Release No. 49
Mexico City, October 5th, 2025

Polytechnic Students Design Explorer Robot that Maps and Detects Risks in Mines

- **Also known as a rover, the prototype identifies hazards such as collapses, fractures, and toxic gases to prevent accidents and strengthen safety measures**
- **The system integrates emerging technologies, including mapping, simultaneous localization, neural networks, and computer vision.**

Using neural networks and computer vision, students from the Instituto Politécnico Nacional (IPN) developed an exploratory rover capable of detecting geological risks, extreme conditions, and toxic gases in mines. The goal is to enhance safety protocols and protect workers operating in hazardous environments.

Carolina Abigail Gallo Meneses, Yesenia Cruz Domínguez, and Lesly Verónica Salazar Jiménez, students from the Unidad Profesional Interdisciplinaria en Ingeniería y Tecnologías Avanzadas (UPIITA), adapted a high-performance Raspberry Pi 5 single-board microcomputer, two gas sensors for carbon monoxide and nitrogen dioxide, a lamp, and a depth camera to a commercial exploration vehicle.

The project aligns with Commitment 33 of the 100 initiatives presented by President Claudia Sheinbaum Pardo and promoted by the Secretaría de Educación Pública (SEP), led by Mario Delgado Carrillo, which seeks to bring young people's technological developments from the classroom to real-world applications.

The Telematics Engineering students explained that the depth camera enables the rover to capture RGB images even in complete darkness. These images are fed into the Visual SLAM (Simultaneous Localization and Mapping) system, which generates spatial maps that are later processed offline.

With guidance from Dr. Rodolfo Vera Amaro of UPIITA and Dr. Lucero Verónica Lozano Vázquez of the Escuela Superior de Ingeniería Mecánica y Eléctrica (ESIME), Unidad Azcapotzalco, the students designed a web platform that stores and displays the robot's collected data through 3D maps, geolocation information, timestamps, and gas measurement graphs.

"The robot's map only shows points and shapes, but once processed at the base station, it produces a detailed model of the mine's conditions—fractures, collapsed areas, rocks, and flooded zones," explained Lesly Verónica Salazar Jiménez.

As part of the prototype's development, the team visited a mine in Durango to observe working conditions firsthand and assess the risks miners face. They noted that while some foreign technologies exist for mine inspection, these systems are typically stationary and must be manually relocated, exposing operators to danger.

"Inside the mine, about 30 kilometers underground, there's no signal at all—the GPS is completely lost. That's why the rover had to be fully autonomous and capable of operating without an internet connection," said Carolina Abigail Gallo Meneses.

To train the neural network, the team used approximately 5,500 original images, which were rotated and processed in different positions to reach a total of 13,000 images, captured both in the Durango mines and in a custom-built testing model.

The IPN students developed a high-performance system utilizing emerging technologies, including simultaneous mapping and localization, neural networks, and computer vision—tools that facilitate more informed decision-making in the mining industry. They plan to pursue a patent and continue refining the rover for large-scale industrial applications.

For more information, visit www.ipn.mx

===000===