**KATEDRA AUTOMATYZACJI PROCESÓW TECHNOLOGICZNYCH I ZINTEGROWANYCH SYSTEMÓW WYTWARZANIA**
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# Modelowanie przekładni pasowej synchronicznej w kontekście automatycznej diagnostyki i optymalizacji działania cięgna z użyciem symulacji komputerowej

(Modelling of synchronous belt transmission in the context of automatic diagnostics and belt performance optimisation using computer simulation)

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## Abstract

The aim of the scientific work described in this dissertation was to search for and study concepts for the identification and reduction of anomalies in the operation of synchronous belt transmissions, with the least possible complexity of instrumentation and manual activity in the operation and diagnostic processes. Based on the knowledge and experience described in scientific publications, patents, technical specifications and texts of practitioner-experts in the field, a specific group of methods and technical systems were considered, which could help solve the problems identified in the area under consideration.

Taking into account industrial production conditions, in which systems improving the operation and diagnostics of drives are of particular value, the considerations were guided by the criterion of minimum instrumentation and manual intervention in the processes of identification and elimination of operating anomalies. Based on the literature review, consideration was given to the possibility of reducing to a minimum the number of measurements necessary to determine the key parameters of the drive system in correct operation. The formulation that it would be possible to determine, based on the pulley synchronisation error, whether there are anomalies in the operation of the transmission related to abnormal levels of operating parameters is a thesis that was verified during the research described in this dissertation.

The basic research experiments carried out sought answers to, among other things, the question of how the level of tension of the toothed belt affects the synchronisation error and whether the unbalance of the rotating bodies, affects the relationships studied. The area of consideration was narrowed down to the belt tension problem in order to identify as cross-sectionally as possible this aspect, which appears to influence all others, and to concretise conclusions oriented towards improving the transmission operating process. In order for such experiments to be carried out, a test stand with a belt tensioner with an adjustable pivot arm (directly related to the adjustment of the tension force value) and a number of sensors and measurement signal acquisition systems is required. The described test stand was created as part of the preparation of the research,

and it was realised in the concept of automation of both the collection and processing of information about the operation of the transmission, and the control of the parameter under consideration, which determines the correct operation. This is a solution that is not only of research value, but is also a prototype of a device for the automatic adjustment of the tension of the timing belt.

The research analysed cross-sectionally the possibilities of identification and reduction or even elimination of selected anomalies in the operation of synchronous transmission. The focus was on parameters that had not yet been collated to try to find relationships between them. A series of characteristics were developed showing the kinematic relationships of the pulleys occurring under different control circumstances and drive installation configurations. The considerations led to the development of a concept for a system for automatic adjustment of the level of tension on the toothed belt. The research allows us to conclude that the proposed solution is an effective response to the problem of changes in the force effects on the belt and, through it, on the bearings and other components of the drive mechanism. Integration with computer simulation environments is included. Unmeasured (not available using common metrology techniques) transmission parameters can be simulated in real time. The system, which was realised as a research prototype, is a virtual replica of the device under consideration – its digital twin that provides relevant information without time delay.

This means that it is possible to link all the elements resulting from the work described in an integrated system for automated drive monitoring and control. Examples of scripts and programmes automating analytical and control activities, consisting of common functions available in standardised PLC-class devices, are presented. Some concepts have been developed and experimentally tested, which are innovations that can be implemented in modern manufacturing systems with an orientation towards extending the life of machine components, as well as optimising the operating conditions of mechanical components.