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Internet of Things, Edge and Cloud Computing in Rock Mechanical Investigation for Underground Surveys

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Abstract : Rock mechanical investigation is one of the most crucial activities in underground operations, especially in surveys related to hydrocarbon exploration and production, geothermal reservoirs, energy storage, mining, and geotechnics. There is a wide range of traditional methods for driving, collecting, and analyzing rock mechanics data. However, these approaches may not be suitable or work perfectly in some situations, such as fractured zones. Cutting-edge technologies have been provided to solve and optimize the mentioned issues. Internet of Things (IoT), Edge, and Cloud Computing technologies (ECt & CCt, respectively) are among the most widely used and new artificial intelligence methods employed for geomechanical studies. IoT devices act as sensors and cameras for real-time monitoring and mechanical-geological data collection of rocks, such as temperature, movement, pressure, or stress levels. Structural integrity, especially for cap rocks within hydrocarbon systems, and rock mass behavior assessment, to further activities such as enhanced oil recovery (EOR) and underground gas storage (UGS), or to improve safety risk management (SRM) and potential hazards identification (P.H.I), are other benefits from IoT technologies. EC techniques can process, aggregate, and analyze data immediately collected by IoT on a real-time scale, providing detailed insights into the behavior of rocks in various situations (e.g., stress, temperature, and pressure), establishing patterns quickly, and detecting trends. Therefore, this state-of-the-art and useful technology can adopt autonomous systems in rock mechanical surveys, such as drilling and production (in hydrocarbon wells) or excavation (in mining and geotechnics industries). Besides, ECt allows all rock-related operations to be controlled remotely and enables operators to apply changes or make adjustments. It must be mentioned that this feature is very important in environmental goals. More often than not, rock mechanical studies consist of different data, such as laboratory tests, field operations, and indirect information like seismic or well-logging data. CCt provides a useful platform for storing and managing a great deal of volume and different information, which can be very useful in fractured zones. Additionally, CCt supplies powerful tools for predicting, modeling, and simulating rock mechanical information, especially in fractured zones within vast areas. Also, it is a suitable source for sharing extensive information on rock mechanics, such as the direction and size of fractures in a large oil field or mine. The comprehensive review findings demonstrate that digital transformation through integrated IoT, Edge, and Cloud solutions is revolutionizing traditional rock mechanical investigation. These advanced technologies have empowered real-time monitoring, predictive analysis, and data-driven decision-making, culminating in noteworthy enhancements in safety, efficiency, and sustainability. Therefore, by employing IoT, CCt, and ECt, underground operations have experienced a significant boost, allowing for timely and informed actions using real-time data insights. The successful implementation of IoT, CCt, and ECt has led to optimized and safer operations, optimized processes, and environmentally conscious approaches in underground geological endeavors.

Keywords : rock mechanical studies, internet of things, edge computing, cloud computing, underground surveys, geological operations
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