Understanding How Sensor Fusion AI Is Making Steel Industry Workplaces Safer

Hazards are ever-present in the steel plant environment, and a heightened awareness and emphasis on safety is a necessary priority for our industry. This monthly column, coordinated by members of the AIST Safety & Health Technology Committee, focuses on procedures and practices to promote a safe working environment for everyone.

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Comments are welcome. If you have questions about this topic or other safety issues, please contact safetyfirst@aist.org. Please include your full name, company name, mailing address and email in all correspondence.

Humans use five senses — sight, touch, taste, smell and hearing — every day to understand our environment and assess any risks or dangers. One sense is valuable, but when all five are used together, the ability to prevent an accident before it happens increases dramatically.

Think about an afternoon bike ride with beautiful weather. Before you even see a vehicle traveling toward you, you hear it and your other senses begin gathering input. By the time the vehicle travels into your line of vision, you're already incorporating that input. Without realizing it, you may use your sense of touch to grip the handlebars a bit tighter to veer out of the way if necessary. And is that exhaust you smell? You're innately processing input from each of your senses and instantaneously deciding if the situation poses any risks. If there is a risk, you naturally move away from traffic. If no risk is indicated, you continue biking and enjoying your day without ever consciously realizing all the data your body just processed.

Now imagine walking through a steel mill, fabricator or processor. Instead of that data coming from your senses, a technology platform is gathering input and data from multiple sources to continuously inform you, your workplace and your team members, proactively protecting you and your co-workers from incidents and accidents. The information it gathers, much like the inputs your senses gathered on your bike ride, is processed by artificial intelligence (AI) algorithms that can make the same type of split-second decisions you made.

Sensor fusion-based AI makes this concept a reality.

Sensor Fusion at Its Core

Sensor fusion is the process of combining data from multiple components to generate an output or action that is more accurate and reliable. Much like our five senses, sensors are often used individually, but a combination of these inputs has been proven to be more valuable. Sensor fusion is how AI in health and safety understands an environment and decides if there are any definable risks or dangers present.

Cameras, computer vision, radar, GPS, lidar and wearables are all devices that can be incorporated into a sensor fusion AI health and safety platform. Inputs gathered from these devices and potentially machine state status via programmable logic controller (PLC) integration are sent to a central system for holistic analysis and processing by AI algorithms that create an almost immediate output. The more data input the system receives, the more it "learns." While output results are more accurate with multiple sensor inputs, sensors are not dependent on each other. Should one sensor fail, the remaining sensors continue to actively gather data. Using multiple state-of-the-art sensors allows for constant gathering of consistent data even in the harshest conditions like a steel mill or construction site.

A Deep Dive Into AI

The hardware sensors that feed data to the deep-learning algorithms provide information used to contextualize the environment, specifically around worker activity. Examples include:

- High-definition cameras and thermal imaging cameras act as inputs for computer vision (CV) which allows the system to "see" and understand digital images and videos. Computer vision is the ability for systems to see or sense a specific stimulus, contextualize what is being seen, and extract and communicate that data in such a way that it can be used to educate and inform the actions taken by AI algorithms.
- Radar sensors detect moving objects, like a worker or mobile equipment, using radio waves.
- Lidar uses a laser to project a beam onto a target and then measures the reflection to provide a measure of range.
- Real-time location systems (RTLS), much like indoor GPS, provides centimeter-accurate location detection. Workers, machinery and mobile equipment equipped with location tags are tracked in real time using RTLS. RTLS anchors create a mesh that keeps in constant contact with the sensors, creating a zone of protection.
- Wearables allow for two-way communications with workers, providing inputs as well as acting as notification devices using haptic responses.

All data is continuously gathered and passed wirelessly to edge servers situated at the edge of the safety zone. True to its name, the edge server must be at the edge of the zone to process the sensory data in real time and access the deep-learning models. These high-powered computers are powered by NVIDIA Titan RTX graphics processing units (GPU) capable of processing 130 trillion calculations per second, per card. Each edge server can be outfitted with a number of cards depending on the environment and the number of sensors a specific safety zone requires.

Supervised Learning

Turning those trillions of calculations into input that educates the AI algorithms or "brain" of the system requires a process called supervised learning. This is where human interaction from engineers and Ph.D.-level technologists becomes imperative to train the models. The process requires sensor fusion inputs to be translated into numeric data sets that create large matrix tables. The data within those tables is labeled by humans looking for positive and negative scenarios to train the AI system on what specifically to look for within the model. This process of feeding positive and negative inputs trains the AI algorithms to detect the underlying patterns and relationships within the data which represent real-world activities, be it the movement of a worker or the trajectory of a crane. The more data the system receives, the more generalized its learning can become as it looks for patterns within the data. This pattern recognition is how the system can contextualize the inputs even when presented with never-before-seen data.

Once trained, this AI process occurs within the edge servers to trigger an immediate response from the system when it recognizes a positive pattern within the data it has been trained to process. Such action can involve an alert to a worker who has violated a safety protocol or the slowing of an overhead crane that is moving dangerously close to humans or machinery. Once sufficient data has been labeled and processed by the system, the models generate predictions with over 90% accuracy which mirrors or exceeds the accuracy of humans to detect potential hazards. However, technology doesn't suffer from distraction, fatigue or the need for a break.

Sensor Fusion Use Across Industries

Today, sensor fusion–powered AI is used widely across multiple industries, the most publicized being in the evolution of the autonomous vehicle. Sensor fusion combined with AI is what gives these vehicles capabilities for static object detection, moving object detection and tracking, occupancy grid mapping, navigation and much more. This is a great example of how a properly trained model can instantaneously process continuous outputs and take actions based on that data even if it has never processed it before, be it swerving to miss a newly fallen branch or slowing down to avoid a new pothole on a city street.

Smart cities are also utilizing this technology. Multi-sensor systems like cameras, motion sensors, and others allow for cities to efficiently monitor pollution, improve traffic flows, and enhance public safety.

And finally, sensor fusion can be found nearly everywhere in hospitals. The technology in the form of wearables are placed on patients to monitor heart rates, oxygen levels, blood pressure, body temperatures and even moods. The combination of the data and inputs from these devices provides a much more accurate picture of a patient's health than one sensor could alone.

Sensor Fusion and the Steel Industry

When it comes to employee health and safety in the steel industry, sensor fusion–based AI gives mills, fabricators and processors the ability to shift from a reactive response to a proactive, behavioral training program. This technology helps bring the industry one step closer to reaching the goal of an accident-free steel industry.

Consider an overhead crane in the process of moving a coil or beam in a shipping bay. The crane

carrying the load is moving south, but there is a worker with their back to the crane moving north, not realizing they are about to walk directly under a heavy load. In a bay equipped with sensor fusion AI, the mix of hardware, software, bio-metric wearable devices and other sensors feed data to the AI algorithms embedded in a technology platform to remind that worker of safety protocols, all in under half a second.

Camera A attached to the crane tells the system the crane is moving and in what direction. Camera B views the worker moving toward the crane and relays that input to the system. The data is processed almost instantaneously to create an alert which is sent to the worker via a bio-metric wearable device before they reach the danger area beneath the moving crane. An alert can also be sent to the crane operator to notify them to stop movement. In addition to the cameras, a sensor can be placed on the crane itself to surround it with a geofence. Once the worker ventures within inches of the geofence, that same wearable on their wrist buzzes with an alert. With multiple input devices, the system does not rely on one set of data but instead continuously assesses the entire environment to train the AI algorithms to act as outlined above.

In this scenario, sensor fusion AI is able to provide behavioral training via the alerts to encourage worker behavior that lowers incident rates and helps avoid dangerous situations before they happen, including fall protection, worker-to-worker and worker-to-vehicle detection, and many others.

Sentri360™ Solution for Steel

Everguard's mission is to make the world's industrial environments safer. To do that, it has developed an approach that offers an AI solution to scan through multi-sensor inputs in real time and proactively alert workers to health and safety concerns. Sentri360™ includes computer vision, AI, real-time location services, sensor fusion, and analytics in combination with multiple sensors to provide live, actionable oversight that ensures worker health and safety. Data is collected in the analytics portal to help recognize improvements in worker behavior, generate reports and manage the system itself. ✦