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ASSEMBLY LINES USING PNEUMATICALLY- DRIVEN MANIPULATORS

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Abstract: Automatic assembly lines hold a highly important place in modern goods manufacturing. The present paper focuses on a widely-used sub-category of these lines, namely assembly lines using pneumatically-driven manipulators.

1. Automatic assembly lines

Automatic assembly lines hold a highly important place in modern goods manufacturing. The present paper focuses on a widely-used sub-category of these lines, namely assembly lines using pneumatically-driven manipulators (Fig. 1).

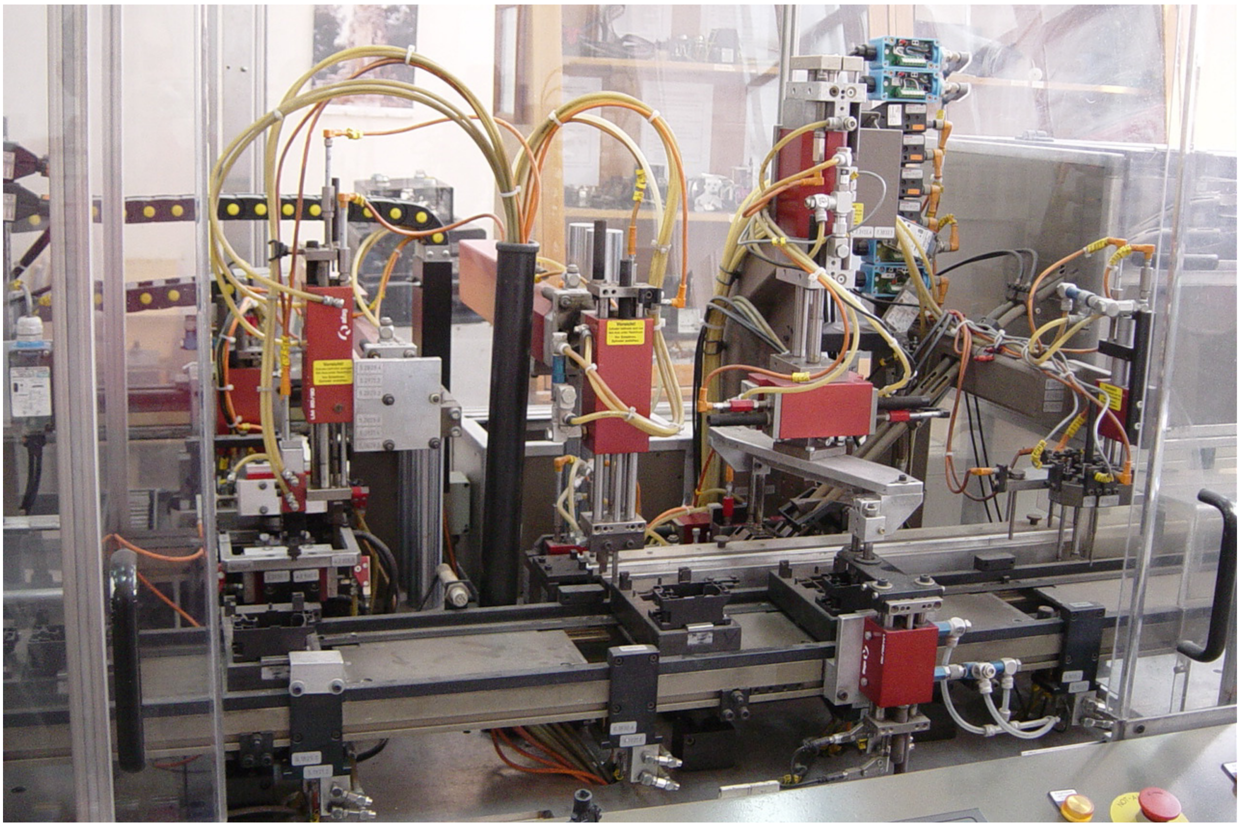

Fig. 1: Assembly line using pneumatically-driven manipulators

Here are the main features of these lines:

- use of manipulators instead of industrial robots;
- use of pneumatic drive (generating higher speeds than other types of drives, but allowing a more reduced control);
- two types of automation systems: rigid automation, based on intermediate relays, or flexible automation, based on programmable automata;

- control of the START-STOP stroke, without any possibility to adjust the speed during its action (adjustment can be done only off-line, using chokes);
- control of the stroke length using stroke stops or proximity sensors.

As a conclusion, these types of assembly lines are mainly used in complex assembly operations, and are cost-effective when it comes to their manufacturing.

2. Automatic-assembly line manufacturing

The manufacturing of the above-mentioned automatic assembly lines involves several stages:

- decomposing the assembly operations into sequences (motion cycles) and setting the number of assembly modules (manipulators) to be used (fig. 2);

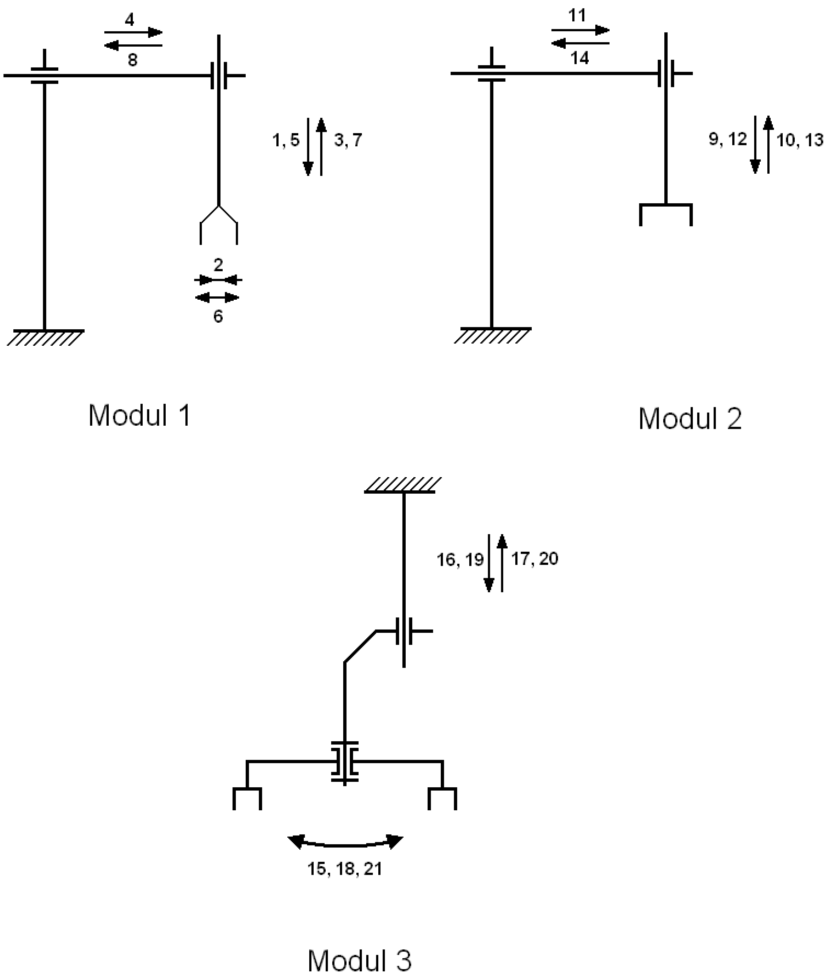

Fig. 2: Decomposing the assembly operations into motion cycles and setting the number of modules required for the line presented in Fig.1

- automatic-assembly line 3D-modeling, using a modeling software (Solid Edge, SolidWorks, etc.), Fig. 3;
- performing motion simulations, and calculating motion geometry and kinematics (stroke length, areas and working envelope, speed, acceleration, etc.), Fig. 3;

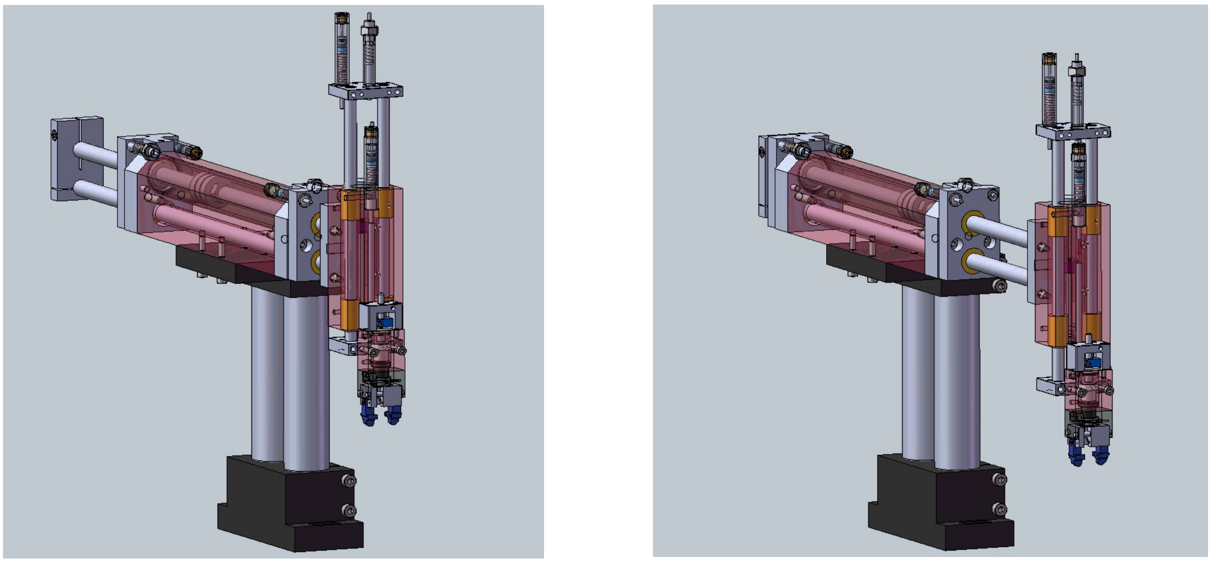

Fig. 3: Frames extracted from Avi file for the motion simulation and geometric-kinematic analysis

- automation system designing and manufacturing;
- generating technical drawings and blueprints for the production of assembly line parts.

3. Shortcomings of the motion simulation and analysis

The combined process of motion simulation and analysis presents several shortcomings, among which we can mention the following:

- the motion analysis is based on a geometric model, which is many times, different from the assembly itself;
- the stroke lengths of the pneumatic modules used for analysis are similar to the standard technical specifications of pneumatic modules, taken individually. The serial assembly of these modules may determine the modification of these values, due to constructive and assembly reasons. Moreover, after a certain operation time, these values may change even more, due to clearances, impurities, etc.
- the speeds considered for simulation have nominal values, while their real values can be different, due to adjustments during the line assembly / functioning.

4. Current approach and objectives of image processing

Calculating an automatic assembly line stroke length, area, working envelope, and real speeds requires nowadays the line shut-down and the use of some complex measurement devices.

The current approach aims at using image processing to determine the above-mentioned data, at low costs and with high measurement precision. Thus, a digital camera will be used to acquire the needed images, which will be subsequently processed using original Matlab-programs made by the author.

4.1. Stroke length measurement

The following methodology will be used to mesure the stroke length:

- images will be acquired using a digital camera;

- a standard reference distance will be marked on the image file (*e.g.* 5 mm for the example presented in Fig.4);
- a Matlab-program will be created, allowing the interactive graphic selection, first of the reference distance, and then of the other distances presented in the picture. The program will enable to visualize and measure the distances between the interactively selected points (Fig. 5).
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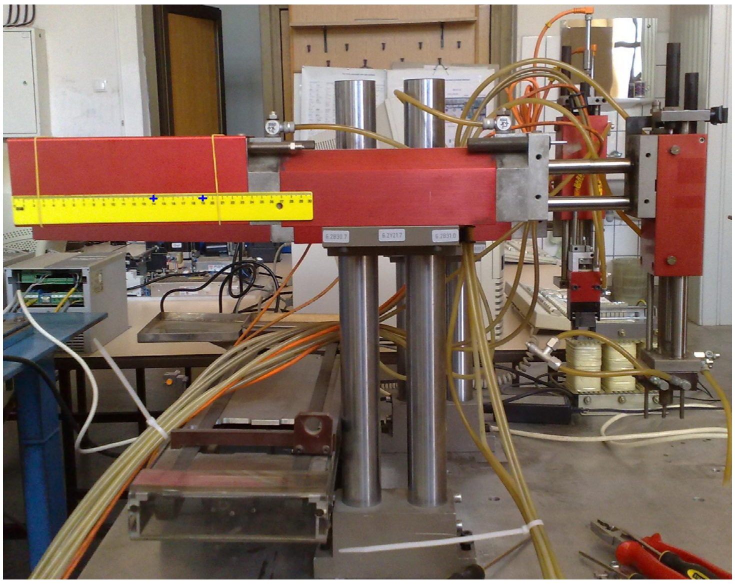

Fig. 4: Image used to mark the reference standard

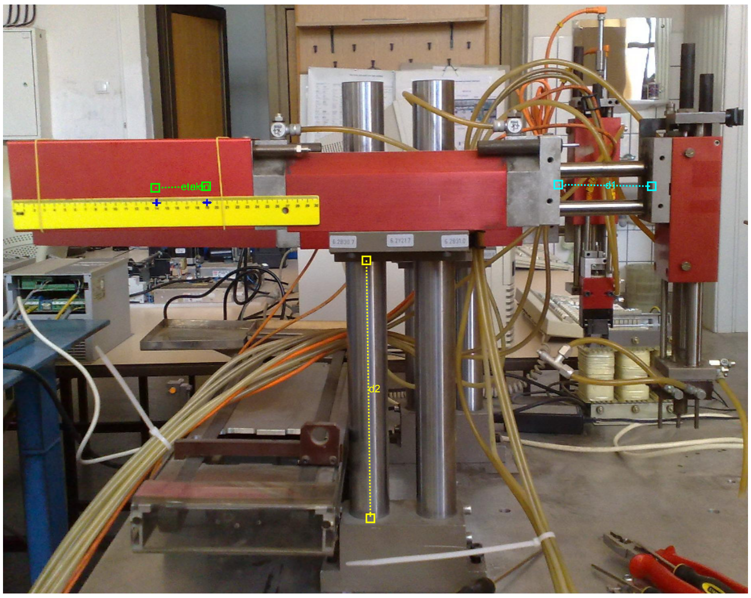

Fig. 5: Visualization of reference standard and of two selected dimensions

4.2. Area measurement

The following methodology will be used to mesure areas:

- images will be acquired using a digital camera;
- a Matlab-program will be created, allowing the interactive graphic selection of points from a closed outline, and then calculation of the area limited by this closed outline (Fig. 6).

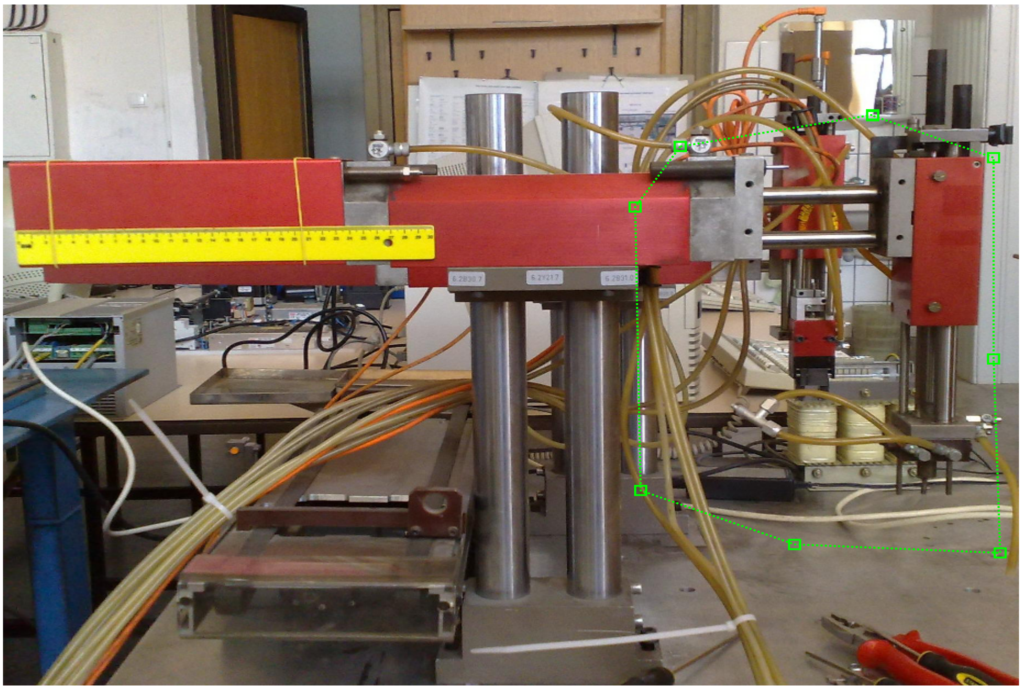

Fig. 6: Interactive selection of points from a closed outline

4.3. Kinematic analysis

The following methodology will be used to perform a kinematic analysis:

- an Avi-format video file will be acquired using a digital camera;
- a Matlab-program will be created allowing the video decomposition into frames;
- the speed of the manipulator mobile parts will be determined by correlating the frame speed with the analysis of the successive positions of some reference points marked on the manipulator.

5. Conclusions

The research made at this point has enabled:

- the geometric dimensional analysis of the acquired images functional elements (area and stroke length measurement);
- the kinematic analysis of an assembly motions by film acquisition and its decomposition into frames;
- the creation of Matlab-based software tools which have allowed the above-mentioned analyses;

Fig.7. presents a comparison between the proposed methodology and the simulation analysis method:

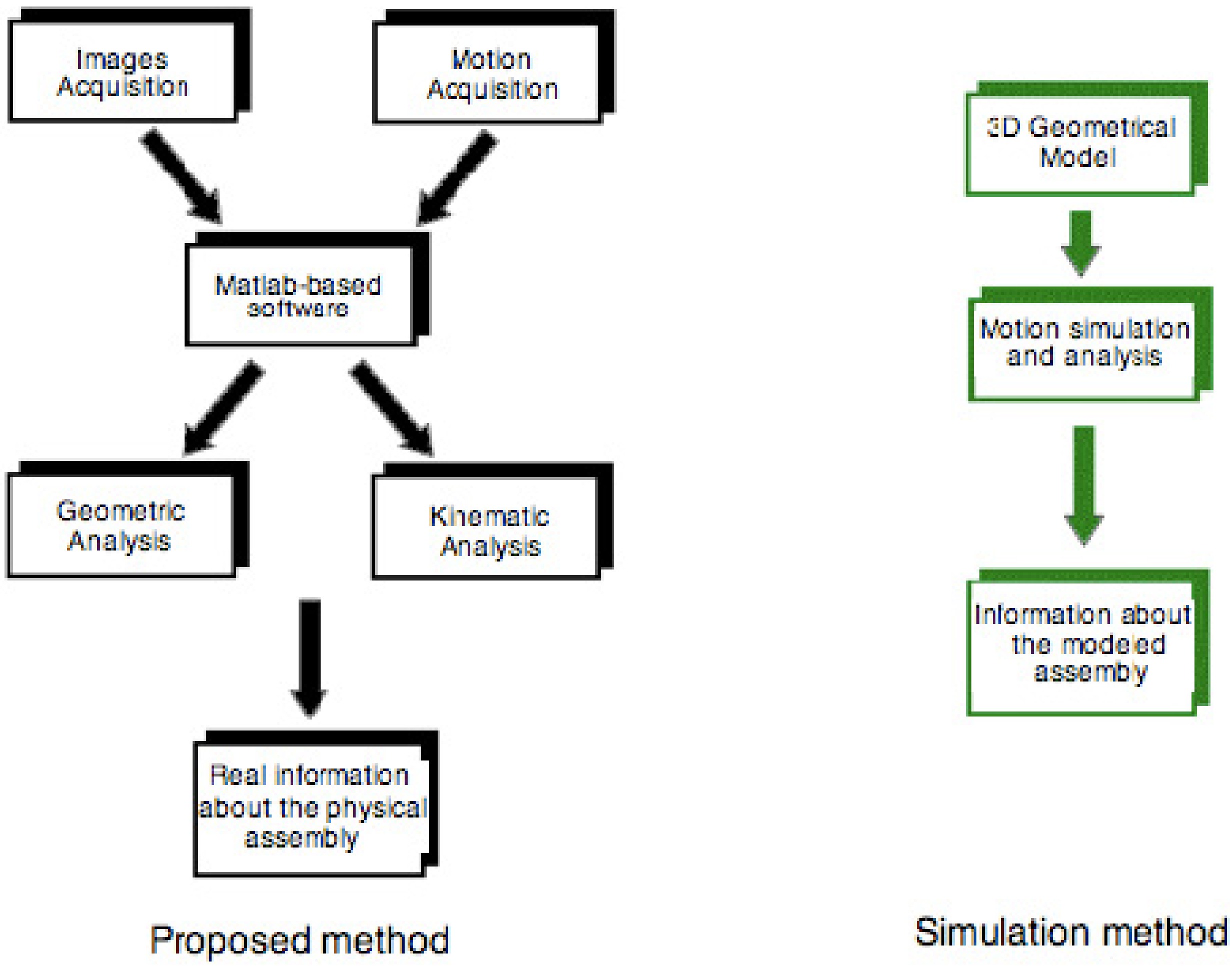

Fig. 7: Proposed methodology versus simulation analysis method

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