

Mine Digitalization: Automation and Collision Avoidance by Radar-tag Localization and Radar-scan Mapping (UPNS4D+)

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ABSTRACT

Motivation

Mine digitization is a consequent approach to establish industry 4.0 / IoT related mine operation models based on various dimensions: flexibility, coverage, real-time capability and analytics. Networking technology, wired and wireless, can be easily deployed large scale. Miniaturized sensors, thus can be placed anywhere.

Laser technology has been successfully used for more than a decade in the manufacturing industry. However, due to restrictions found in challenging heavy industry environments, such as dust, fog, rain or snow, laser technology can only rarely be found in mining applications. At the same time, technology-supported geometrical environmental scanning is essential for the control of mining machines. GPS in open pit mining is the state of the art technology for machine allocation and dispatch, whereby an underground equivalent is still missing.

Because of this technology gap, many machines are frequently operated beyond their original design boundaries, and not according to the production planning which may result in significant safety impacts and collisions. Recent breakthroughs in radar technology both in 2D/3D passive scanning as well as /3D Active localization is bound to trigger a revolution in mining. In close collaboration with major universities, radar technology has been developed to mature and ruggedized industrial sensors by indurad.

The public funded project “UPNS4D+” which stands for “Underground 4D+ Positioning, Navigation and Mapping System“, funded by BMBF (FKZ: 033R126), focuses on fully autonomous operated vehicles, including navigation, orientation, collision avoidance by driving autonomously around obstacles whether detected with the radar-tag system or by environmental Radar-scan.

Asset and Personnel Localization

Radar-tags are suitable to detect any tagged object or person. Vehicle based Radar-radios are used to measure distances and angles to radar-tags, relative to the vehicle. Any other

machinery, person helmets, equipment can be tagged and thus can be localized. Based on this information, collision avoidance systems can be realized, by informing the vehicles operator or as break assistance system. Next to important localizations “geotags”, e.g. at crushers, the system can be used to exactly position vehicles, like LHDs to perfectly dump the moved material. Virtual fences can be realized to stop machinery if anyone enters a secured area. This enables fast operation e.g. at drill rigs, where manual work is required, when drill pipes have to be added. In room and pillar environments road crossings can be secured, by detecting exactly the own position at the crossing and observation other vehicles.

Environmental Face and Rib Mapping

Radar-scan Mapping is further, very advanced radar based technology to measure 2D planes or even the complete 3D environment around vehicles. As well infrastructure based usage might be considered, e.g. at crossings or crushers. Autonomous mapping radar scans algorithms are developed to reconstruct the surrounding and to detect the own driven trajectory including 3D translation, rotation.