A CRITICAL STUDY ON AI HUMANOID ROBOTS IN MINING

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***Abstract*:** Over the past few decades, the technological advancements made human life easier and more digitalized. Artificial intelligence being one of them, aims at revolutionizing the entire world. Though changes are necessary in order to improve and grow towards a better tomorrow, this revolution would inevitably cost a lot in terms of jobs of working sector as with the passage of time, AI and AI humanoids will take hold of numerous jobs of diversified nature and will render millions of people jobless, further resulting in other dreadful repercussions. Today's fast changing world leads to massive industrialization which require enormous amount of energy and other materials obtained from mining. In contrast to such a harrowing scenario, we can devise an aspect of world where humans retain their existing jobs and concurrently AI humanoids performing certain hazardous and very hard jobs. Such a measure would pave the way for a win- win situation where both human's usual course of life and technological advancements do not come to a standstill, otherwise AI might entirely take over the world leaving its creators, i.e. the humans behind. This paper aims to impart that AI humanoids can be created with certain special features to carry out work in mining, one of the most hazardous industries comparatively with much ease thereby saving lives of millions.

Keywords: Artificial Intelligence, Humanoid, Hazardous, Mining

I.INTRODUCTION

Computer stands as one of the greatest human inventions till date. Initially they were used only to serve the purpose of performing calculations, but with the passage of time and drastic evolution of technology it has led to the evolution of artificial intelligence (AI), a field which combines computer science and robust datasets to enable problem solving. Today's era being the AI era, emphasizes that machines can learn, at least to some extent like human beings. The same is evident from the application of AI in recent times across diversified sectors such as agriculture, healthcare, education, banking and finance, customer service, etc.

Apart from this, AI played a pivotal role in the invention of humanoids. Humanoid robots refer to robots whose shape resembles human structure, i.e they are usually given an anthropomorphic body which enables them to move and multi contact technology is used to make them move in environments where it is difficult for existing robots to operate. Until recently, there was no humanoid robot that has been put to practical use other than R&D and communication applications. This is because there is no necessity to use humanoid robots where existing robots can be easily applied. On the other hand, to promote the industrialization of humanoid robots, it is thought that their deployment as avatar robots would be an effective way, as it will enable humans to perform tasks that are difficult or dangerous while allowing them to be in a safe and comfortable environment.

Recently in Kerala, introduced an AI robot named Iris as a teacher. It was reported by various news channels that Iris can answer complex questions pertaining to various subjects, provide personalized voice assistance and also facilitate interactive learning experiences. Thus, by starting industrialization of humanoid robots in this manner and

utilizing them in the real fields every day, a virtuous cycle can be expected to emerge whereby costs are reduced while reliability and autonomy are improved. All of these advancements may seem beneficial to the fullest but they possess their own negatives. One of the most dreadful consequences of excessively using AI and robots in various jobs will definitely be massive unemployment of people all over the world.

Every year, thousands of miners die and several miners are left injured in accidents, especially while engaging in coal mining and hard rock mining. The surviving people of such families will also lose the job of any nature which is their only means for livelihood since AI will replace their place in their workplace. Though the mining industry, particularly coal mining, is undoubtedly renowned for its hazardous nature, in the need of valuable resources vital to our modern society, it has been a cornerstone of our economic development for several decades. This article aims to critically analyze the inherent hazards in mining activities and subsequently, delve into the realm of humanoid robotics, discussing their potential as a transformative solution to mitigate these risks and revolutionize the mining industry.

II.OBJECTIVES OF THE STUDY

This study will propose a feasible solution for workforce transition to bring out a balance between the jobs of humans and AI integrated humanoids by investigating how the integration of AI humanoid technology can enhance safety in coal mining operations after analyzing the hazardous working conditions in mines. The coal mining process is fraught with perilous working conditions, exposing workers to a multitude of risks including exposure to toxic substances, physical hazards, and the constant threat of accidents. Despite concerted efforts to improve safety protocols, accidents and fatalities persist, indicating the pressing need for innovative solutions to enhance worker safety.

III.MINING HAZARDS

Mining is the extraction of valuable minerals in either solid, liquid or gas form from the earth. Mining is required for the supply of all the basic resources like oil, coal, etc. for electricity generation and other purposes. The other materials recovered by mining include aluminum, copper, lead, zinc, gold, silver, diamond, metal, coal etc. There are mainly two methods for extracting coal from earth-surface mining and deep underground mining.

Most surface mines are open cast mines. In surface mining, soil and the rocks covering the mineral deposits are removed. The advantages of such mining are high productivity, low operating cost and good safety conditions. Most of the coal is extracted using the surface method. In case of deep underground mining, the underground mines are either supported or unsupported mines. The supported method uses artificial pillars for support and is often used in mines with weak rock structure. The artificial supports are not available for unsupported mining as this method is used in those areas where strong rock structures are available. Underground coal mining involves a higher risk due to the problems relating to ventilation and collapse. Underground mining operations present a multitude of risks, including structural collapses, equipment failures, and exposure to hazardous substances. Moreover, the physically demanding nature of mining work predisposes miners to musculoskeletal injuries and fatigue-related accidents, further compromising their health and safety. The main reason for miner death is the presence of lethal gases and its explosion. In coal mines carbon monoxide, methane, and lpg exist and they are very harmful for the human body. The inhalation

of other toxic gases and particulate matter, such as coal dust and silica, can lead to a range of respiratory ailments, including pneumoconiosis and chronic obstructive pulmonary disease (COPD).

The other main reasons of accidents are gas or dust explosions, improper use of explosives, electrical fires, rock falls from roofs and side walls, flooding, workers stumbling, slipping, falling, use of personal protective equipment like helmet, shoes etc. are not proper and proper arrangements are not there to check if the person is wearing personal protective equipment or errors from malfunctioning or improperly using the mining equipment, The proper supervision for workers is a very important factor for consideration. Beyond the immediate physical risks, the adverse working conditions prevalent in many mining environments contribute to long-term health issues and psychological stress among workers. Irregular working hours, isolation from social support networks, and the constant threat of injury or death take a toll on the mental and emotional well-being of miners.

The world has proven reserves equivalent to 133.1 times its annual consumption. The all-India production of coal during 2022-23 was 893.19 mt with a positive growth of 14.77%. India is the second largest coal producing country after China. Coal is the key contributor to the Indian energy scenario. Thus, many people and children are being forced to be employed in mining industries for two main reasons, to attain the desired amount of coal production and due to their poor economic conditions. It is obvious that a lot of lives are at stake.Hence to eradicate deaths of miners and to not become a target as mentioned in the flowchart, an alternative must be chosen wisely since it cannot be denied that overall growth is not possible if the focus is concentrated on only one aspect, i.e., technology.

IV.SUGGESTIONS

It is believed that AI and AI integrated humanoids can be used to help people to focus more on creative activities by replacing them in numerous activities such as receptionist, food service employment, etc. and in hazardous tasks. Since Honda introduced the P2 in 1996, numerous humanoid robots have been developed around the world, and research and development of various fundamental technologies, including bipedal walking, have been conducted. At the same time, attempts have been made in various applications such as plant maintenance, telemedicine, vehicle operation, home security, construction, aircraft manufacturing, disaster response, evaluation of assistive devices, and entertainment. One of the major concerns which arises due to the emergence of AI and such AI integrated humanoids, is the displacement of human jobs. It has been estimated that around 14% of the workers worldwide have experienced job displacement due to AI. It is further expected that by 2030, AI can potentially replace around 800 million jobs across the globe.

Therefore, instead of AI replacing various jobs in numerous diversified sectors, AI and AI integrated humanoids can be used only in two instances. Firstly, they can be used in extremely hazardous and unsafe environments which are a threat to the lives of people such as mining, pesticide industries, etc. Secondly, they can be used to perform certain tasks which are very complex and physically demanding in nature. In this way, the livelihood of the people who belong to the poor strata of society is also ensured by not snatching away their jobs entirely and safeguarding them from several health hazards caused due to working in such industries. This paper focuses on the

first perspective to provide a win-win situation for both the workers of the mining industry and for the application of AI integrated humanoids. Existing safeguards for coal miners such as hi vis gear which ensures that miners are always visible, especially where vehicles are tend to operate, gloves to prevent scrapes and abrasions, smart helmet which provides a real time monitoring of harmful gases, person fall detection, compulsory eye protection measures which comprises safety spectacles, goggles, face shields or a full facepiece respirator and traditional safety measures such as fixed monitoring stations and manual monitoring, may not provide real-time and comprehensive monitoring of crucial parameters, which can result in delayed actions thereby increasing risks for miners.

Mining being a physically demanding job, workers are not provided even with equipment that is comfortable and easy to wear for long durations. The existing wearable solutions lacking in integration of multiple sensors and timely alert mechanisms. There is a need for an advanced technology that can provide real-time monitoring of important health and safety parameters. The wired communication network is not so effective because when a natural calamity or a roof fall occurs, the wired network is damaged, so it is very difficult and costly to reinstall the entire system. In wired network technology installation and maintenance cost is very high. The effective solution for communication from base station to underground mine with wireless network. Even if this need is addressed, the deaths caused due to mining activities cannot be eradicated completely. Therefore, miners can be replaced by AI integrated humanoids which has either in built features that can monitor various parameters, such as gas concentration, temperature, and motion in real-time and notify supervising miners in case of any abnormalities or have all these features embedded in a sensor suit exclusively made for the new age miners –Humanoid Miners.Proper supervision and proper communication are a very important requirement of the mining industry. Remote mining operations can be carried out, if necessary, where AI-humanoid robots can be controlled remotely by operators who use the data from sensors to make decisions about the safety and operation in extremely dangerous mines.

A. SPECIFICATIONS

Humanoids designed exclusively for mining shall have certain specifications that make them suitable for harsh and potentially dangerous conditions. The major elements that are extremely necessary are:

- Ruggedness: They must be able to withstand the rough conditions of a mining environment. This means they must be built to be tough and durable, able to withstand abrasion, exposure and impact of dust, moisture, and other environmental factors.
- Data logging and analysis: It must be capable of generating large amounts of data, which can be used for identifying patterns and trends in worker safety and productivity. It should have the capability to log and analyze data over time, and to provide reports and insights to management and safety teams.
- Wireless connectivity: Additionally, to provide real-time data and alerts, they need to communicate wirelessly with other devices and systems. This requires robust wireless connectivity, with features like Bluetooth, wi-fi, or cellular connectivity.
- Sensor: It must be equipped with a microcontroller, temperature sensor, gas sensor and emergency button
- GSM module: when the measured values of sensors reach the threshold values, a GSM module will send an alert message to notify the workers and the supervisors about the potential danger. The accuracy of the sensors in the suit is crucial for ensuring worker safety.

- GPS module: It must possess a GPS module so that manual operators can know and keep track of their location.
- Thermal camera: Thermal cameras integrated with humanoid robots offer enhanced vision through dust and smoke, ensuring safety and efficiency in mining environments. Their ability to penetrate obstructions aids in navigation, equipment monitoring, and search and rescue operations, enabling uninterrupted productivity and proactive maintenance.

B.DESIGN OF SENSOR SUIT

In the case of a suit, a sensor suit needs to be comfortable, durable, and easy to wear. It is important to choose materials that are lightweight and can withstand the harsh conditions of a coal mine. The suit should be designed to fit snugly on the humanoid's body, with sensors placed in strategic locations to ensure accurate readings.

TYPES OF SENSORS

The sensors used are critical to the success of the mission of deploying humanoid miners instead of human miners, thus these sensors need to be reliable, sensitive enough to detect dangerous levels. Some of the most used sensors can be implanted in the humanoids for much effective and safer mining and they are as follows:

GAS SENSOR

Gas sensors are utilized to distinguish ignitable, combustible and lethal gases along with oxygen exhaustion. This is utilized majorly in industries and in firefighting. These often use perceptible caution to alarm individuals when a perilous gas has been identified. Gas sensors are critically important to ensure the safety of workers and equipment. AI-humanoid robots equipped with gas sensors can play a vital role in mining operations. Integrating the sensor data into the robot's control system and decision-making algorithms is crucial to achieve optimal efficiency. This allows the robot to respond quickly and autonomously to gas-related events. The following are the ways how gas sensors can be used in AI-humanoid robots for mining:

Gas detection - One of the primary functions is to detect the presence of harmful gases such as methane (CH4), carbon monoxide (CO), hydrogen sulfide (H2S), and other lethal gases. These sensors can continuously monitor the air quality in the mining environment. If dangerous gas levels are detected, the AI-humanoid can provide real-time information about the concentration of hazardous gases in the vicinity and immediately alert the supervisors to evacuate the mine.

Mineral sourcing - AI-humanoid robots equipped with gas sensors can detect the presence of valuable minerals or resources based on the analysis of gases emitted from rock formations.

Compliance with environmental regulations - They can detect emissions of harmful gases that may be released during mining operations, helping companies comply with environmental regulations and reduce their ecological footprint.

Equipment protection - If the sensors detect abnormal gas levels, the AI-humanoid robot can shut down or adjust the equipment's to prevent accidents due to overheating of equipment.

Accident - In the event of accident or emergency, deployed AI-humanoid can be of the capacity to assess the situation. They can enter potentially dangerous areas, evaluate gas levels, relay critical information and plan their operations more effectively.

FIRE SENSOR

A fire sensor is designed to detect the presence of a fire and respond accordingly. It may include issuing a warning to disable a fuel line (such as a propane or petroleum gas line) and launch a fire suppression system. They are usually used in battling fires. Mining operations often involve working in environments with a high risk of fire due to the presence of combustible materials, machinery, or electrical equipment. The integration of fire sensors in AI humanoids used in mining enhances safety and also helps to protect assets along with following usages:

Detection: Humanoids will be able to spot potential fires early with the aid of this, enabling prompt response and stopping a minor incident from turning into a catastrophic disaster. This is particularly important in the mining industry since flames can spread quickly and have negative effects.

Safety: When a fire occurs, AI humanoids can quickly alert operators and trigger predetermined safety protocols. This ensures the safety of the humanoid itself and supervisors who rely on the AI for support.

Equipment and asset protection: Fires can cause substantial damage to valuable mining equipment and infrastructure. Since humanoids provide early detection and localization of fires, damage and potential financial losses can be minimized.

Efficient resource allocation: The humanoid can prioritize its operations based on the severity and location of identified flames, optimizing firefighting efforts and resources.

Compliance with regulations: AI humanoids with fire sensors built in abide by the regulations framed by many for mining operations, including requirements for fire detection and prevention, preventing penalties and legal problems.

Environmental protection: Fire in the mining environment can have adverse impact on the surrounding ecosystem and air quality. AI humanoid robot's fire sensors can help in minimizing environmental damage by swiftly resolving any fire incidents.

To attain the above listed usages or merits, the fire sensors embedded in the AI humanoids must possess these fundamental features. , High sensitivity to LPG, iso-butane, propane, alcohol, smoke, etc. and stable and long-life simple drive circuit.

TEMPERATURE SENSOR

The temperature in the mining environment can be detected with the help of a temperature sensor. LM35 temperature sensor can be used in a humanoid robot to measure and monitor temperature. It can help in managing the robot's thermal conditions and prevent overheating, ensuring optimal performance and safety. It can mainly help to detect if the environment around the humanoid is too hot or cold. So that the remote mining can be carried out accordingly.

The LM series are precision integrated circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (centigrade) temperature. These sensors have an added advantage over kelvin calibrated sensors and do not require the subtracting of constant voltage from its output to obtain convenient centigrade scaling. With LM35, the temperature can be estimated more precisely than with a thermistor. It likewise has low self -warming and doesn't cause more than 0.1 °c temperature rise in still air. The working temperature goes from - 55°c to 150°c.

For instance, if the temperature being measured is 20°c, the output voltage of the sensor will be 200 mv. The output voltage of the sensor can be read and converted to a temperature reading using software.

Global Positioning System

In mines, humanoid miners may be spread out over a large area and may be working in dangerous or hazardous conditions. By embedding the GPS (Global Positioning System) in the body of humanoids, the location of each miner can be monitored and recorded, allowing supervisors to quickly respond to emergencies or incidents. Further it can also be used to track the movement of equipment and vehicles in the mine, which can help optimize mining operations and reduce downtime.

The GPS module is a component that uses signals from satellites in space to determine the location, it also contains a receiver that receives signals from GPS satellites orbiting the earth. The module then uses these signals to calculate the device's latitude, longitude, and altitude. The GPS module used may support different GPS standards, such as the Global Navigation Satellite System (GNSS), which includes GPS, Glonass (Russia's Gnss), Galileo (Europe's Gnss), and Beidou (China's Gnss). The module may also support different communication protocols, such as the NMEA (National Marine Electronics Association) protocol, which is commonly used in GPS devices.

However, it is important to note that there are potential limitations and challenges associated with using the GPS module in mines. GPS signals can be disrupted by the environment, such as by tall buildings, mountains, or tunnels, which may limit the accuracy of the device in certain areas of the mine.Overall, the GPS module is a crucial component that has to be installed in a humanoid miner, as it enables the device to determine its location and send location data to a remote server or mobile device.

GSM MODEM

Global system for mobile communication (GSM) is a globally accepted standard for digital cellular communication. A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem sends and receives data through radio waves. GSM modems are used in mobile telephones and other equipment that communicates with mobile telephone networks. They use SIM to identify their device to the network. A GSM modem can be installed in an AI humanoid robot to enable communication and data transmission over cellular networks. This allows the humanoid to send and receive information, making it capable of remote control, reporting, or other network-related tasks. However, the number of SMS messages that can be processed by a GSM modem per Minute is very low - only about six to ten SMS messages per minute. The GSM architecture consists of three major interconnected subsystems that interact with themselves and with users through a certain network interface. The subsystems are base station subsystem (BSS), network switching subsystem (NSS) and operational support subsystem (OSS).

MERITS OF USING GSM MODEM IN HUMANOIDS

Remote communication: The GSM modem allows communication with the humanoid robot from a remote location. Supervisors can send commands and receive data using a mobile device or a computer connected to the cellular network.

Data transmission and monitoring: The humanoid can transmit real-time data, such as sensor readings, video feeds, or status updates, to a central control center. This data can be important for monitoring the robot's performance, safety conditions or environmental factors within the mining

site.

Warnings and emergency notifications: In case of an emergency or malfunction, the GSM modem can send warnings and notifications to designate contacts or the control center. This ensures a quick response and appropriate action to mitigate potential risks or issues.

Integration with AI and analytics: Data transmitted via GSM modem can be processed using algorithms and AI analysis. This enables real-time decision making, predictive maintenance or optimization of robot operations based on collected information.

GPS tracking and geofencing: The GSM modem can integrate GPS capabilities, allowing the location of the robot to be tracked within the mining area. Geo-fencing can be deployed to define boundaries or restricted areas, improve security, and comply with operational guidelines.

THERMAL CAMERA

In recent times, thermal and infrared cameras have come into utilization and can be found in mechanical plants, processing plants, pharmaceutical assembling, fumigation offices, paper mache factories, hazardous materials activities, squander water treatment offices, indoor air quality testing. Thermal cameras are valuable tools in the context of mining safety and efficiency, particularly when integrated with humanoid robots. In the following areas thermal cameras can be useful:

Hazard Detection: Thermal cameras can detect heat signatures, making them effective for identifying potential hazards in mining environments. They can detect hotspots, gas leakages or underground fires, allowing operators to take preventive measures before accidents occur.

Personnel Tracking: In underground mines, thermal cameras can be used to track the movement of personnel, including miners and rescue teams. This capability is crucial for ensuring the safety of workers and coordinating rescue operations in the event of emergencies such as cave-ins or gas leaks.

Equipment Monitoring: Thermal cameras can monitor the temperature of mining equipment in real-time, helping operators identify equipment malfunctions or overheating components before they lead to breakdowns or accidents. This proactive maintenance approach can minimize downtime and optimize equipment performance.

Environmental Monitoring: Thermal cameras can assess environmental conditions such as temperature gradients, airflow patterns, and gas emissions in mining tunnels or shafts. By providing insights into the thermal behavior of the environment, they can help optimize ventilation systems, mitigate heat stress risks for workers, and improve overall air quality.

Search and Rescue Operations: In the event of accidents or emergencies, thermal cameras can aid search and rescue teams in locating missing or trapped miners. Their ability to detect body heat signatures in low-visibility conditions, such as smoke-filled tunnels or darkness, can significantly expedite rescue efforts and increase the likelihood of survival for trapped individuals.

Efficiency Optimization: By integrating thermal cameras with humanoid robots, mining operations can enhance efficiency and productivity. Humanoid robots equipped with thermal imaging capabilities can autonomously patrol mining sites, inspect equipment, and monitor environmental conditions, allowing operators to identify and address potential issues proactively.

Overall, thermal cameras play a crucial role in enhancing safety, efficiency, and situational awareness in mining operations, ultimately contributing to safer and more productive mining environments.

V.CONCLUSION

While the advent of AI promises to revolutionize various industries and enhance efficiency, its indiscriminate implementation without careful consideration of its impact on the workforce can lead to adverse consequences. The displacement of human jobs by AI may initially seem like a relief from stress, providing individuals with more leisure time. However, in the long run, it can have detrimental effects on both mental and physical health, exacerbating societal inequalities and decreasing overall productivity.In the mining industry, humanoid robots hold immense potential for saving human lives by undertaking hazardous tasks in place of human workers. By deploying AI humanoids equipped with advanced sensors and decision-making capabilities, mining companies can minimize the exposure of human workers to danger and optimize operational efficiency. The successful integration of AI and Humanoid asks for a balanced approach that prioritizes safety, collaboration, and skill development. By adopting such an approach, we can harness the transformative power of AI while preserving the dignity, health, and productivity of the human workforce.

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