21 October, 2009, pp. 601-604.

[7] Buza K., Buza Sh., Gojani I., Pajaziti A., Radoniqi F.: Design of Lathe-Blade Mechanism with Basic Kinematics Blocks Using Methodology of Dual-Vector Algebra, Proceedings of the 14th International Research/Expert Conference "Trends in the Development of Machinery and Associated Technology", TMT 2010, Mediterranean Cruise, 10-19 September, 2010, pp. 449-452.

[8] Buza K., Gojani I., Pajaziti A., Radoniqi F.: The Motion Characteristic Code, Screw Motion and Spatial Presentation of Five Combinations of Motions for Basic Kinematics Blocks at the Mechanism Design, Proceedings of the 15th International Research/Expert Conference "Trends in the Development of Machinery and Associated Technology", TMT 2012, Prague, Czech Republic, 12-18 September, 2011, pp. 621-624.

[9] Moon Y.-M., Kota S.: Automated synthesis of mechanisms using dual-vector algebra, Mechanism and Machine Theory 37, pp.143-166, Ann Arbor, 2002

[10] Y.-M.Moon, Reconfigurable Machine Tool Design: Theory and Application, Ph.D. Dissertation, The University of Michigan, Ann Arbor, Michigan, 2000.

[11] Waldron K. J., Kinzel G. L.: Kinematics, Dynamics and Design of Machinery, Second Edition, John Wiley and Sons, USA, 2004.