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Automation of Ship-To-Shore Container Cranes: A Review of State-of-the-Art

The paper gives the state-of-the-art of automation of ship-to-shore (STS) container cranes, as the biggest investments in the port terminal system. The automation techniques increase the productivity of the ship-to-shore container crane, and consequently increase the port terminal efficiency, as an integral part of logistic network. The paper also shows a short survey of some most important and recent researches in control of ship-to-shore cranes, and main principles of operation of currently existing devices.

Keywords: ship-to-shore container cranes; automation; control; efficiency; productivity

1. INTRODUCTION

The competitive world economy, and the increasing performance expectations of customer lead to a demand for low cost, rapid and dependable shipping of cargo. The development of efficient, automated, high-technology loading/unloading equipment has the potential of considerably improving the performance of terminal operations. Advances in ship-to-shore (STS) container cranes technology, as the major part and the biggest investment (capital costs for container cranes are 70-75% of total costs in ports [1], of the cargo storage and removal system, have a significant effect on the efficiency of port terminal operations once properly implemented [2]. Today, any port wishing to be at the forefront of terminal operations and container handling should be able to reduce to a minimum the time that the ship is docked in the berth. The fact of ensuring the shipping companies of having a port terminal with a high quality and a fast service of movement of cargo, by means of more and faster cranes, facilitates competitiveness by showing higher productivity [3]. The expansion of multimodal transport has led many ports (even smaller ports) because generally 80-90% of costs are independent of volume of cargo handled in container operations [3] to make capital investments in facilities, considering automated container handling systems. The purpose is to increase the speed and efficiency of handling containers. The transfer of cargo between ships and ground transportation remains an expensive and time-consuming activity. The need for faster loading is reflected in the current trend toward faster, higher-powered motors and better drives [4]. For the years many authors have been researching and developing ways to make STS cranes transfer containers faster and more safely through computerized anti-sway

and automatic controls.

The STS container crane presents for itself a complex system, but at the same time is a part (Elementary Sub-System, ESS) of the port terminal system, Figure 1 [2].



Figure 1. An outline of port terminal system

STS container crane productivity has always been one of the critical components of terminal productivity, but the crane is only one of the terminal elements that control production. Within the next decade crane productivity may become the limiting component of the terminal production [5]. Increasing productivity is always desirable, but for large ships is necessary. Vessel turnaround time depends on [7]:

- Vessel and crane parameters;
- Operating parameters;
- Container yard performance;

It will take nearly four days to service a 32000 TEU ship exchanging 75% of its containers, using 6 assigned cranes producing 30 lifts an hour [5]. Increasing productivity to 7.5 lifts an hour cuts the turnaround time to a little less than two days. In Table 1 are presented some typical turnaround times for various vessels and crane lifts per hour [5]. Some improvements increase production incrementally, by 5-20%, and other improvements make a quantum jump, by 25-60%. This paper deals mainly with the increasing of port terminal productivity, as a part of logistic network, due to automation of STS crane. Automation continues to

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