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CONSIDERATIONS REGARDING OF MECHATRONICS TYPES OF STRUCTURES FOR POSITIONING IN NON-DESTRUCTIVE TESTING

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Abstract: *Quality control of welded joints and the structure of materials is made with techniques becoming more efficient. A commonly used class of techniques is known as non-destructive testing (NDT). Among the known NDT variant types in this work are taken under study those based on the principles of radiation emission (X-rays) and ultrasound. Obtaining reliable results, approached in a short time and protected from the effects of disturbance factors depends on different parameters of control techniques. Among these should be mentioned: the correct positioning of the emitter of radiation and the waves , against the weld and / or parts-piece surface, the position control of these parts, so that to be respected the terms of "feeling" and "collision" of the weld and surface, the conditions imposed by the NDT equipment manufacturing company, replacing attributions of human operators in NDT in order to protect them against irradiation etc. In this paper are detailed factual information about these issues. It is insisting on mobile systems designed in view of mechatronics, introduced in the NDT structures.*

Key words: *Inspection robots, nondestructive testing*

1. INTRODUCTION

In establishing the design parameters and conception of NDT techniques in general and positioning systems of radiation emitter and from where in particular, the knowledge of defining details related to the weld joints and the technologies of materials developing are determinant. Equally important is also the knowledge of principles about the emition of radiations, waves, the construction of their emitters, the construction of weld equipment, the knowledge of all types of damage which may occur in development, in joining or after a specific period of time.

The constructive variants for positioning systems presented in the paper have constructive particularities which are taking account the principle of construction of means of nondestructive testing, about its metrological characteristics, and the geometry of measuring source (eg, welding cordons on the pipes, welding cordons on the elbows, structures of cast parts, etc.).

2. COMPLEX TECHNICAL SYSTEMS DRAFTING AND DESIGN STRUCTURAL MODEL

This model aims to list the steps to follow when conducting operations of drafting complex technical systems in a continuous interrelation between the structural elements of these systems and external factors that influence the positions of elements in the structure of these systems.

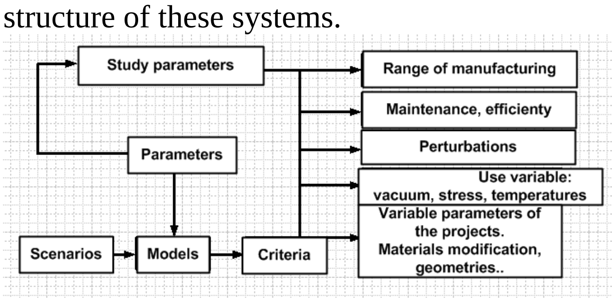


Fig. 1. Study parameters of complex technical systems

Figure 1 shows the study parameters of complex technical systems whose design and manufacturing purposes were well-defined. These parameters determine the efficiency of the model that will have to have a final behaviour scenario subjected the final utility of the complex technical system. These parameters are determined in the range of manufacturing of the technical systems, isolating the technical systems from perturbations, defining usage variants of the complex technical systems, determining the optimization variables needed in the design stage of optimization models, respectively determining the reliability criteria of complex technical systems.

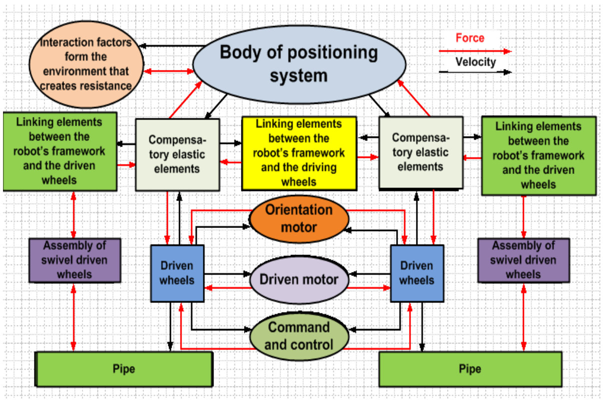


Fig. 2. Study parameters of complex technical systems

The positioning model design was done in accordance with the structural model from figure 2. This model highlights the mechanical structure which is defined by linking elements between the positioning system's elements, the compensation elastic elements, the engine elements, respectively the leading elements of the positioning system. The electrical structure of the positioning system is determined by the driving and guidance engines of the positioning system, as well as the command and control system of the elements' positions in the structure of the positioning system. The software and hardware structure is suggested by the signals that are based on kinematic parameters (speed) and dynamic parameters (force) that interact between mechanical and electrical components of the positioning system's structure. Note that this positioning system is always under the impact of some interaction factors from the environment, factors that generally create resistance, and which tend to disturb the metrological characteristics of the developed positioning system. If the control information source is the weld cord on a cylindrical pipe, then the used conceptual model is actually the one in Fig. 4. Every component of the model has a physical correspondent in the developed positioning system.

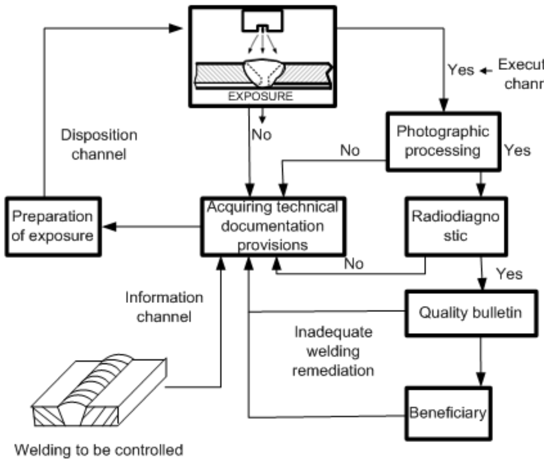


Fig. 3. *Structural diagram of principle for a generalized control system CND*

In figure 3 is represented a structure principle scheme for an equipment of type control system generalized for such operation applied to a weld.

The way in which they are arranged, during exposure, the source of radiation, the controlled part and the radiographic film determine the exposure geometry. Contributing greatly to obtain high quality radiographs, the exposure geometry is perhaps the most important factor for radiographic exposure.

3. POSITIONING SYSTEMS WITH CLOSED FRAMEWORK

Figure 4 presents with more details another option for a different positioning system. Although conceived and played in SolidW the important structural parts of the system are explicitly detailed and nominated.

The system is formed from a support framework 3 made of two semi rings with lengths proper to a 2700 centre angle. Three boards on which the parts with the rolling systems are mounted bind the two semi rings.

On the intermediary board, besides the rolling system, the positioning system of the radiation or ultrasound emitter is also mounted. On this intermediary board the rolling system serves for training purposes. Noted in figure 4 with (5). This assembly is detailed in figure 7. On the other parts, which have extreme positions only the rolling system is mounted. Each system is made of two pivoting wheels (1) mounted on a support board. Two guiding rods (6)and a screw that has a driving role reinforce the support board. These functions are necessary in the radial positioning operation of the system toward the pipe axis on which the welding line subjected to a non-invasive control is placed.

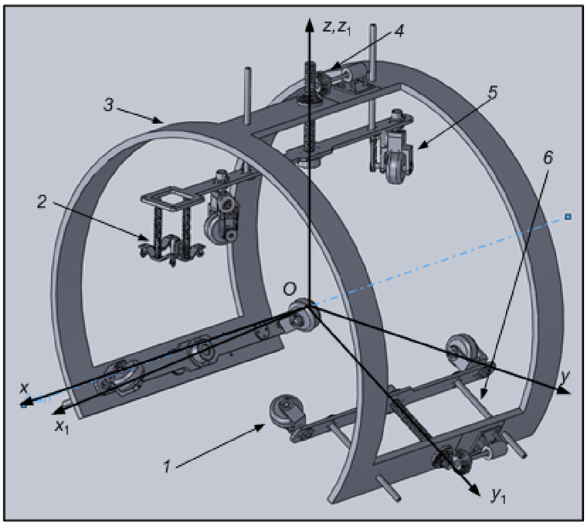


Fig. 4. Positioning system, II variant, 1 - free pivoting wheel, 2- final effecter, 3 - robot body, 4- Placement system of the robot, 5 - Orientation and training parts of the motor wheels, 6 - guidance

The screw is mounted in a nut driven by the gear wheel rotates a bevel gear. The pinion is driven by a stepper motor.Such an action (4) we find on each of the three panels corresponding to the three pairs of gears on the three boards that connect to the rails of the body positioning system.

The second assembly (2) is designed to be operated and controlled independently from the rest of the role of positioning.

Figure 6 is detailed driving subassembly trained as described above. In this figure the guide rods are denoted by 1, 2 and with 3 the running wheel-drive system.Constructive version of Figure 5 serves as a means of positioning radiographic nondestructive testing of welds and joints that occur in manufacturing various types of pipes.Its purpose is to verify the existence of different types of defects that can occur in the composition of materials joining. The system is self-enabled mobile agent to perform a translation movement along the pipe, a rotating motion around it and a combination of the two movements. Being possible this combination , it enables the spiral welded pipes. The axis that joins the contact points of wheel-bore on each set of two wheels is always parallel to the axis of cylindrical pipe or implied by the corresponding generators to the imaginary cylinder attached tube. Travel subassemblies are positioned equidistant from the pipe surface and feeler positioning system provides a constant distance from the weld seam controlled. The drive nut subassembly running or running-training has a more complex form. This framework is based on the robot body by two thrust bearings to provide rotational movement with minimal friction.

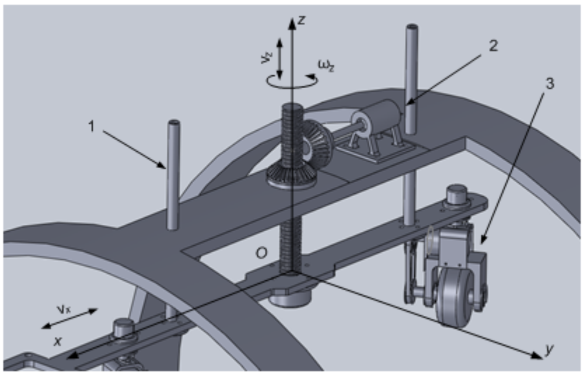


Fig.5. The settlement unit positioning system, 1-guide, 2-engine, 3-wheelmotors

The radial translational movement is continuous. Any locking are avoided by means oftwo guide rods fixed to support the running wheel. Gates of the three boards areindependent from each other even if they only asegura running or running and training.Taking these degrees of freedom ensured there is opportunity for them toautoorienteze after positions and movements that require the two driving wheels -Detailed driving on the Intermediate plate in Figure 5.

Figure 6 presents a detail on how to run - the drive system shown in Figure 6 the same role. Driving wheel - drive is mounted on a shaft which has camps in an asymmetrical fork. In an extension of the shaft, fork out (in a mounting bracket) is fixed a wheel belt. On the axis fork, at the top of its sidewalls is mounted a stepper motor drive. The motor shaft is fixed corresponding belt wheel. The rotation of the wheel moving the robot is thus achieved through the mechanism of the belt drive motor shaft at the wheel. To ensure the orientation of the wheel can be seen in another top fixing system. Engine is placed over a piece of masking an engine role after guiding the wheel motors when the weld seam is helical.

Figure 6 is seen in more detail wheel drive subassembly by component. The piece of plate on engine 1 has a flange on the bottom is assembled and on the other hand it takes the rotation of the drive motor 2 located on a mounting bracket on the component that supports both wheels and the end effector also through a flange. In this support there is a special geometry designed for so that a wheel bearing is inserted to ensure rotation around the surface normal at the point of wheel contact with the pipe. This Need to use of the bearing appeared knowing that by pressing the barrel must ensure the necessary adhesion between tire and tube.

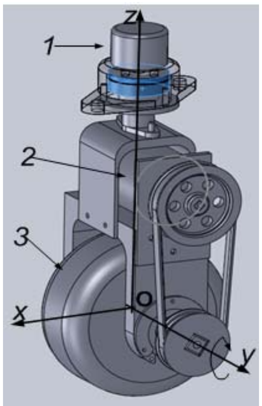


Fig.6. Details of the wheel motors, 1 - Guidance motor,2 Driving motor,3-wheel

These two driving wheels must be synchronized by controlling the engines every time to ensure the proper concentric position of the bearing the robot from the pipe control. This will be one of the main aspects that will require special control

The other two sets of wheels are pivoting, without driving. Their axes are free and will be considered to auto-guide on the directions imposed by the driving wheels.

A matter of the usefulness of this system is that which concerns the possibility of positioning "feeler" on the portions of the pipes that has some type of bends or elbows joints. The system shown in Figure 4 and detailed in Figure 5 and Figure 6 provides positioning especially difficult because the mounting position of the bearing the supporting system.

4. POSITIONING SYSTEM WITH RING FRAME

Figure 7 suggests another model for means of positioning the system for nondestructive testing of welds. This is derived from the previous and has a simplified frame. It uses a single ring and the systems running and respectively running and Driving are simplified in the sense that the auto-guide uses a single guiding rod.

Otherwise, the principle of movement keeps the same aspects that the previous version. Both the motion and orientation of the wheels as well as their closing to the pipe to achieve the necessary grip displacement remained unchanged. Instead the degree of maneuverability is improved. This will secure better conditions in the of positioning the feeler on areas of the pipe which shows elbows or bends .

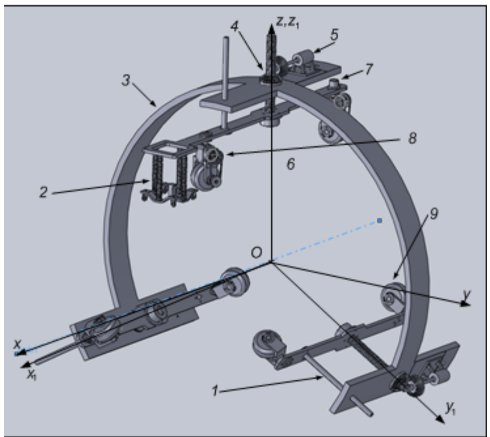


Fig.7. Ring frame positioning system, 1-handle, 2-subassembly supporting the "feeler" 3-ring framework, 4-drive mechanism and radial positioning, 5 - drive system, 7-pivoting motor, 8-wheel driving system, 9-running wheel system.

In figure 8 is presented an improved version of the system shown in Figure 7. This version ensures the positioning of nondestructive systems on a wider range of pipe sizes. If the previous versions there is only one "source" to adjust the system for certain diameters of the pipes, respectively adjusting the running systems - moved by screw-nut drive assembly , the variant of Figure 8, except this option of settling there is also the possibility of "lengthening "the ring from the supporting frame with two sections added to the appropriate size pipe radius.

Otherwise, the structures of other parts are similar.

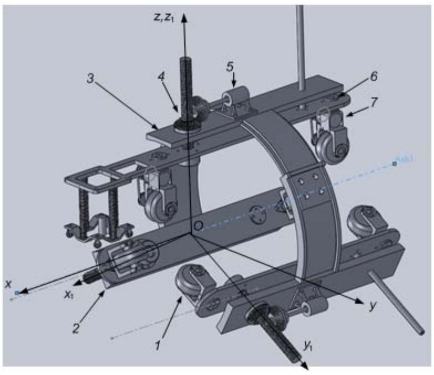


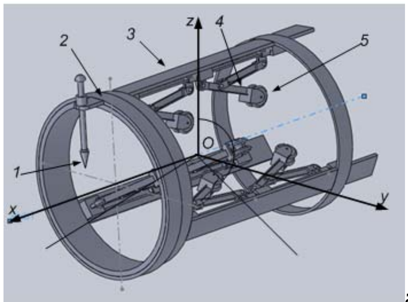
Fig.8. system Adjustable Ring Frame, 1, 2 - wheel drive, 3-radial positioning positioning unit, 4 - radial positioning drive and positioning mechanism ; 5 - radial positioning engine, 6-swivel motor, 7-running -driving system.

5. MECHATRONICS SYSTEMS FOR POSITIONING WITH ARM-SLIDING MECHANISM

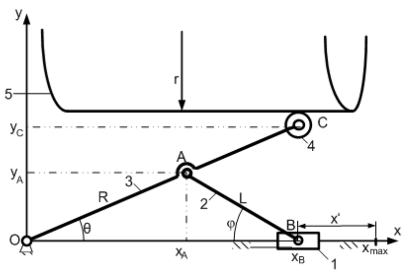
Moving mechanical systems designed in view of mechatronics will have to provide opportunities for control of radiation emitter positions and orientations so that to be possible to obtain optimal images and to protect against irradiation of human operators. The positions that emitters will occupy in NDT are varied: orientation is along the tube or on direction of a cylindrical spiral .Variants presented in this work are designed in SolidWorks.

In figure 9 is presented a version of a positioning system. This system has in structure the crank rod mechanism in structural versión beam-slide. It provides emitter "end effector" a movement for positioning along a longitudinal weld.

An important characteristic and benefit of this system is to be able to make measurements on pipes of different diameters, this is possible because the mechanism of approaching the wheels F on pipe until the contact necessary to realize translational motion along it.



a)



b)

Fig.9. Positioning system, version I; a) view, 1-end effector, 2-rotation ring, 3-corp, 4- rolling subassembly, 5- wheel, b) structural scheme.

6. CONCLUSION

Structuring principles of moving mechanical systems offers possibilities for achieving high performance positioning systems

On the principle of ensuring the desmodromia for mobile mechanical system, positioning systems ensure compliance with optimal conditions for palpation the welded cordon.

Structuring principles of command and control components designed in mechatronics vision are providing both the maintenance of mobile mechanical system as well linear and spiral trajectory. It is possible to coordinate accordingly the system position while on the rectilinear direction (linearly welded pipe) and positioning on portions of the pipe which shows curvature.

7. REFERENCES

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Consideratii privind tipuri structurale mecatronice pentru pozitionare in control nedistructiv

Rezumat: Controlul calitatii imbinarilor sudate si a structurii materialelor se realizeaza cu tehnici din ce in ce mai eficiente. O categorie de tehnici frecvent utilizate este cunoscuta sub denumirea de controlul nedistructiv (CND). Dintre tipovariantele cunoscute ale CND in lucrare sint luate in studiu cele bazate pe principiile emisiilor de radiatii (radiatii X) si de ultrasunete. Obtinerea unor rezultate viabile, intr.-un timp scurt si protejate de efectele unor factori perturbatori depinde de diferiti parametri ai tehnicilor de control. Dintre acestia trebuie mentionati : pozitionarea corecta a emitorului de radiatii si de unde fata de cordonul de sudura si/sau fata de suprafata reperelor-piese, controlul pozitiilor acestor subansamble astfel incit sa fie respectate conditiile de “palpare” si “coliziune” a cordonului si suprafetei, conditii impuse de firma constructoare de echipamente de CND, substituirea atributiilor operatorilor umani in CND in scopul protejarii acestora impotriva iradierilor etc. In lucrare sint detaliate informatii concrete despre toate aceste aspecte. Se insista pe sisteme mobile concepute in viziune mecatronica, introduse in structuri de CND.

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