

Robotic Mine Mapping and Accident Response

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ABSTRACT

Our coalfields are vulnerable to breaches, inundations and entrapment, since complete, accurate maps do not exist for many mines. Submergence, roof fall, rotted timbers and water seals prevent human access for re-mapping, and they motivate the use of robots. Robots offer unique capability relative to complementary mapping technologies, and future robots will exhibit further technical, safety and cost advantages for mapping abandoned mines. The presentation will describe what mine robots are, how they build maps, how they know where they are and where they are going. A robot map will be compared to a human-surveyed map to illustrate the distinctions of the new technology. The presentation will exhibit live mapping of a mine by a robot to convey the power of the technology in action. We will view a robot from our symposium in Charleston, while it maps a mine from another state. We will share the experience of exploration and mapping to graphically understand the principles and capabilities offered by the technology.

Technical advantages of robotic mine mapping include: (1) Physical presence by a robot inside underground cavities guarantees the existence of void (2) Direct observation of the surface of an internal cavity is superior to complementary approaches that only make inference from external observation (3) Robotics offers survey quality mapping versus approximation of location (4) Robotics models 3-D surfaces like roof, walls and floors versus approximation by a centerline (5) Small robots will be developed to access confined voids undetectable by complementary approaches

Safety considerations for mine mapping robots include: (1) Use of robotic machines precludes people from harm's way (2) Robots can be certified for operating in the circumstances of abandoned mines

Roles of abandoned mine mapping robots, present and future, include: (1) Premapping perimeters adjacent to proposed new mines to audit old maps for fidelity (2) Operating during accident response to search, communicate and deliver (3) Exploring post-breach events to tie all maps of old workings together (4) Exploring from boreholes and breaches to fill mapping gaps, if any (5) Exploring from boreholes and breaches to confirm perimeter as safety assurance for future mining

The technical agenda for robotic mine mapping is: (1) Develop mineworthy mapping robots (2) Create new physical forms of mapping robots like minefish and amphibots (3) Invent robotic mapping sensors specialized for coal mines (4) Create technology for mine robot exploration autonomy (5) Develop methodology for creating complete mine maps from selective access (6) Create interfaces to facilitate ease of use in field operations

Opportunity and charter for the mining community to fulfill robotic mine mapping: (1) Lead the world and support robotic mine mapping (2) Grant variances to enable robotic mapping of abandoned mines, at least for R&D (3) Resolve technical standards for certifying robots and ops in abandoned mines (4) Support research enabling robotic mine mapping operations (5) Support enterprise enabling commercialization and support of robotic mapping services to the mine industry