XXIII International Conference MHCL 2019 – Extended Review Abstract

Conceptual design of a modular, hybrid sensor system (*Duck Box*) for the implementation of location-based material flow analyses

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Abstract

Intralogistics, which includes all internal material storage, handling and transport costs, accounts for 25% of the total personnel input, 55% of the space required and 87% of the actual throughput time. These percentages show the great potential of an efficient implementation.
An essential component of intralogistics is the material flow relationships that are required in the context of value creation. Despite increasing automation, these are usually carried out manually and are associated with high personnel and cost input. The distances covered by industrial trucks or forklift trucks vary, among other things, in terms of their distance, intensity and relevance for the actual value-added process. These and other properties are investigated within the framework of a material flow analysis.[3, 7-9]
The current basis for the analysis of intralogistic material and goods flows is a large number of visualization and modeling tools. For the underlying database, so-called Indoor Positioning Systems (IPS) or Real Time Location Systems (RTLS) are used to locate transport vehicles and to draw conclusions about the existing traffic volume based on the positioning data. By using such systems for further optimisation, an efficiency increase of 15-20% can be achieved in the picking area of a warehouse. [2, 4, 6, 8, 10]
The advancing digitalization with the seemingly infinite number of different technologies and sensors is currently used by companies inadequately or not at all. A lack of standardisation, poor user-friendliness and a myriad of influencing factors do not permit a specific application for location-based material flow analyses in an industrial environment.[1, 5, 11]
The target is to link company-specific requirements and technological framework conditions, in order to make the use of modular, hybrid sensor technology possible and to create the basis for the analysis of material flows.
Due to the different requirements resulting from the respective company conditions and processes, individualization is usually necessary. Different technologies and sensors must be combined into a hybrid overall concept. The use of a modular, hybrid sensor technology enables the company to carry out a complete material flow analysis.
This paper descibes the development of a conceptual measuring unit (project name: Duck Box). It essentially has a processor which is powered by a mobile battery and which connects and controls various modules and sensors. All components have been selected for the highest possible economic efficiency and can be obtained easily and inexpensively from independent retailers. An ultrasonic sensor is used to record the loading condition. Depending on company requirements, the position data, the distance travelled and the associated dwell times are to be recorded alternately using an active RFID tag, UWB, WLAN or Bluetooth. Depending on the selected IPS and sensor technology, the generated data is recorded locally on a storage medium or alternatively transmitted via a wireless connection to a database positioned in the analysis area.

All components are accommodated in a compact and at the same time robust housing suitable for industrial use. The housing is manufactured using the 3D printing process and has various mounting options for industrial forklifts.
A picture of the developed Duck Box incl. the corresponding circuit diagram is shown in the following picture.

Keywords: Intralogistics, IPS, Material flow analyses, Sensors, Duck Box, ultrasonic, forklifts

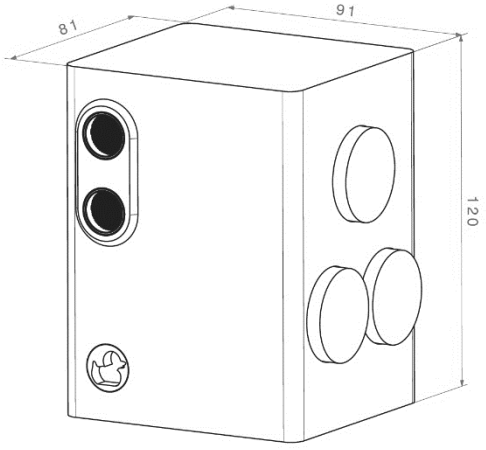

Fig. 1. Isometric view of the Duck Box

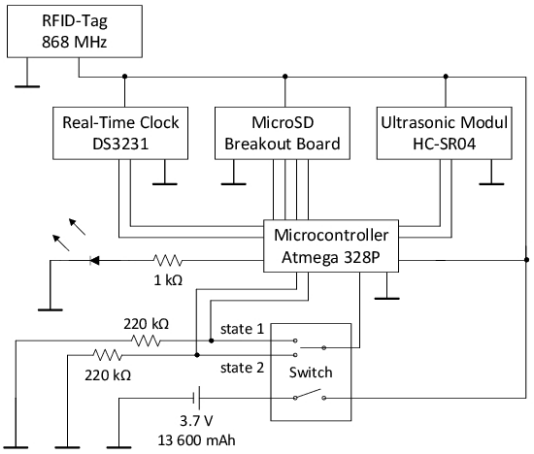

Fig. 2. Circuit diagram of the components used

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