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HAZARDOS AVOIDANCE SYSTEM IN COAL MINES

(HASCOM)

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Abstract - The development of a drone car appropriate for coal mines is a significant obstacle, made more so by the strict safety regulations imposed by the Mine Safety and Health Administration (MSHA). The complexities of designing an intrinsically safe propulsion system for such an environment are explored in this essay. With an emphasis on maximizing effectiveness and reducing heat production, this study works through the subtleties of drone sizing. It also describes the experimental setup used to measure the propulsion system's performance precisely. A range of problems found throughout this investigation are analyzed empirically, and related solutions are carefully investigated.

Keywords – Coal Mines, Hazardous Gases, Poisons Gases

I. INTRODUCTION

Drone use in surface and subsurface mining operations has increased significantly in recent years. For example, Shahmoradi et al. (2020) carried out an extensive analysis showcasing the various uses of drones in the mining industry. They created a comprehensive database of the features and characteristics of drones that are sold commercially and are designed specifically for mining [1]. In a similar vein, Zimroz and colleagues investigated the viability of using drones for search and rescue operations in deep underground mines. Their study provided examples of how drones could be used to help find injured or stranded people who are unable to move or communicate.

Jones et al. investigated the application of Hover map autonomous flight systems, specifically in subterranean conditions where GPS reception is blocked. Drones are incredibly versatile when it comes to navigating difficult terrain androm enhancing safety and efficiency to enabling unprecedented insights into inaccessible or hazardous areas.

DRONE TECHNOLOGY APPLICATION IN MINING INDUSTRY:

Drone use in mining operations has two primary benefits. First, in an emergency or to identify potential hazards, drones fitted with various kinds of sensors can quickly survey a region. Second, drones can be used for inspection and unblocking of clogged ore passages and box holes. Drones can also be utilized for product delivery, bomb detection, and obstruction assessment. Drone uses in the mining industry are divided into three categories by Lee and Choi: surface, underground, and abandoned mines

II. WORKING

The HASCOM operates in five distinct parts:

- Finding the Mine
- Picking the Gas
- Planting HASCOM
- Gas Recognition
- Finding a well-known location

One of the most important steps in guaranteeing worker safety after dynamite detonation in a coal mine is the deployment of HASCOM. After the dust settles, HASCOM is carefully placed inside the mine to begin a thorough search of the whole region. Its main goal is to gather detailed information on the amount and kinds of gases that are present in order to provide a thorough analysis of any potential risks. After the scanning process is over, HASCOM uses its cutting-edge technology to determine which sites are the safest and most appropriate for workers.

After the scanning process is over, HASCOM uses its cutting-edge technology to determine which sites are the safest and most appropriate for workers. Its ability to identify regions with low levels of dangerous gas concentrations guarantees a safe environment for task completion without endangering worker safety. By providing precise location suggestions, HASCOM turns into an invaluable resource that helps employees work with confidence while reducing the risk to their safety. The importance of this complex system is increased by the way it integrates with several gas sensors. With the help of this state-of-the-art technology, HASCOM can simultaneously detect multiple gases, including carbon monoxide and methane, enabling a more thorough and precise evaluation of the air quality inside the mine. These sensors' real-time data collection helps to provide a more complex understanding of gas concentrations, allowing an accurate determination of possible hazards. HASCOM is essentially shown to be an important and versatile tool in the proactive management of mine safety. Its array of gas sensors and ongoing monitoring and analysis of air composition establish it as a state-of-the-art solution.

By ensuring a prompt and well-informed response to possible hazards, HASCOM protects mine workers' health and greatly reduces the risks connected with gas exposure.

Fig1:Actual image of working model of HASCOM

III. CIRCUIT DIAGRAM & BLOCK DIAGRAM OF HASCOM

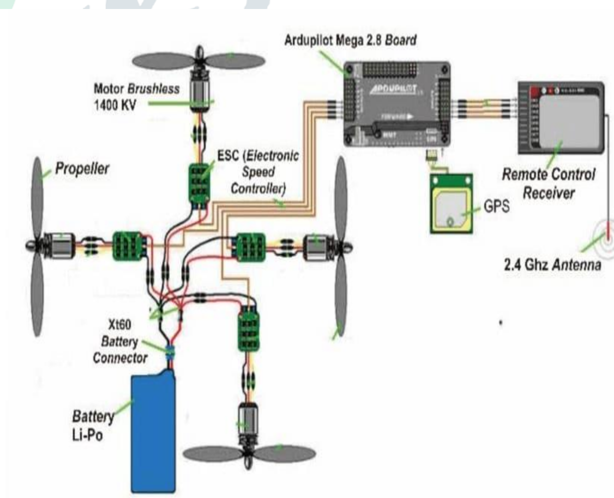

Fig2:(a) Circuit diagram of drone

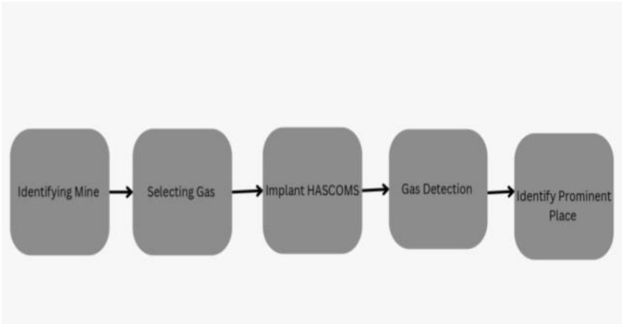

Fig2: (b)working block diagram of HASCOM

IV. SENSORS USED IN DRONES FOR MINING

The mining industry has access to a variety of sensors for gathering the necessary data. Drones can be equipped with a variety of sensors to gather data that is geospatially tagged and timestamp-capable, allowing for the overlaying of the data for improved comprehension and analysis. Reviewing actual mining progress and, if any, deviations from the mining plan can be facilitated by integrating the gathered data with mine planning data. The kind of information needed will determine which sensors are chosen, and the drone that is best suited for the job will be chosen after taking into account the area that needs to be covered, the sensor's weight and power requirements, and other factors.

MQ6 SENSOR: A common semiconductor device for detecting propane, butane, and Liquefied Petroleum Gas (LPG) in the air is the MQ-6 sensor. It is frequently used in safety applications, like those in homes and businesses, where gas leak detection is crucial. A wider series of MQ sensors, which are capable of detecting different gases, includes the MQ-6 sensor. Both analog and digital outputs are available on the MQ-6. The analog output is directly correlated with the gas concentration, while the digital output can be programmed to activate at a certain gas concentration threshold. Operating Voltage: 5V is the standard operating voltage, which is suitable for a variety of microcontrollers and other electrical equipment.

Fig3:MQ-6 Sensor

Detection Range: Typically, it is able to identify gas concentrations between 200 and 10,000 parts per million (ppm).
Warm-up Time: In order to get reliable readings, the heating element needs time to stabilize, usually 20 seconds or more.
Typical Use: Gas leak detection equipment frequently include the MQ-6 sensor. It can be utilized in commercial settings to monitor gas levels to avert hazardous situations or integrated into a home safety system.
LPG, Butane, and Propane Sensitivity: Because of its great sensitivity to butane and propane, the MQ-6 sensor is very helpful in locating fuel leaks and cooking gas leaks.
Heating Element: To detect changes in gas concentrations, the sensor heats up a metal oxide semiconductor, which alters its resistance in the presence of target gases.

MQ9 SENSOR: Designed to detect airborne amounts of carbon monoxide (CO), methane (CH_4), and liquefied petroleum gas (LPG), the MQ-9 sensor is another popular gas sensor in the MQ sensor series. It is especially helpful in situations where identifying these gases is necessary to reduce the risk of explosion or poisoning in both industrial and residential environments.

Fig4:MQ-9 Sensor

Goal Gases: Methane, LPG, and carbon monoxide can all affect the MQ-9. With regard to these gasses, it responds quickly and with excellent sensitivity.

Structure: The MQ-9 is made up of a metal oxide semiconductor, which, like other MQ series sensors, alters resistance when the target gases are present. The sensor is heated to the necessary working temperature by its built-in heating element.

HYGROMETER: A hygrometer is a device that measures humidity, or the amount of moisture in the atmosphere. Hygrometers are essential for a wide range of applications, including industrial operations, meteorology, climate research, and HVAC (heating, ventilation, and air conditioning) management. They are essential to maintaining the well-being, safety, and comfort of people and things in a variety of settings, including offices, residences, warehouses, and greenhouses.

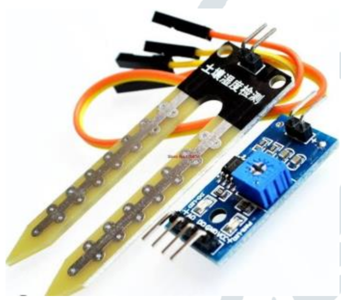

Fig5:Hydrometer

Hygrometer Applications:

Hygrometers are employed in many different settings and sectors of the economy:
Measuring humidity levels is important for meteorology and weather forecasting since it affects weather patterns and projections.
HVAC systems: To keep an eye on and regulate the humidity of the air inside buildings, improving comfort and avoiding the spread of mold and structural damage.
Agriculture: To regulate greenhouse conditions and guarantee the right amount of humidity for plant growth.

TELEMETRY: Telemetry is the process of wirelessly transmitting data from inaccessible or site for analysis and monitoring through autonomous measurement. The word is derived from the Greek words "tele," which means far away, and "metron," which means measurement. Numerous industries, including healthcare, automotive, aerospace, environmental monitoring, and more, heavily rely on telemetry.

Principal Elements of Remote Telemetry Monitoring: Telemetry makes it possible to remotely monitor circumstances, which eliminates the need for physical labor and the requirement to be present in potentially dangerous or inaccessible regions.
Real-time Data: Usually, it offers real-time data so that any modifications to the parameters being tracked can be responded to right away.
Automation: Systems are frequently programmed to gather, send, and occasionally even analyses data without the need for human participation
Telemetry has revolutionized data collection and monitoring in various industries by enabling the management and analysis of critical systems from afar, contributing to advancements in technology, safety, and efficiency.

LIDAR SENSOR: A LiDAR system may use a scan mirror, multiple laser beams, or other methods to "scan" the object space. LiDAR is valuable for a variety of applications because to its accuracy in measuring distance.

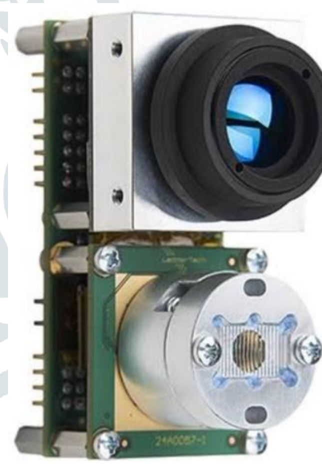

Fig6:Lidar Sensor

LiDAR systems are employed in remote sensing to measure the scatter, absorption, or re-emission of air particles or molecules. To do these, the systems could need the laser beams to have a specific concentrations are two examples of specific molecular species whose concentrations in the atmosphere can be measured. The distance and rate of precipitation of a storm can be ascertained by measuring the amount of raindrops in the atmosphere.
Other LiDAR systems produce profiles of three-dimensional surfaces in the object space

V. EQUATIONS

The functional relationship between the physical input signal, or stimulus (s), and electrical output signal (S), as demonstrated by the transfer function, is represented by S= f (s), where "S" is the response to the stimuli. The relationship between the input and output can be used to assess if the function is linear or nonlinear. There are several ways that nonlinearity might appear, such as power, exponential, or logarithmic functions [1-3]. A unidimensional function, which connects a single stimulus to the relationship between the input and output, frequently characterizes the interactions. The following is one way to express this linear relationship:

$$s = a + b(s) \qquad (1.1)$$

where an is the intercept that the output signal uses at zero input, and b is the slope, also referred to as sensitivity S.

Depending on the properties of the sensors, this could be amplitude, phase, or frequency. It is also known as the sensor's output, which is what gadgets employ to get data. Other non-linear functions include as follows:

The logarithmic scale: $S = a + b\,ln\,s$

Exponential function: $S = ac^{ks}$

$$s = \frac{1}{k} sin \frac{s}{a}$$

Power Function : $S = a_0 + a_1 \dot{s}^k$

$$S = \sqrt{\frac{s-a}{b}}$$

S s a b, where k gives numbers that are constant.

When some sensors don't fit the previously listed criteria, a higher-order polynomial approximation must be used.

Precision:

Accuracy is a critical feature of sensors and is expressed in terms of measurement error, which is the difference between the true and measured values. It is given as a percentage of the whole scale or the reading.

Complete error Measured worth One way to calculate the relative inaccuracy is as follows: The true value (1.8) can be expressed as –

Absolute Error =|Measured value - True Value|

Ac=|Mv-Tv|,

where Tv is calculated by taking the mean of an infinite number of measurements and

relative error can also be calculated as-

$$Relative\ Error = (Absolute\ error \div True\ value)\ Rc = |Mv - Tv| \backslash Tv$$

The accuracy grade illustrates how measurement defects in sensors, such as dead band, linearity, calibration, and repeatability issues, affect measurements overall.

Equilibration Numerous:

Sensors are available, but in order to select the best one with the highest level of accuracy, the sensor must first be calibrated in the intended device. To make a sensor or device operate precisely and without errors, an adjustment—or series of adjustments—must be made to it. For example, a sensor is rated with an accuracy of ± 5 pa, and we need to measure the pressure with ± 5 pa accuracy. 10 pp. Will this pressure sensor work for us? Absolutely, we can, but first we must determine the initial transfer function of the given sensor and calibrate it.

Finding its specific variables is necessary for the calibration process. Identification of these variables is necessary prior to calibration as they describe the entire transfer function. Equation (1.1) is used to compute linear device calibration, and variables "a" and "b" need to be precisely specified.

The linear transfer function is computed as v=a+b(p) to effectively obtain constant values in the equation. Two pressure values (p1 and p2) can be applied to a sensor in relation to their respective output voltages (v1 and v2) in order to discover constants "a" and "b." therefore we have v1 = a + b(p1) and v2 = a + b(p2); the constants are then computed as follows: the pressure of calibration may then be calculated as follows:

$b = \frac{v1-v2}{p1-p2}$ and $a = v_1 - bp_1$ (1.10)

p= v-(a÷b) (1.11)

When the devices or sensors are calibrated in the factory, manufacturers tolerate a certain form of inaccuracy known as calibration error. This obtained mistake is not constant and is subject to change as the decision-making process proceeds.

VI. FUTURE SCOPE

Enhancement of Safety: By using drones for remote inspections, human workers in dangerous mining areas can be protected from harm.

Efficiency: Drones can quickly survey broad mining regions and collect data to help with decision-making, which helps to optimize operations.

Environmental Monitoring: They can support regulatory compliance by monitoring the effects of rules on the environment.

Cost reductions: Using drones to automate operations can result in labor and fuel savings.

Data analytics: Drones can produce useful data for process improvement and predictive maintenance.

Market Growth: Drone solutions are becoming more and more popular as the mining sector adopts technology.

VII. CONCLUSION

In summary, the idea of a drone car for mining

exhibits significant promise for raising mining operations' efficiency and safety. Drones' adaptability and capability can be used to create a car-like vehicle that is specifically made for mining areas, which has many benefits.

In order to plan and optimize operations, a mine drone car can help with remote mapping and surveying of the mine site. Drones can improve the mining process overall by completing surveys more quickly and accurately, saving time and resources.

When HASCOM is used in coal mines, safety precautions are greatly improved, leading to revolutionary outcomes. By use of real-time gas detection, the system preemptively addresses possible risks by guiding labourers to regions with low concentrations of hazardous gases, ultimately reducing the possibility of mishaps and explosions. The optimal allocation of resources guarantees effective operations, and the recommendations for specific locations provide mine workers with confidence and increased security so they may work with greater assurance. The data-driven methodology of HASCOM enables well-informed decision-making, which in turn promotes ongoing enhancements to mine safety procedures and the general mitigation of hazards related to gas exposure, guaranteeing a safer working environment for everybody.

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