A Test and Evaluation Method for Smart Fully Mechanized Mining Robot Production System

Jiacheng Xie (✉ tyutxiejiacheng@qq.com)

Taiyuan University of Technology

Fuxiang Ge

Taiyuan University of Technology

Tao Cui

Taiyuan University of Technology

Xuwen Wang

Taiyuan University of Technology

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Abstract

A test and evaluation method for smart fully mechanized mining robot production system is proposed. Based on the actual operation data of the geology and equipment of a particular working face, the kinematic models between equipment and coal seam are established. The virtual off-line operation system of fully mechanized coal mining face is constructed. The mining situation of virtual operation of working face reproduced and the simulation initial data and virtual scene operation data are determined. The perception operation model is added to the virtual equipment and AI robot analysis system is constructed. Based on sensor error analysis, execution error analysis and other error analysis, the equipment and geological exploration means are input according to the parameters of smart development and operation in the future. The operation evaluation system of fully mechanized coal mining face which considers cutting track, straightness, working space and dynamic coal seam is constructed. The operation of fully mechanized mining robot in the future is simulated, the development trend is determined and the robot operation performance is tested. The related prototype system is developed, and the testing of the overall operation of the working face was improved from the aspects of smart equipment and digital sensing elements. It shows that this method realizes the reappearance of fully mechanized mining operation process based on actual operation data and operation parameters. The current level of smart mining and some local or a small aspect of technological progress on the overall operation of the working face are analyzed and evaluated. The test and evaluation method points out the direction for the development of coal mine robot and smart mining.

Full Text

Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the manuscript can be downloaded and accessed as a PDF.

Figures

Figure 1

Overall framework of test and evaluation method

Figure 2

System software interaction

Figure 3

Specific situation and demand analysis of demonstration working face

Figure 4

Relevant equipment data and coal seam data of 100 cycles

Perceptual element		Extract virtual angle variable	+Noise	Delay	Current accuracy	Equipment
Extract virtual angle variable	+Noise	50ms	0.3degree

Extract virtual travel variable	+Noise	50ms	50mm+50mm
Script interaction, virtual interface	Extract position and attitude	+Noise	50ms 200ms+	3D angle 0.1degree Position error10mm+
Coal and rock identification method		Extract the information of coal seam	+Noise	1s	100mm	
3D modeling of coal seam in geological exploration		Dynamic coal seam information	+Noise	Preset, calculation per cycle	>300mm+
Camera		Virtual vision	+Noise	2s	500mm	
Detection of curvature and straightness of scraper conveyor		Virtual detection	+Noise	calculation per cycle	20mm 40mm
UAV detection scanning		Virtual detection	+Noise	calculation per cycle	>100mm	

Figure 5

Composition of virtual perception system

Figure 6

Off-line operation simulation system

[illegible]

(a) Cutting data of shearer operation

(c) Surface fitting

(b)Analysis of cutting roof and floor model

(d) Coal seam construction

Figure 7

Working face coordinate system

Figure 8

Construction method of coal seam cutting floor based on Mesh grid

Figure 9

The general framework of AI operation of the virtual synthesis mining robot

Figure 10

Initial scenario construction and offline simulation results

Figure 11

Forecast coal seam

Figure 12

Evaluation method

Figure 13

Straightness information extraction of scraper conveyor and hydraulic support group

Figure 14

Three dimensional schematic diagram of workspace of fully mechanized mining equipment with three cutting schemes