THE DESIGN OF REMOTE CONTROLLED BOMB DESTRUCTION ROBOT IMPLEMENTED USING MECHATRONICS DESIGN METHOD

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Abstract: At the present day, the duration of product life is much shortened as a result of the customer demands changing rapidly and intensive competition. The customary design and production technologies have remained incapable against such hard conditions and consequently new concepts and methods have arisen. One of those concepts is "Mechatronics Engineering". The mechatronics design method is based on an integrated approach to form the design eventuating in mainly match-purpose products instead of sequential design. The basic combination of the mechatronics approach is based on the usage of system model and simulation through prototype stages. The first step in development of the mechatronics systems is analyzing customer demands and the technical frame in which the system is combined. Generally the Mechatronics Design Process is rounded up the under seven mean headings. At the present day, remote controlled robotic systems are required for various purposes such as research, education, commerce etc. The target in this study is to design a remote controllable robot equipped with control capability with a robotic arm, to be developed following the Mechatronics Design Processes and used for the purpose of bomb defusing.

1. INTRODUCTION

The word "mechatronics" has gained its up-to-date usage by providing a focus point and title which joins the electronic equipment (hardware) and computer software with mechanical engineering for a product or process (Erden, 2002). Mechatronics is a method used for the optimal design of the electronic products. The method is a collection of the applications, procedures and rules which are used by employees in a particular branch of a science or discipline.

As a result of this definition the mechatronics system is: an integrated approach which covers the subjects of four disciplines and between disciplines such as electrics, machine, computer science and knowledge technology (Devdas, 1997; Erden, 2002).

2. MECHATRONICS DESIGN

The engineering branch known as System Engineering uses the synchronous approach for the first design (Devdas, 1997). According to this meaning mechatronics can be thought as the extended system engineering approach. However, mechatronics is supported with information systems in order to set light to the design and to render the whole design more comprehensive, and is not only applied to the first stage of the design but also to all of the stages. There is a synergy in the whole of electrical and computer systems as well as the information systems for the production of products and procedures and design. Synergy is produced with the right combination of the parameters, which means the last product can be better than all of the parts. Mechatronics parts used to show performance characteristics which were difficult to achieve without sy-nergy combination. The basic components of mechatronics design are shown in Fig. 1.

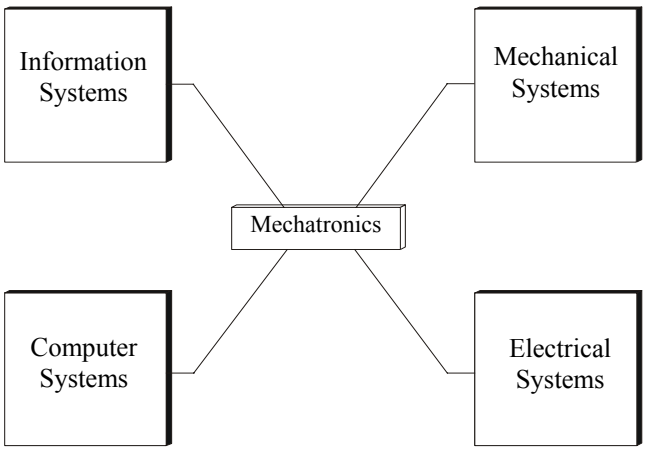

Fig. 1. Basic components of mechatronics design

Although the literature has adopted this essential/genuine representation, a more clear but more complicated representation is shown in Fig. 2.

Mechatronics is the result of the application of information systems to physical systems. The physical system actuators on the right hand dotted block contain electric and computer systems as well as sensors and real time interfaces. In the literature this block is call electromechanic system (Histand and Alcatiore, 1999; Çetinel, 2000).

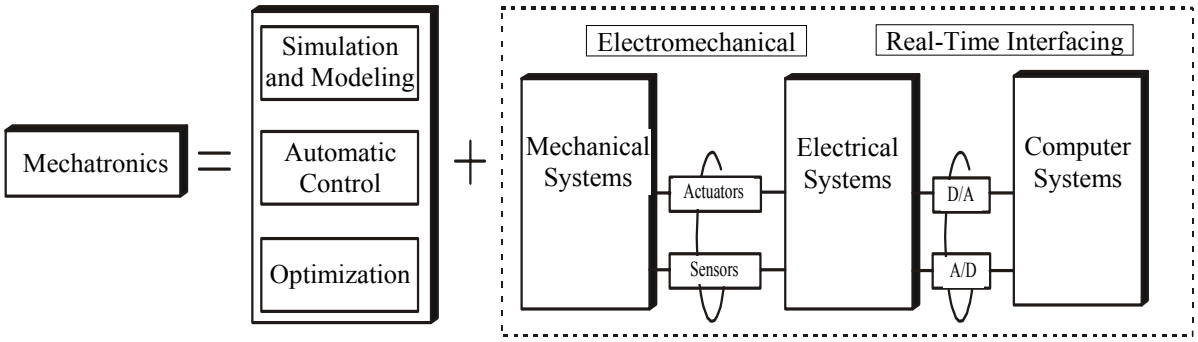

Fig. 2. The key elements of mechatronics design

3. THE PROCESS OF MECHATRONICS DESIGN

Mechatronics is an integrated approach both in design philosophy and engineering philosophy. Mechatronics provides suitable conditions in order to increase synergy by means of the simulation of inter-disciplinary ideas and techniques. Typical mechatronics systems collect data and information from the technical environment by using sensors. The next procedure is using model and design methods in detail in order that the system covers all the subtitles in an assembled way. The first step in mechatronics system design is to analyze customer needs and the technical environment which the systems assemble. Accordingly, the Process of Mechatronics Design can be collected under seven subtitles. Needs: The design process may start with the needs coming from either a customer or a purchaser. This may be determined by Market research done
in order to understand the needs of potential customers. The Analysis of the Problem: The first stage of the development of the design is finding the genuine nature of the problem for example analyzing it. The analysis of the problem in a good way is important to define the problem completely and to avoid losing time on designs which won't satisfy the needs. Preparing the technical details: Following the analysis the properties of the needs can be prepared. The limitations which will take place in the solution and the criteria which will determine the quality of the design will explain the problem. While exposing the problem all the functions as well as all the properties which the design requires must be determined. Therefore, the mass of the required motion, its dimensions, types and area of change space, and accuracy of the elements, conditions of access and input and output, interfaces, conditions of power, operation environment, and related standards can be a report about the application codes. Determination of plausible solutions: This stage is called "conceptual state". Draft solutions which can be worked out in sufficient details in order to show the way to obtain each desired function such as approximate dimensions, shapes, materials and prices are prepared. This also means showing what has been done for similar problems before. There is no meaning in inventing the wheel again. Choosing the Suitable Solution: Various solutions are evaluated and the most suitable is chosen. Production of a Detailed Design: In this section the details of the chosen design must be operated. This might require the production of prototypes in order to decide on the best details of a design. Production of the Working Drafts: The chosen design is then changed to working drafts and electric circuit diagrams so that the design equipment can be produced.

It mustn't be thought that each stage of the process of design will be followed stage by stage. Sometimes it might be necessary to go back to the previous stage and to work on it more. Therefore, during the stage of the production of the plausible solutions it might be necessary to go back and to revise the analysis of the problem (Çetinel, 2000).

4. APPLICATION OF THE TECHNIQUE TO THE BOMB DESTROYER ROBOT

The Design of Bomb Destroying Robot was realized in three parts. The first part is the realization of the mechanical design. The second part is he design of the electronic audit card. The third part was prepared on the LabVIEW program which maintains auditing by computer. Electronic audit card was designed connected to NI-cfp-1808 compact Field Point. Step engines which have the power to enable the robot arm to move and to lift the weight with the communicating unit, and audit unit by realizing the pallet system were chosen. In order the picture to be transmitted IP camera was chosen and NI Field Point SRM6000 Radio Modem was used along with access point as the transmitting unit in the device which enables all the audits to be done
on the internet basis.

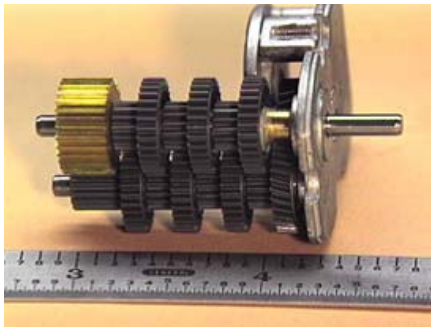

Fig. 3. Gearbox

Mechanical design stage of the project; The desired motion is put into a new mold by changing direction and shape; that is, by being modeled; by means of these processes the needed power or the direction of acceleration can be gained. Below gearbox which is the best example for this and their structures can be seen.

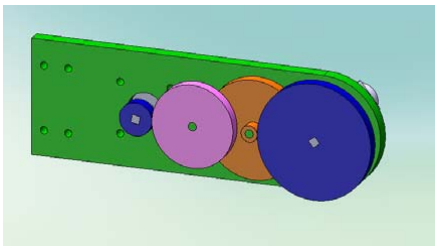

Fig. 4. Gearbox transmission system for robot arm designed

The picture of gearbox system transferring disturbance received from step motors provide movement of robot arm is shown in Fig. 4.

According to data given, numbers of gear, power account, torque, size of module and gearbox, external forces and response values incoming to bearings. Choice of Motor and design of driver circuit; driver circuit and step motors chosen for robot arm is shown below.

- Card operating voltage (12 – 24 VDC)
- Motor operating voltage (12 - 55 VDC)
- Maximum Motor driver current is 8 mA.

Driver circuit has been designed for step motors chosen. Driver circuit is shown in Fig. 5.

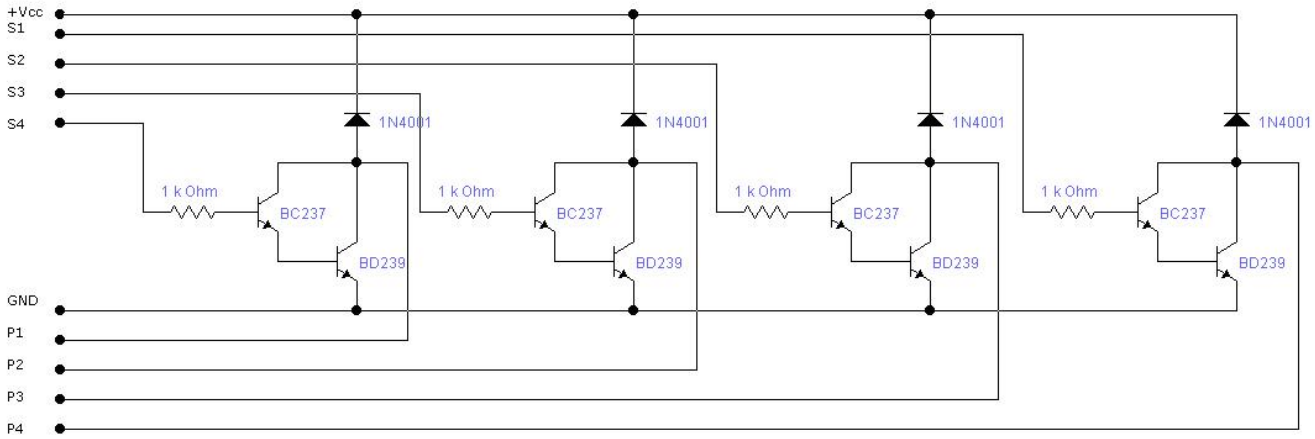

Fig. 5. Driver circuit designed for step motors

Control Card; The designed control card holds the drivers which control the movement of the device and robot arm movement by the signals coming from FieldPoint, and lighting system. On the main control card there are connection sockets which enables step motor drivers cards to be attached as a module. The voltage of the control card to work was chosen 12V.

Energy Conducting; The need for the power of the device is provided by dry batteries. A stand-by circuit which prolongs the life of the battery by cutting feed during stand-by of the system was added.

Feedback and Sensing; Sensors do the duty of a bridge which connects the physical environment and electrical/electronic devices produced for industrial purposes. These devices have a wide spectrum of usage such as control, protection and projection during an industrial process. Below are shown the sensors which were chosen to realize the intended movements and their properties.

Sensing Distance; It has become easier to measure distance thanks to the advancement of present-day sensor technology. There are ultrasonic infra-red models for this. We will, on the other hand, will sense this distance by means of the cameras installed on the device.

Sensing Obstacles; The general properties of the HOKUYO- Obstacle-Sensor which is planned to be used in the project are as follows; The scanning angle (Sensing space) has been increased to 180 degrees and the dead space which can be sensed is decreased. The picture of the obstacle sensor which is used is shown in Fig. 6.

Fig. 6. The obstacle sensing sensor

Seeing; Two high-soluble cameras to get information about the environment and to guide the device accordingly are planned to be installed on the device. Axis PTZ14 model, which gives high-quality pictures by means of high rate of zooming and Sony lens in addition to the picture transmitting facility and easy intervention possibilities, was used in the project.

Communication; Access Point was used for the communication of the robot. WAP54GPE model, which was deve-loped by Linksys Firm for the communication of IP cameras outdoors, was used. It enables to use cameras with four Ethernet ports, which were installed on it.

Fig. 7. LinkSys WAP54GPE outdoor Access Point

Fieldpoint SRM-6000 Radio Modem; SMR6000 Radio Modem, which was again produced by NI Firm, and which allows to work without wire and real time with compact FieldPoint, which performs the main controls of the device.

Fig. 8. SMR6000 Radio Modem

Prototype drawing in SolidWorks;

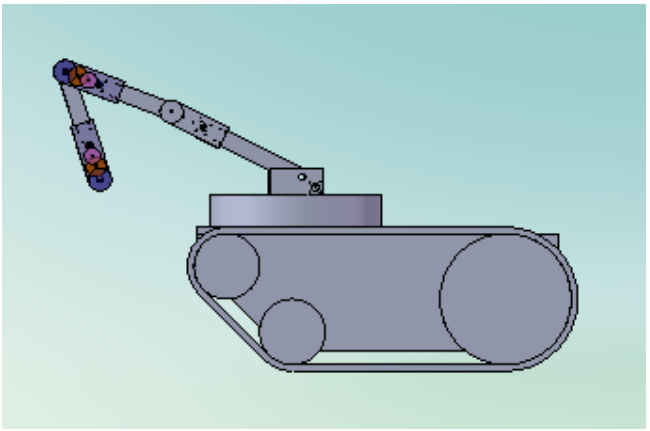

Fig. 9. Vehicle image drown with SolidWorks

Programming of Control Program of System; LabVIEW soft ware package of NI firm has been used for project. Vi and subvis written to implement the control of system is shown below.

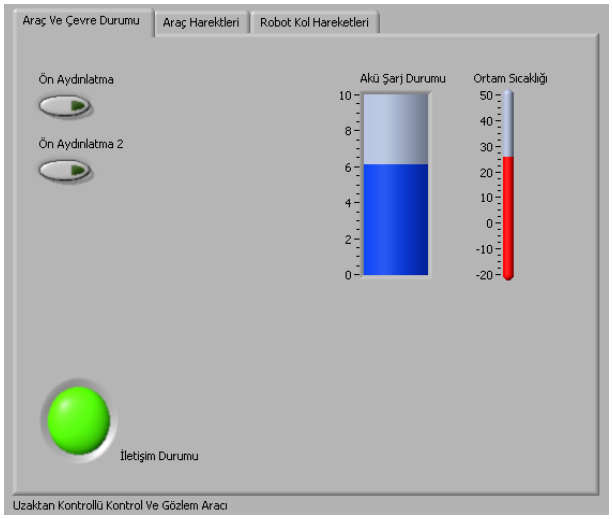

Fig. 10. Front Panel 1 Written For Project

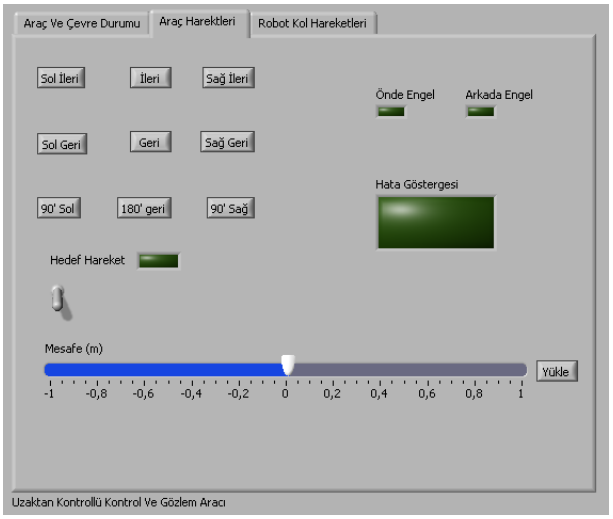

Fig. 11. Front Panel 2 Written For Project

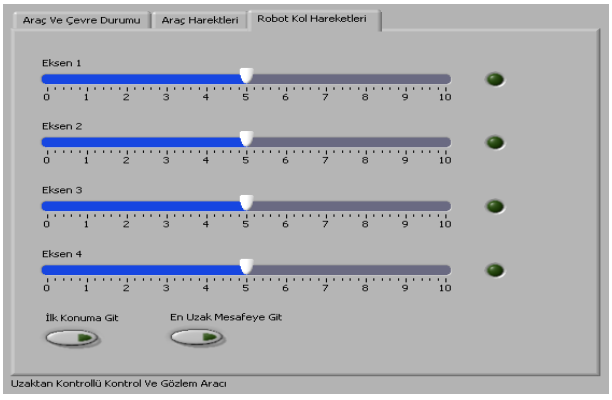

Fig. 12. Front Panel 3 Written For Project

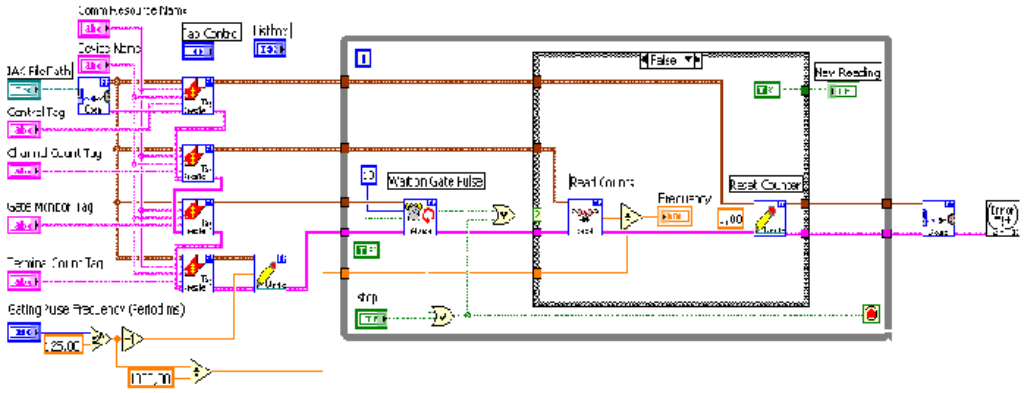

Fig. 13. Block Diagram Written For Project

5. CONCLUSION

Mechatronics is a joint approach both in design philosophy and in engineering designing. The main factor in Mechatronics is the combination of these fields within the framework of the process of designing. The method provides suitable conditions in order to increase the synergy by means of the simulation the interdisciplinary ideas and techniques. In this way it provides catalytic effect for new solutions to technically complex conditions.

If a product is joint with Mechatronics Design Technique, there can be impressive results. With the usage of Mechatronics Design Technique more productivity, high quality, feedback system and product reliability are provided. In order to apply Mechatronics Design Technique to obtain these aims, the organization's changing needs of tomorrow, the data functions, the control, and the combination of the devices have to be considered at the beginning of the design. The prior aim of the device, which was developed by following Mechatronics Design steps, is to be used in the operations carried out to destroy bombs. Besides being used in the applications to destroy bombs, it can be also used in rescue operations, in sample collecting in dangerous environments, and in mini military tank applications with the additional equipment attached to it. Moreover,
it can be of use to inspect suspicious packages for the contents in the applications to destroy bombs and to find people who are still alive during rescue operations. With its capability to save lives by being used in the operations to destroy bombs it will play an active role in defusing the bomb packages which can be encountered anywhere nowadays.

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