HANA Cloud integration for Connected Tunnel Safety

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Field of Invention

This invention is related to the safety of Tunnels which are connected together. Example: mining tunnels. This invention provides safety inside the tunnel lines. This provide a safest way for the working staff inside the tunnel in case of any hazard like gas leakage, water filling, fire, tunnel blockage, Lake of oxygen and many other type of hazard. In case of hazard it also provides alert to the safety team and probably what equipment they will require to fight with the hazard inside the tunnel. Example in case of fire inside the tunnel, the safety team need to send fire extinguisher or may need to call Fire Brigade.

Description of Current Approach used for tunnel safety.

Currently In case of any hazard inside the tunnel they trigger the bugler alarm and the person inside the tunnel has no idea where to go. They follow manual approach to get out from the tunnel. They follow the MAP or some expert advice to find the safest path to get out the tunnel. But sending some expert person with detailed information will takes time, which can lead to human death inside the tunnel. Mean while situation may become more critical. Also safety team has no detailed idea of how much the level of hazard is there. If hazard level is high then team has to take proper and quick action to get rid of the hazard so that less affect to human life. Also no one have idea that with what rate hazard is increasing in that area.

My invention will provide all the detailed information about following:

1. Which path should be followed by the person inside the tunnel to get rid from the tunnel as soon as possible as well as which path will be the safest for the person according to their current position inside the tunnel.
2. What is current level of hazard and with what rate it is increasing.
3. What safety major should be follow in current hazard scenario.
4. How much time they need to get rid of the tunnel.
5. What type of hazard is there.
6. Automatic notification to the safety admin with the proper map of current tunnel system and color level of hazards.

DETAILED DESCRIPTION OF THE INVENTION

This invention uses two basic factors for their path calculation, first the hazard factor and second is the path distance. Hazard factor is a numeric value which directly depends upon the hazard type and their affect in human life. Let understand following graph.

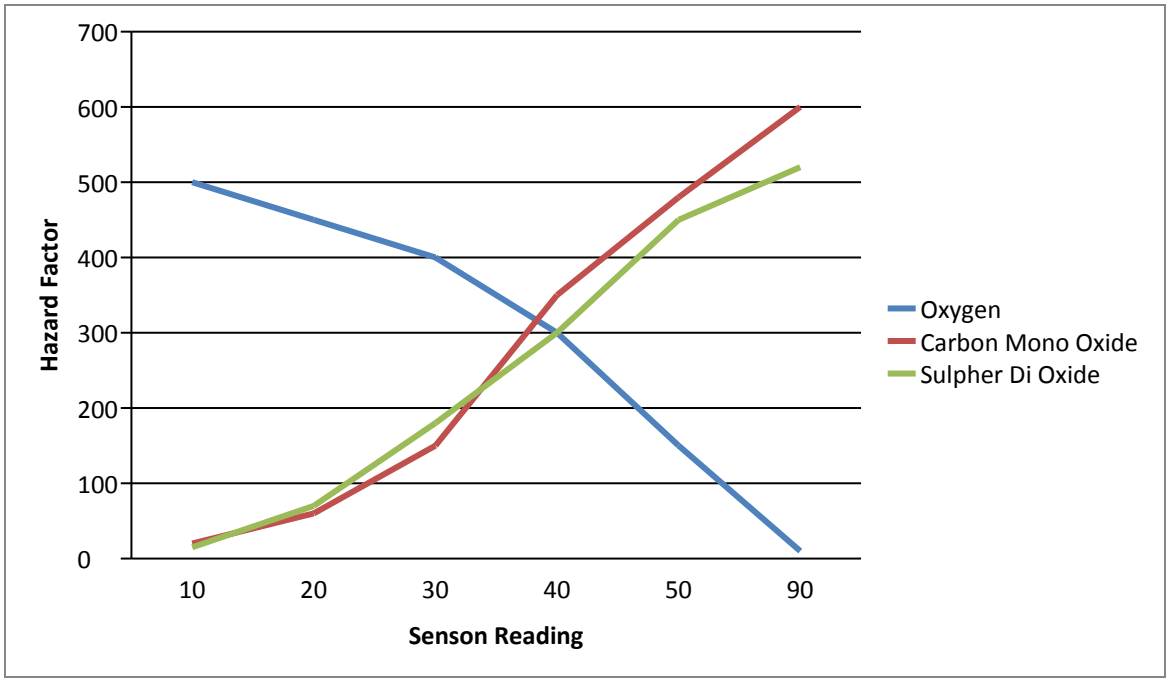
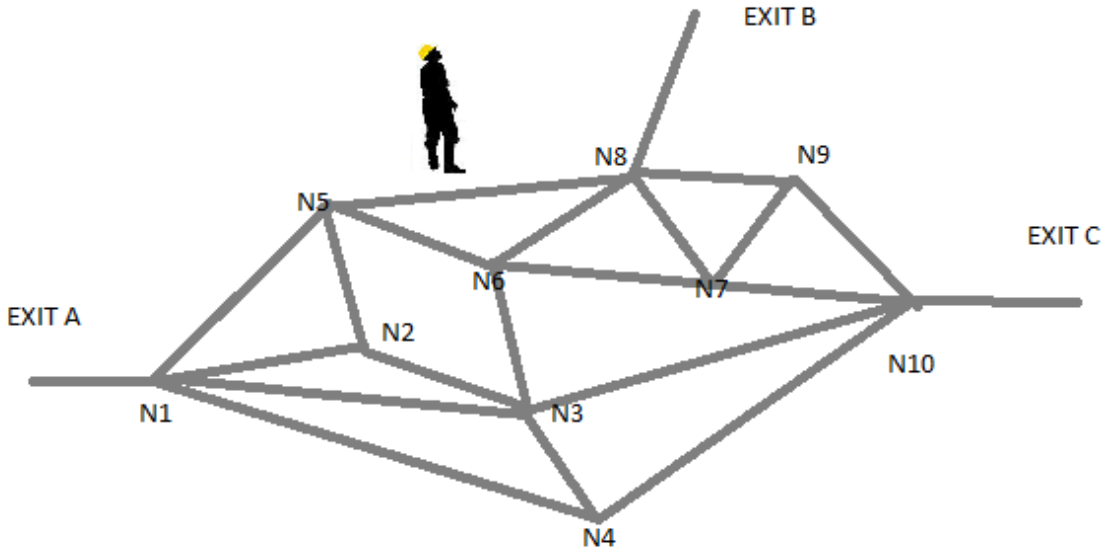


Figure 1

This may be a typical scenario of a mining tunnel where raise in oxygen level actually decreases the hazard level and raise in other toxic and flammable gases increases the hazard level for that mining station. This hazard factor graph can vary from industry to industry based upon their requirements.

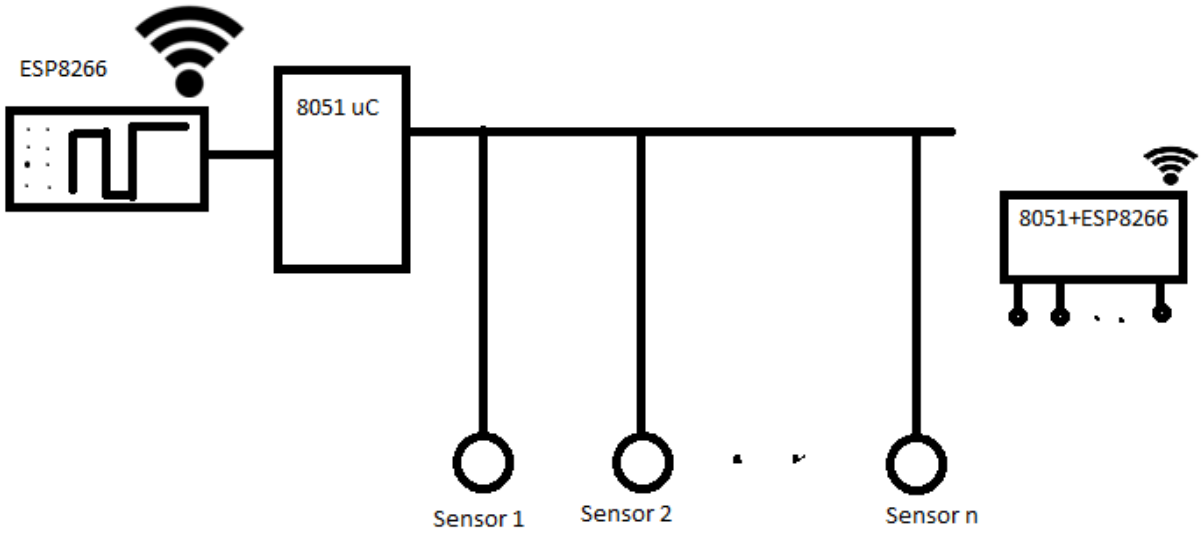
Note: Above given data is only for illustration. There is no feasibility of this data and cannot be used for industries.

Now consider following tunnel floor plan.



In this floor plan there are three exit points namely Exit A, Exit B, and Exit C. A person is working in the tunnel between the Node N5 and N8. Now suppose In Node 8 and Exit B there is a hazard and the person has to get rid from the tunnel as soon as possible. Since that person has no idea that which routes is hazardous hence he will try to take the shortest path which goes via Node N8 to the Exit B. But this is the same path where hazard is present. Hence this can cause a serious injury to that person. Instead of path via Node N8 if he has taken the path via Node N5 to N1 to Exit A then he has to face less hazard affects.

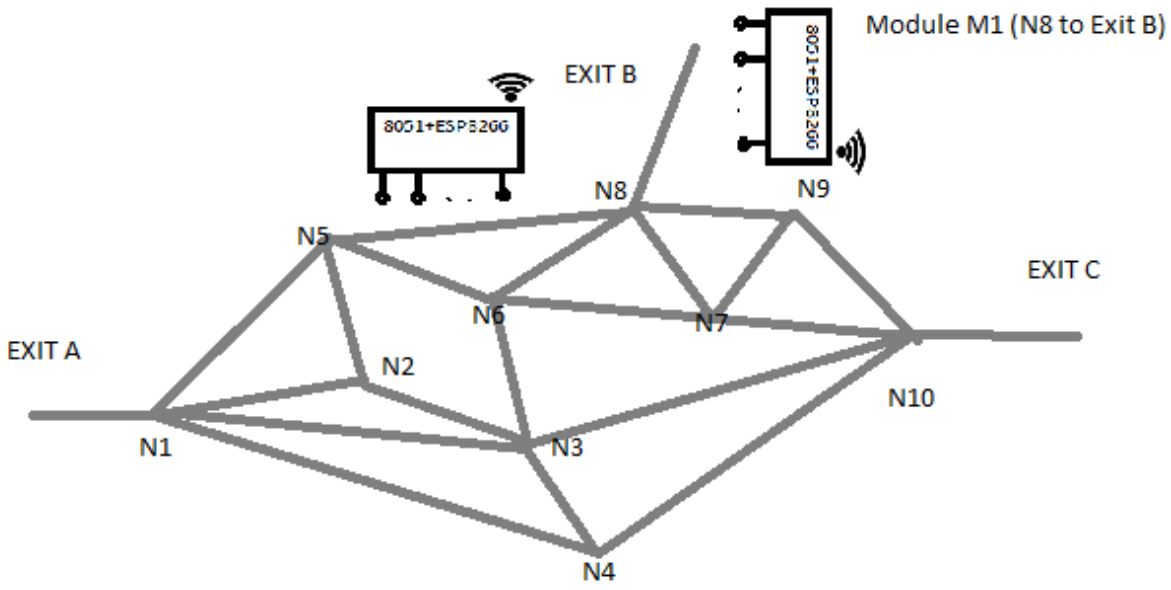
This invention has actually a network of sensor which actually senses the hazard of that path. For example a temperature sensor can be used to find the hazardous level for fire hazard, toxic gas sensor can be used to find the toxic level of that path, oxygen sensor can tell that how hazardous is that path due to lack of oxygen. Our sensor will be connected to a small microcontroller which actually read the data from the sensor and send it to the ESP8266 wifi module. Wifi module will push this data to the HANA cloud. Since HANA cloud is very fast, it can be used as real time data processor. Let consider the following figure.



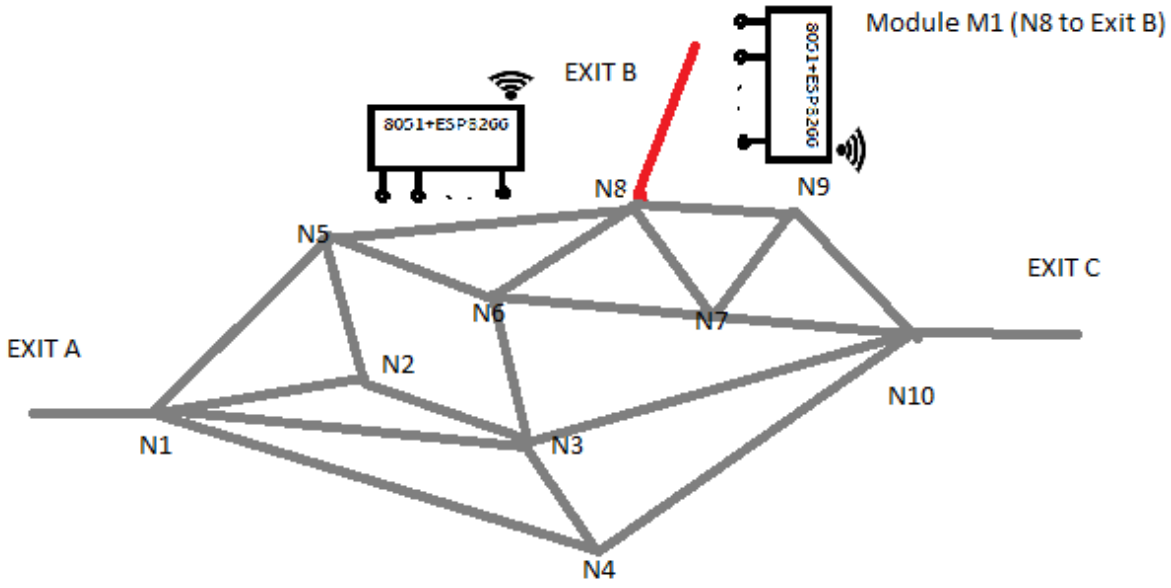
This is a single module which can be used to monitor a single path. In below section I will use block diagram in place of above figure. Now we need to place this module to the every path inside the tunnel. Every module will have a unique identity, using which we can identify the device and there location. Every module will send following message to the HANA cloud.

message{
    deviceid : *device unique identity number,*
    sensor 1 : *data read by sensor 1*
    sensor 2 : *data read by sensor 2*
    …
    Sensor n : *data read by sensor n*
}

Now one desktop application (usually with safety team) will have an actual path or floor plan in the screen. So it will show all the node and path to the team. We also need to tell the application that which module is in which position in the map. This application will continuously monitor every path by fetching data from the HANA cloud. Following figure will tell you how the desktop application screen will look like.



As here you can see that Node N8 to Exit B there is a module. In every path this module will present. Now when sensor will sense some hazard in this path it will send the reading to the HANA cloud. Our desktop application will receive this sensor reading from the HANA cloud and will calculate the hazardous factor using special functions. Let the β be the hazardous factor calculated by the function. If β is more than the threshold limit then we'll multiply this factor β to the path length of the hazardous path. So now the path weight has been increased by a large factor (usually hazard factor will be more than 500 if maximum path length is 30 from one exit point to any other point). So it will change the color of that hazardous path in the screen to dark red. Color intensity will directly depend upon the hazardous factor. So following will be the screen to the safety team.



Now this desktop application will apply “single source shortest path dijkstra algorithm” for every exit point as source. As we know weight of Exit B to Node N8 is very large due to hazard factor, so path from Exit B to any Node will not be feasible. So there will be two feasible paths for every node, one is from Exit A and other is from Exit C. Every node will contain a structure which contains the distance from every exit point. In case of hazardous situation this structure will be update. Now this application will select the nearest exit point using these data.

Every Node inside the tunnel has a direction indicator (*a device with direction arrow equipped with LED in each direction*) which will actually show the path to the person inside the tunnel. So when some hazard will occur, our desktop application will calculate the shortest and safest path from every node to the exit point. According to this calculation desktop application will send the path direction to the every node’s direction indicator system. So when any person will come to any node he can see the correct direction to get out from the tunnel.

This will be the help in context of the person inside the tunnel. Now how safety team can use this application to make proper decision. As we seen that every module will send the monitor data to the HANA cloud which came from different sensor, so safety team will easily see what hazard has actually occurred. Suppose our application show that high quantity of toxic gas to that place then safety team can send the necessary equipment needed to fight with that situation. Also application can show the rate of increasing of the hazardous level inside the tunnel. Which can also help them to calculate how much time they have to fight back? Also in case of hazardous situation our application can send SOS calls to the respective person as well as the Govt authorities like police, fire fighter and other.

This invention can also be used for shopping malls, railways network, traffic management in roadways and many more places. A small step towards safety can save many lives.