MOTION CONTROL AS A KEY TECHNOLOGY IN ADVANCED MECHATRONICS OF BUILDING MACHINES

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Summary. The motion control of the modern mechatronics systems of the building machines as the key (base) technology is discussed.

Key words: motion control, key technology, advanced mechatronics, building machines.

Motion control is now recognized as a key technology in mechatronics (and for such one systems for building machines). The robustness of motion control will be represented as a function of stiffness and a basis for practical realization. Target of building machine’s motion is parameterized by control stiffness which could be variable according to the task reference. However, the system robustness of motion always requires very high stiffness in the controller. The paper shows that control of acceleration realizes specified motion simultaneously with keeping the robustness very high. The acceleration is a bridge to connect such robustness and variable stiffness. For practical applications, a technique to estimate disturbances is introduced to make motion controller to be an acceleration controller. Motion control of flexible structure and identification of mechanical parameters are also described.

One of the most important elements in mechatronic technology (for building machines as well) is undoubtedly motion control. However, the word “mechatronics”, registered as a trademark by Yaskawa Electric Co., in 1971 did not always include a concept of motion control [1].

In the 1970’s, industries began to replace mechanical elements with electronic ones to achieve higher reliability and less maintenance. Also the mechatronic devices were designed to occupy smaller space in the final products. Totally function of reliability, availability, and serviceability has been very much improved in relatively more compact products.

In the 1980’s a remarkable progress in mini- and microcomputers and power electronics technology made it possible to improve the performance of motion. For example, vector controlled induction motor has higher cut-off frequency almost up to three times in the speed control loop compared to the same-sized dc motor. Following these results, the novel theories of control were tested in such mechatronic systems (of building machines). In the late 1980’s and the early 1990’s, mechatronics seemed a showcase of various application of control theories.

The first IEEE Workshop on Advanced Motion Control (AMC’90) held in 1990 pointed out the importance of physical interpretation of motion control, though the proceedings included many examples of modern control techniques [2]. The phenomena observed in the early 1990’s also came from the so-called “software-servo technology”. Generally major part of software applied to motion control carries out the indispensable routines for diagnostics and sequential procedures. Only small area is assigned for programming control algorithms. The area was hardly sufficient for conventional PID controller. Recently the fast processor has gradually enabled more complicated algorithms within a shorter sampling time. Since the software-servo technology has generated more room for control algorithms, higher performance and flexibility
have been realized without additional investment. Then the novel algorithms have gained high evaluation from the practical viewpoint because the quality of motion was improved. The motion control is now recognized as an important area in mechatronics (just for the building machines as well) [3-6].

The paper intends to show recent advances in motion control of building machines and energy conversion [7] for the tutorial purposes. The physical meaning is emphasized rather than mathematical exactness. As is well known, control and estimation are twin aspects of system design. The fact holds in motion control of the building machines. The robust control of the last objects and the estimation of their parameters have the same basis. The several examples shown later seem different approaches; however, the single interpretation is possible from the physical viewpoint. The paper, at first, defines the stiffness (of the crane’s ropes) in relation to various motion controls. This concept leads to both the meaning of robustness and the general structure of building machines’ control. Then the paper points out the necessity of modification against flexible structure.

Several examples will assure the concluded remarks at the end of the paper.

References

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