

INDUSTRIAL TECHNOLOGIES PROGRAM

Effective Conveyor Belt Inspection for Improving Mining Productivity

Low-Cost, Comprehensive Inspection System Will Identify Defects in Mining Conveyor Belts, Reduce Unscheduled Maintenance and Downtime and Increase Efficiency

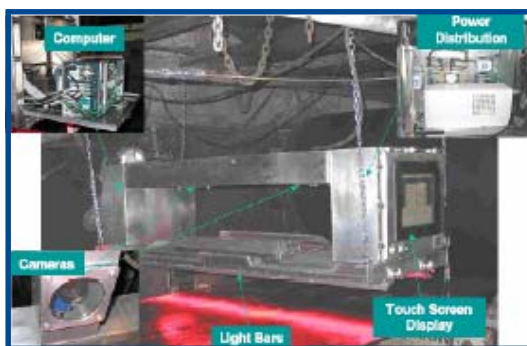
Mining operations rely on conveyor belts to move mined material from the working face to a processing plant. When a conveyor belt breaks or its operation is halted for unscheduled maintenance, this generally results in a stoppage of production as the belt is the only way to carry material away from the mining unit, and stockpiling is typically not available at the point of extraction. Longwall mining operations can produce revenue at \$1,000/minute and a mainline belt break will stop production for a minimum of four hours, resulting in \$240,000 of lost revenue. Current belt inspection methods have a limited capability, as they can only detect mechanical splice defects but not surface defects, or early signs of longitudinal rips in the steel cabled belts. If an effective belt inspection system was in place, belts that showed signs of degradation could be scheduled for repair during planned shutdown shifts, eliminating the possible breakdown and loss of revenue during production.

To address this challenge, Carnegie Mellon University's National Robotics Engineering

Consortium (NREC) and their project partners are working to develop and commercialize a low-cost, comprehensive inspection system to identify defects in conveyor belts used in underground and surface mines, and other large scale material handling operations. The system will monitor belt quality and provide status to the mine personnel in time to take action before a belt breaks.

Two technical approaches have been identified that will combine to detect most defects that cause major belt failure. The first uses digital imaging with custom vision algorithms to detect failures. The second uses structured light to highlight defects. These two approaches could be integrated to create a robust and reliable inspection system.

Current belt inspection systems do not have the capabilities for use in surface mines and process plants. The work on this project is aimed at expanding the capabilities of the current system to address the needs of surface mines as well as material processing plants and other facilities that use conveyor belts to transfer materials. The system will also be re-engineered to reduce its cost, thereby making installation on the majority of mine belts, cost-effective.



Current Belt Inspection System



Benefits for Our Industry and Our Nation

- *Expected to reduce unexpected belt failures by 70%.*
- *Decreases energy consumption and increases revenue by reducing downtime and operation stops.*

Applications in Our Nation's Industry

A low-cost version of the current Belt Inspection System will be developed. This will allow mine operators to install these systems on all of their production belts, thus enabling its predictive maintenance capabilities to be applied broadly across a wide range of mine operations and conveyor belt types. This system will create energy savings across the mining industry, coal-fired power generation plants, and other large scale material handling operations.

Project Description

The objective of this project is to develop a low-cost automated belt inspection system that will decrease the frequency of unexpected belt failures and increase overall belt availability in underground and surface mines.

This development will be completed through two primary efforts over a three-year period. The first will be based on digital camera visual inspection. New vision algorithms will be developed through software to detect edge damage, cover damage, holes and vulcanized splices on fabric belts. This will alert mine management of specific belt problem areas prior to catastrophic belt failure. This development will also provide managers with the information necessary to schedule maintenance activities during planned maintenance periods. The second effort will utilize structured light through the development of structured light sensor hardware, which will be able to detect edge damage, cover damage, holes, rips and gouges.

The project team is composed of the National Robotics Engineering Consortium (NREC), CONSOL Energy Inc. and the Beitzel Corporation. The NREC will take the technical lead in the design of the low-cost system, in the development of vision algorithms to give the system the expanded capabilities required for the applicability of the system to all mine belts, and for the development of a structured light system.

CONSOL will work with NREC to install the technology in their mines. Beitzel will provide NREC with advice on manufacturability and supportability for this technology.

Milestones

- Developed and demonstrated a prototype version of the low cost image-capture and lighting hardware. (2004)
- Complete development of structured light inspection system. (2006)
- Conduct long-term testing of the belt inspection system across different belt types and production mines. (2006)
- Demonstrate vulcanized splice integrity system. (2006)
- Demonstrate low-cost pre-production hardware at NREC. (2007)
- Develop and fabricate the entire lowcost belt inspection system and begin long-term testing in a production mine. (2007)

Commercialization

- Total of 16 Belt Vision (prototype) units deployed in 7 different mines, including two commercial customers.
- More than 2 million cumulative miles of belt inspected by deployed evaluation systems.
- Beitzel Corp is currently producing and selling a very low volume of the developmental systems for end user evaluation. The logistics of deploying and supporting a system in mines dictate a cautious approach.
- Beitzel Corp continues to survey belt managers for input into desired system features and potential new target markets.
- Low-Cost Smart-Camera subcontract is signed and development work is well underway.

Project Partners

Carnegie Mellon University
Pittsburgh, PA

CONSOL Energy, Inc.
Pittsburgh, PA

Beitzel Corporation
Grantsville, MD

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.



U.S. Department of Energy
**Energy Efficiency
and Renewable Energy**

Bringing you a prosperous future where energy
is clean, abundant, reliable, and affordable

August 2006
Ending in FY 2007