ANNALS OF THE ORADEA UNIVERSITY
Fascicle of Management and Technological Engineering
ISSUE #1, MAY 2013, http://www.imtuoradea.ro/auo.fmte/

DESIGN OF CLEANING ROBOT SYSTEM TO EXTERNAL GLASS WALLS OF BUILDINGS

Assist. Prof. Eng.Dănuţ Pavel TOCUŢ, PhD[1]

[1]University of Oradea, Faculty of Management and Technological Engineering, Mechatronic Department, Romania
e-mail: tocutpd@yahoo.com

Abstract — The paper is based on the previous author research with the aim of research and implementation in services fields of washing-cleaning or periodical inspection of operational robots systems, used at exterior frontage of buildings that are realized from modular glass panels. The climbing constructive variant of robot is designated at service fields of robots, which are more used in cleaning-washing services of frontage buildings with glass walls. The system is composed from mechanical system with light structure, power system formed by pneumatic-vacuum system, and command-moving in conformity with predictable software.

Keywords— Climbing vacuum robot system, Cleaning-washing services, Inspection of external glass frontage of buildings

I. INTRODUCTION

THE continuous development of dynamic economy recorded in Romania in last time, it has allowed the construction, modernized and extension of many company headquarters and offices from the big cities. The modern architecture of frontage buildings of offices with many levels is made from glass walls. The periodical cleaning-washing of them were got the implementation of new robotic services to obtain these operations.

The author of this paper proposed himself the design of constructive variant of climbing vacuum robotic system destined to service field of smart building area. The beginner step was the design of 3D model of cleaning robotic system, presented in next. The smart buildings incorporate multiple robotic systems with the aim to realize of periodically services of cleaning and washing of glass windows of buildings, endowed with maxim of 30 levels. In general, these buildings are stipulated with a plan terrace at last level since design phase, where the operator can position the climbing vacuum robot system in safety conditions to work [1]-[10]

The modern buildings are endowed with external walls from glass and a diversity design in accordance with the project them and specific architectural complex of that buildings zone.

At the base of this project of vacuum climbing robot system, the author took in consideration the followings functionally and constructive particularities, as:

- The cleaning robot system design must to realize a good adherence at vertical glass of wall surface on which it will be action.
- The vacuum system that assured the adherence must to exert a low pressure on glass wall surface on which is moving to avoid the windows breakages.
- The vacuum climbing system to realize a uniform vacuum and un-vacuum of the fixing suckers in concordance with a well-established working program to do the move cleaning-washing cycle.
- The size of robot system will be design in such away to allow the access on entirely cleaning surface of buildings windows.

The cleaning robot system is endowed with a video cam to assure supplementary tasks, which it located in frontal way of robot moving.

In addition, to avoid the accidental detachments of robot on the glass wall surface is attached a safety system that is formed by a supporter cable type Cordelier, watching to realize a supple structure of system made from light modular components. An important aspect at design of cleaning robot system consists in assuring on all working time a moving in closed circuit system of cleaning fluid thus to stipulate with more filter elements of cleaning solution since design phase. So, the system are realized a concomitant economy of fluid by re-moving. The filter system recycled the cleaning fluid from impurities particles in conformity with Normative or Laws of Medium Protection [8]-[17].

In Fig. 1 is presented a picture with modern building frontage that included the external modular glass windows, which are cleaned, washed or periodically inspected with the helping of robot systems services that assure specific operations.

Fig. 1. The architectural example of frontage building with glass windows

An important aspect at design of climbing vacuum robotic system represents the cleaning-washing system, composed from a brash of gorsier cleaning of daft particles, following of the washing phase that is realized with a rectangular sponge in *I* shape.

The washing system has a constructive particularity that are not allow of cleaning used fluid to pray the fluid outside of working area as vertical moving way of robot from up to down sense.

For realizing of cleaning-washing cycle it was established a clear direction of robot moving on the surface of vertical glass wall of building from up to down way by using a predictable program.

II. 3D MODELING OF VACUUM ROBOT FOR CLEANING OF WINDOWS

At design of 3D model was used SolidWorks which allows the users to define and organize multiple structures of assembly [16]-[17]. The assembly design became an excellent productive medium for design and drawing of parts that assured for user multiple advantages, as:

- Generation of mounting structures into a productive mode,
- Design for mounting,
- An attitude from up to down (from assemble to part) and from down to up (from part to assemble) of assembly design,
- Advanced modes of parts location into the assemble with or not constraints,
- Dynamic location of parts in the mounting process,
- Presents an editor for assembly structure that offers a intuitive and efficient structure during of altering of parts drawings,
- Dynamic analysis of assembles definitions, inclusive collision detecting of parts and analysis functions of fits.
- Allows automatic watching of assemble decomposed in parts and generation of materials list in conformity with requirements of beneficiary,
- Direct access at catalog of parts and standard assembles.

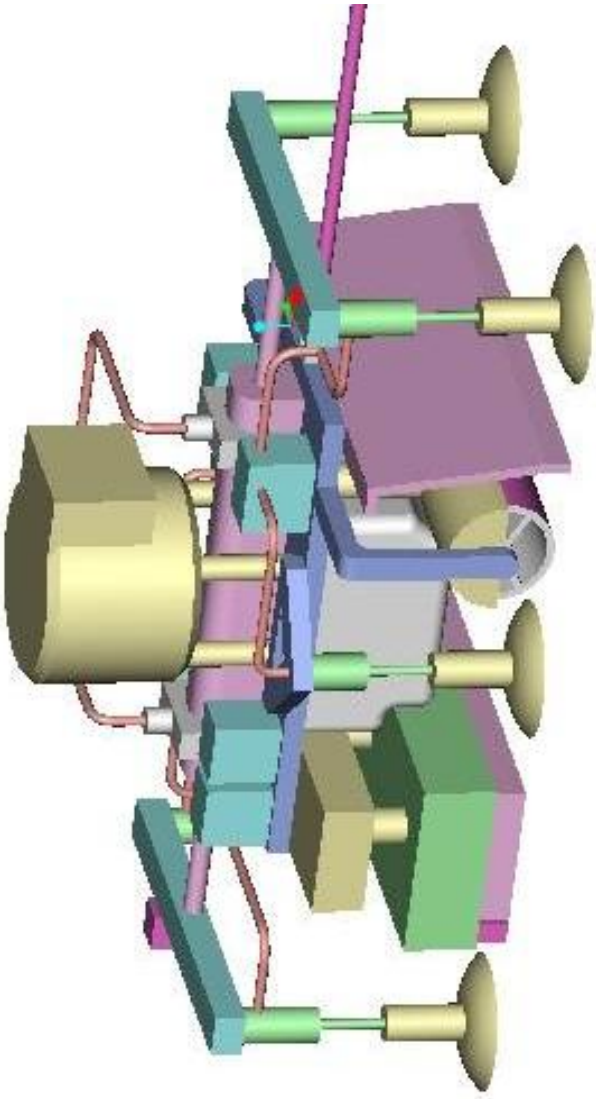

Fig. 2. 3D model of the vacuum robot-Isometric view

3D and 2D design was made on previous particularities presented in first part of paper, which is a constructive variant of climbing vacuum robot used for cleaning of glass windows of frontage buildings. 3D model of climbing vacuum robot assemble, presented in paper, are presented in Fig.2 and Fig.3. These isometric views can be shown the architecture of mechanical robot system and the cleaning-washing system, and vacuum system of moving respectively.

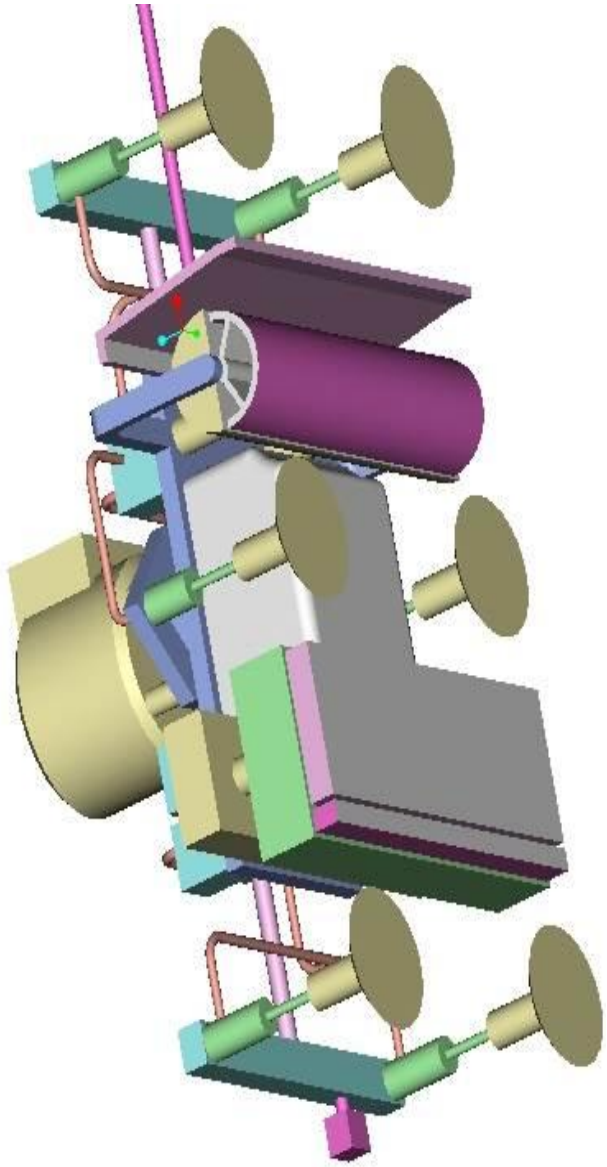

Fig .3. 3D model of vacuum model-Isometric view

III. 2D MODELING OF VACUUM ROBOT ASSEMBLE AND ITS COMPONENTS ELEMENTS

2D model of vacuum robotic assembly system for washing-cleaning and inspection, used in services robot fields was designed in special for periodically cleaning frontage of glass walls of buildings.

2D model from A-A section of robot system presented in paper can be seeing in Fig. 4.

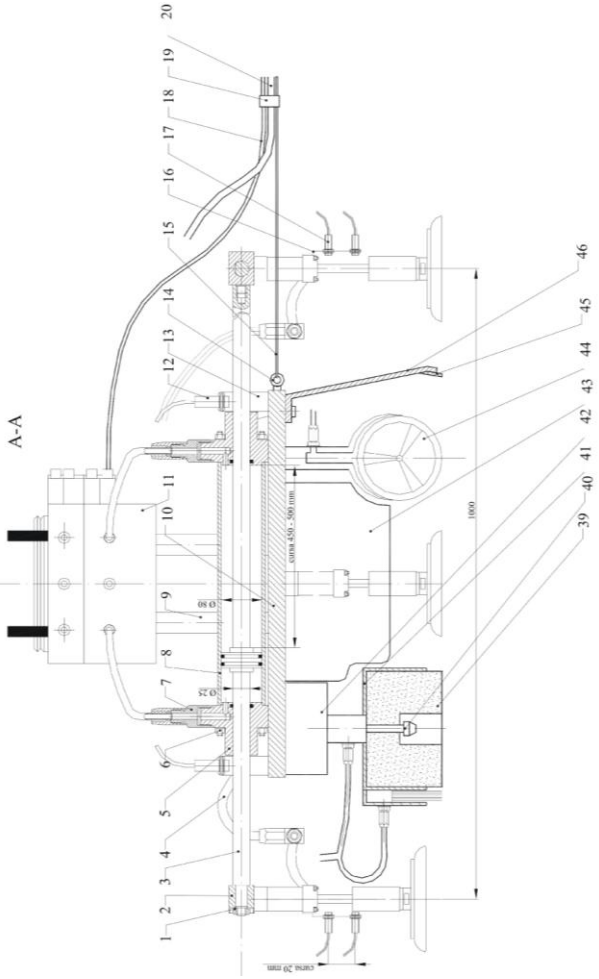

Fig. 4. 2D model of vacuum robot: A-A section

In Fig. 5 is presented 2D model of robot system, where from upside view can be observed the constructive elements of robot structure.

2D model of robot assembly system from Fig.4-5 are the followings parts, as:

(1)- Nut M16; (2)-Support; (3)-Piston; (4)-Hose; (5)-Cover; (6)-Nuts M8; (7)-Connection; (8)-Pneumatic cylinder with double action with rods at both ends; (9)-Support for instruments; (10)-Support plate from aluminium, (11)-Sensor; (12)-Senzor support; (13)-Safety ring; (14)- Supporter cable type Cordelier; (15)-Sensor support; (16)-Sensor II; (17)-Conductor electrical cable; (18)-Hose; (19)-Ring; (20)-Hose; (21)-Cylinder cover I; (22)-Inlet nut; (23)-Cylinder I; (24)-Cover; (25)-Cover II; (26)-Piston; (27)-Leg; (28)-Sucker support; (29)-Sucker; (30)-Hose I; (31)-Hose II; (32)-Connection; (33)-Hose III; (34)-Hose IV; (35)-Plate of distribution; (36)-Screw M16; (37)-Nuts M16; (38)-Sheave; (39)-Washing system type brush and sponge; (40)-Sprayer; (41)-Sponge frame; (42)-Vibrating; (43)-Fluid tank; (44)-Cleaning drum of aspiration fluid; (45)- Fixing lamella; (46) Lamella support; (47)-Hose V; (48)-

Spraying pump; (49)- Aspiration pump; (50)-Inspection pump formed by video cam.

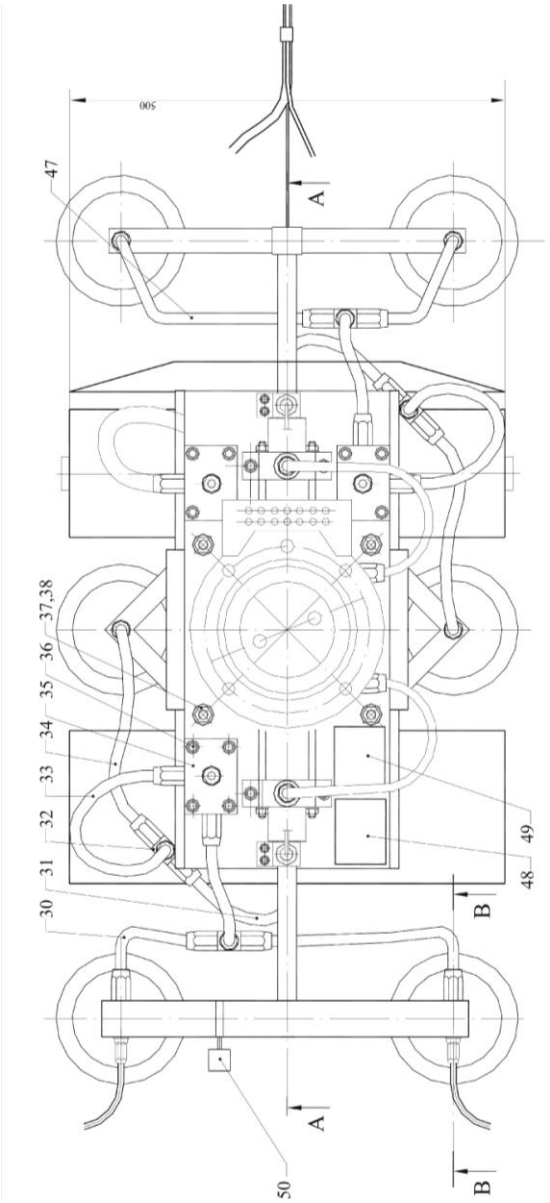

Fig. 5. 2D model of vacuum robot-Upside View

The external size of climbing vacuum robot designed was selected in function of windows' sizes of frontage glass walls, with more using of 500 mm x 1200 mm x 500 mm.

The adhesion by climbing of robot on the vertical surface of glass wall's building to assure the cleaning from washing is realized progressive action of 6 suckers that interfere by flexible pipes of vacuum robot system.

The leading and control of robot at long distance is realized by a predictable program and a PC operator. The cleaning robot used is composed from 2 sponges, brush and brush-I, and drying, and aspiration drum respectively, on which is wrapped the brush-II, located between mobile sidewise suckers.

V CONCLUSION

The construction and maintenance of smart buildings with architecture of frontages from glass walls attract the services of washing-cleaning and periodically inspection of them. Handling cleaning of these frontages' buildings supposed high costs as cleaning handling conditions which are difficult and dangers.

The constructive variant of climbing vacuum robot from services fields as cleaning robotic operations of frontages of external glass walls, presented in this paper, has the aim to substitute the human operator from hard, danger and risk's workings.

This vacuum robot presented makes possible the robotized operations of washing-cleaning, verifying, the range of services which can be made by it can be extended when needed.

REFERENCES

[1] Demian, T., *Micromotoare pneumatice liniare şi rotative*. Editura Tehnică Bucureşti 1984.
[2] Maniu, I., "Calculul şi caracteristicile ventuzelor pneumatice". *COMEFIM-5* Partea a II a Timişoara 1998.
[3] Stareţu, I., *Sisteme de prehensiune*. Editura Lux Libris Braşov 1996
[4] Tocuţ, P D, *Dispozitive de prehensiune vacuumatice. Optimizare constructiv - funcţională*. Ed. Univ. din Oradea, 2008
[5] Tocuţ, P. D., Pop, A., Ţarcă, R. C. *Functional model and simulation of pneumatic model, afferent to prehension vacuum device*. 11th International Research/Expert Conference "Trends in the.Development of Machinery and Associated Technology" TMT 2007, Hammamet, Tunisia, 5-9 September, 2007.
[6] Ţarcă, R.C., *Roboţi de servicii*. Editura Universităţii din Oradea, 2004.
[7] ***Catalog FESTO – Automation with pneumatics, 2011.
[8] ***Catalog SCHUNK INTEC Carolina USA
[9] ***Catalog ATI Industrial Automation
[10] ***Catalog W.G.S. Grip System.
[11] http://www.techno-sommer.com vacuum components
[12] http://www.agi.-automation.com
[13] http://www.fipa-online.com
[14] http://www.WGSGreifersysteme.com
[15] http://www.WindowcleanerforSkyscrapers
[16] Book of SolidWorks2011 Software, 2011.
[17] Book of AutoCAD 2011 Software, 2011.