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ExtendedExcavatorHMI

Abstract

The innovation shows new visualization possibilities for excavator operation. Digital information is displayed to the operator in relation to the real environment in an intuitive way. Deviations from the planning model and potential hazards (people, underfloor media) are displayed in the operator's direct field of vision. The use of 3D sensors and AI in conjunction with innovative visualization technologies creates a productive and safe working environment.

Detailed description:

The safe and efficient operation of an excavator places extensive demands on machine operators. While controlling the excavator movement requires experience and concentration, the safety of bystanders must be ensured at the same time despite severely restricted visibility. In addition, the operation of modern assistance systems, such as a 3D machine control system, requires additional attention and disrupts the continuous workflow through interaction with a touchscreen. An intuitive HMI (human machine interface) contributes significantly to a productive and safe working method. However, today's excavators are usually limited to a large number of displays in the operator's peripheral field of vision. This is not conducive to the efficient use and acceptance of assistance systems. The innovation presented here presents new visualization options for the intuitive use of assistance systems on excavators. In order to bring the height control during model-based digging with a 3D machine control system directly into the operator's field of vision, an LED matrix display was attached to the underside of the stick, which visualizes the current difference between target height and actual height of the bucket. The relevant information on the height deviation is displayed directly at the point of action, enabling precise working. To monitor the danger zone on the excavator, cameras with an AI-based personnel monitoring system were installed. Information about the risk and direction of a collision is encoded via a light strip arranged around the front facing window. If a person approaches the excavator inside the danger area, the operator sees a colored light indicator, which shifts from green to red as the risk of collision increases and becomes larger at the same time. The low-threshold visualization enables a constant assessment of the hazardous situation in the direct field of vision. The operator can use this information to independently assess whether a check of the associated camera image is necessary and whether intervention in the control system is required. The third technology developed in this context is the real-time recording of the topography using 3D sensors in order to visualize the reference between the digital planning model and the real environment. When using 3D planning models for model-based earthworks, the machine operator must check whether the model, sensors and the parameterization of the measuring system are correct. A mental link between the digital 3D model on the display and the real working environment is difficult to establish. A colored 3D visualization of the environment topography measured in real time, in conjunction with the digital planning data and the digital twin of the excavator, allows the operator to clearly evaluate the correctness of all systems. Furthermore,

it is possible to visualize the deviations from the target design model. Current systems only show the deviation below the current tool position. The machine operator therefore has all the information they need to plan and carry out the excavation work efficiently. The innovation presented combines the latest assistance systems with an intuitive HMI, which contributes to greater efficiency, productivity and safety thanks to high operator acceptance.