

Grant Number: AFC417-21

Title: Autonomous Underground Mining Systems To Improve Safety - Intelligent Coal Mining

Organization: University of Kentucky

Principal Investigator(s): Zacharias Agioutantis

Partnerships: Virginia Center for Coal and Energy Research, Virginia Tech Transportation Institute, and Alliance Resource Partners, LLP

Focus Area: Health and Safety Interventions

Topical Area: Machine Design

SYNOPSIS

Research Topic and Problem Statement: The working face of an underground coal mine is a dynamic work area that exposes miners to numerous occupational hazards, including mobile equipment congestion, excessive noise, and respirable dust. The goal of this project is to address these hazards by supporting the development of an autonomous shuttle car system that will enhance and transform the role of the shuttle car operator and reduce risk to all miners at the working face. The intent of this work is not to replace the role of the shuttle car operator with automated machinery, but to complement their expertise, and improve their comfort and well-being and ensure that they remain competitive in a challenging and changing industry. This project involves multiple technical and ergonomic challenges, namely: a) developing an accurate and reliable underground navigation system and methodology, b) accounting for human factors related to the automation of certain tasks, and c) designing developing and demonstrating a functional autonomous shuttle car.

Holistic Approach: The design and demonstration of an autonomous shuttle car system requires a concerted research effort to address knowledge gaps and uncertainties spanning multiple scientific disciplines. To this end, the research team will comprise experts in mining, automation, human factors, and organizational psychology. This multidisciplinary team will support an integrated methodology that holistically considers the impact on the machine operators, nearby miners, and the overall work organization of the autonomous technology in addition to its development. The research will be composed of two primary solution elements: (a) mining systems and (b) human factors. Mining systems will address technological solutions to challenges associated with automating the shuttle car. These technical challenges include autonomous navigation, adapting and conforming to safety regulations, and integrating the shuttle car into the mining process. Human factors will address challenges including basic function allocation between the human and machine, impacts on the social organization of the workplace, and psychological impacts of humans working in tandem with automated machinery. To ensure that the priorities, concerns, and

talents of each working group are fully utilized, representatives of each working group will meet regularly to foster both prudent project management as well as a fruitful collaborative environment.

Proposed Outcome and Impact on Mining Health and Safety: The introduction of an autonomous shuttle car system has the potential to significantly reduce the health and safety hazards faced in shuttle car haulage. The proposed project aligns with the Alpha Foundation for the Improvement of Mine Safety and Health's topic area (1) Health and Safety Intervention. This project intends to remove the shuttle car operator from the hazards and conditions present in the active mining area between the continuous miner and the feeder breaker. Automation of shuttle cars will prevent operators from encountering hazards derived from performing shuttle car haulage tasks. By locating the operator away from the shuttle car, exposures to noise and dust, which is a particular focus of the proposed research, are also dramatically reduced. The developed autonomous system will also reduce operator hazards and risks associated with repetitive heavy equipment operation, such as fatigue-related incidents and soft tissue injuries.