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An IoT-based Temperature Monitoring System for Underground Cable Tunnels

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ABSTRACT: Underground electricity transmission cables regularly have to face the mission of poor air flow, which decreases energy transmission capability and damages the materials of the cables in a hightemperaturesurroundings it's far essential to take a warmth dissipation degree to ensure not most effective the safety but the performance of strength transmission systems. presently, for underground tunnels, two temperature discount techniques have been used. One is to exhaust warmness through enhancing air circulate and the alternative is to hire chilling gadgets. but, regardless of the devices little records can be used to decide when these gadgets must be activated. Overusing the gadgets may additionally cause high electricity consumption. additionally, underusing the devices might result in the decrease of transmission efficiency. consequently, this paper proposes an IoT-based underground tunnel temperature monitoring gadget in which the wireless transmission technique used is after the test. Temperature sensing nodes are placed in an underground tunnel, after which a gateway collects sensed records and sends them to a database, so control personnel can display the temperature distribution in the tunnel in real time to decide whether air flow devices need to be activated

KEYWORDS:- Temperature monitoring, IoT, underground cable tunnel

I.INTRODUCTION

In recent years, not most effective have the city populations grown sharply, the populations in metropolitan areas have also persisted to increase. The demand for energy for business, business and family use has also risen. Overhead transmission strains aren't appropriate for deploying in densely populated areas and metropolitan areas. therefore, the development of underground tunnels for electricity transmission cables is vital pass forurban improvement. Having stated that, the underground cables can also cause many troubles [1]. as an example, a tunnel with low ventilation is susceptible to bring damage to the cable insulation due to immoderate temperature, which can also bring about energy outages or even quick-circuits, inflictingforemost screw ups in densely populated cities. one canincrease the safety of underground tunnels, this paperproposes to monitor underground cable tunnels via using the technology of internet of things (IoT) to enhance thesafety and reliability of underground cables and the tunnelas a whole. Transmission cable tunnel tracking is bound to emerge as the point of interest of research in destiny improvement ofclever grids.

A. advent and issues of underground cable tunnels

The temperature inside the tunnel is typically laid low with two other elements. The humidity and the cable expend the heat inside the air. but, due to the fact the humidity has little effect on the air temperature, the cable temperature is aspect that in particular impacts the temperature of the tunnel

[2]. inside the power transmission technique, the generated warmth is transmitted to an underground tunnel thru

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warmness conduction. however, due to bad air flow inside the tunnel, it's far hard to reduce the inner temperature of the tunnel through herbal warmth convection. If the temperature within the tunnel is just too excessive, the strength transmission efficiency might lower, and even worse, the cable could go to pot

[3], causing the cable brief circuit, which might create an explosion and set a fireplace inside the tunnel. therefore, this have a look at makes a speciality of the temperature tracking of an underground tunnel, as proven in figure 1, by using introducing an IoT-based totally temperature monitoring device for transmission cable tunnels. the sort of temperature monitoring gadget

can beautify the safety of energy transmission even as reduce the charges related to maintenance and repair. In fact, extraordinary monitoring methods have been used to improve the protection of underground transmission cable tunnels. for instance, a few underground cable tunnel tracking systems consciousness on the partial discharge hassle



Fig. 1. Actual underground cable tunnel.



Fig. 2. Actual underground cable tunnel 2.

II. RELATED WORKS

1. Fault location for underground power cable using distributed parameter approach

The paper affords an research of a proportional circuit that models a blamed underground cable framework using circulated parameter technique. research of succession organizes in three-level arrange with the aid of making use of the restrict situations is moreover introduced. utilizing the examination, the location of the problem is resolved with the assistance of cutting-edge and voltage conditions

2. Fault distance locator for underground cable circuits

Clarifies how infusing a development of tweeted beat streams into the blamed cable, soon after the event of the cable flaw making use of a heartbeat generator unit may be utilized for an actual matter of the region of the cable deficiency.

3. Improved GPS travelling wave fault locator for power cables by using wavelet analysis

proposed a superior way to deal with cable flaw location framework, essentially comprising of synchronized trying out approach, wavelet research and voyaging wave widespread. along the prologue to a few substantial methods and a blueprint of the brand new plan, this paper offers a specific wavelet exam of broken brief waveforms and consequently decides the exceptional wavelet tiers for this unique utility

4. Traveling-wave-based fault location scheme for multi-end-aged underground cable system.

Introduced a wavelet-based problem region conspire for matured cable frameworks whilst synchronized advanced deficiency recorded information are available at the 2 terminals of the cable. The wavelet peculiarity identity hypothesis is applied as an exquisite signal dealing with tool to appraise the place of the issue in multi quit-matured cable frameworks.

5. On-line Incipient Faults Detection in Underground Cables Based on Single-end Sheath Currents

Brought the blackout of a line due to an issue can be costly, subsequently the problem ought to be cleared as quick as could be predicted underneath the situations. automatic safety transfers comprise of shortcoming locator depending on a few techniques

III. EXISTING METHOD

In strength device underground cables are used to transmit the electrical power from turbines stations to distribution factor then it's miles transferred to the client ends. Underground cables face diverse troubles because of getting older and one of a kind sorts of faults. to conquer those issues in cables, hundreds of studies art work has been performed previously. here we proposed a way to rectify those problems. formerly there are such quite a few strategies to be had for detection of fault.

These methods are used for fault detection of underground cables. they're Murray Loop method, Sectionalizing method, Thumping method

IV. PROPOSED SYSTEM

Several strategies are being polished within the direction of the most ultra-modern couple of many years for cable line shortcoming popularity. The maximum substantially identified approach being applied is overhead cable strains. The deficiencies are handily identified in this technique however the problem on this technique is that during some overpopulated metropolis regions we cannot make use of this method. So we make use of underground cables. This paper factors in finding the precise area of the deficiency. The paper makes use of the usual concept of Ohms law that's low DC voltage being implemented at the feeder end through an association resistor (Cable lines), at that point current could fluctuate contingent at the place of deficiency inside the cable. The hobby of the framework expresses that when the existing actions via the deficiency detecting circuit module the present day might fluctuate contingent on the period of the cable from the spot of flaw that befell if there's any brief out shortcoming with the single Line to floor trouble, or

twofold line to floor trouble, or 3 stage to floor problem .The voltage drops over the association resistors adjustments correctly and afterward the issue signal goes to interior ADC of the microcontroller to create computerized statistics. At that factor microcontroller will system the superior records and the yield is being proven in the lcd associated with the microcontroller in kilometers and degree in line with the issue conditions.

This study develops a wireless tunnel temperature monitoring system based on the IoT technology. This system transmits environmental information of an underground tunnel, such as ambient temperature, to a gateway for data integration, and then the data packet is uploaded to a decentralized cloud database through a wired or wireless network. Finally, the temperature distribution in the underground tunnel is analyzed. This information can also be used to establish underground tunnel maintenance and monitoring related services.

V.BLOCK DIAGRAM

The purpose on this project is to decide the separation of underground cable shortcoming from base station in kilometers the use of a pc microcontroller. The underground cable framework is a typical exercise followed in several urban zones. If a flaw occurs for reasons unknown, around then the fixing technique identified with that cable is difficult because we do no longer recognize the specific region of the cable shortcoming. The proposed framework is to find the specific region of the deficiency.

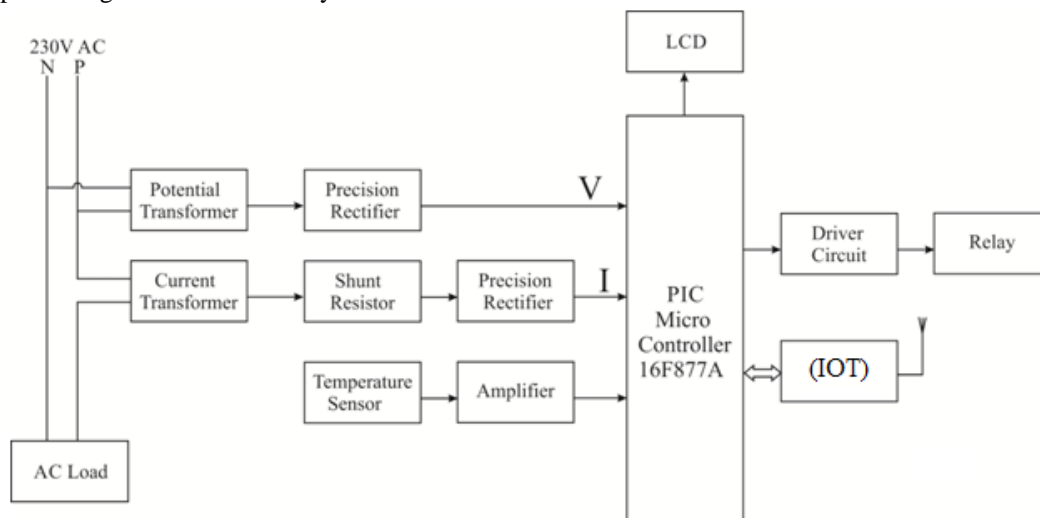


Fig 3: Block diagram of underground fault detector

PIC microcontroller The microcontroller which is being used in this project is from PIC arrangement. PIC microcontroller is the main component in this project which fetches instruction from various hardware components and then displays in the LCD display.



Fig 4 : PIC microcontroller

Relay The Relay is an electrical switch. Current moving through the curl of the transfer makes an attractive field which draws in a switch and changes the switch contacts. The relay acts upon the instructions of PIC microcontroller given to driver circuit which then given to relay.



Fig 5 : Relay

LCD Display LCD includes two glass boards, with the fluid gem material in the middle of them. The inward surface of the glass plates are covered with anodes. This LCD display is used to display the fault locations occurred in the underground cable system. Using an LCD display the user can easily know where the defect is located and can repair it easily.



Fig 6 : LCD Display

VI. EXPERIMENTAL RESULTS

To check the proposed machine, experiments have been performed in an underground tunnel for Shenmei-Da'an line in Taipei, Taiwan. The inner diameter of the cable line of Shenmei-Da'an line is 5.5m, and the duration of the defend tunnel is about zero.96km. The tunnel contains 161kV XLPE cables, 345kV XLPE cables, cooling water pipes and auxiliary electromechanical device. The test effects are defined as follows.

A. Transmission stability testing

As mentioned earlier, this paper chose the OQPSK module over other modules, based on the test results on communication stability and stability experiment. In the test, the performance of two wireless communication modules, an OQPSK module and a chirp spread spectrum (CSS) module, were examined. Because the transmission power of OQPSK and CSS module are unable to set to the same value, this experiment sets the transmission power to close to the value, 18dbm and 21dbm and select the appropriate length of the signal transmission line to cause different signal attenuation, so that the transmission power of the two transmission modules can be similar. And both modules used a 5 dBi gain antenna according to their frequency band, and were fixed at every 10 meters to test the data receiving rate. The communication band for the OQPSK module was 2.4 GHz. From the entrance of the underground tunnel to 260 meters down the tunnel, the data receiving rate continued to maintain at 100%. Since 270 meters, the receiving rate started to decline. After 290 meters, data transmission as completely impossible. By contrast, the communication frequency band of the CSS module was 433 MHz. From the entrance of the underground tunnel to 80 meters down the tunnel, the data receiving rate continued to maintain at 100%. Since 90 meters, the rate of data receiving dropped sharply. After 100 meters, the data transmission capacity almost disappeared. These test results indicate that the communication range of the OQPSK module is much larger than that of the CSS module. Considering the cost and flexibility of installations, if a node was installed every 80 meters, the cost of the whole system would be too high to bear. Compared to the CSS module, the OQPSK module is obviously more suitable for the underground tunnel monitoring because of its stable data transmission capability. In addition, the data transmission speed of the OQPSK module is greater than that of the CSS module, which increases the flexibility of providing other monitoring functions in the future.

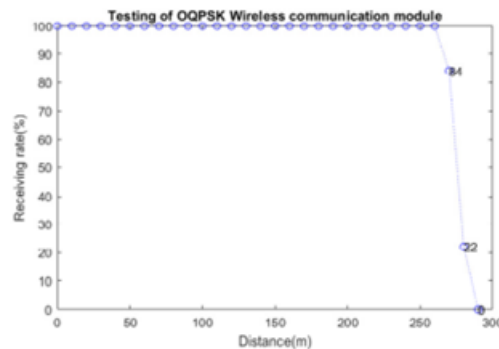


Fig. 7. Transmission test results for the OQPSK wireless communication module deployed in an underground tunnel.

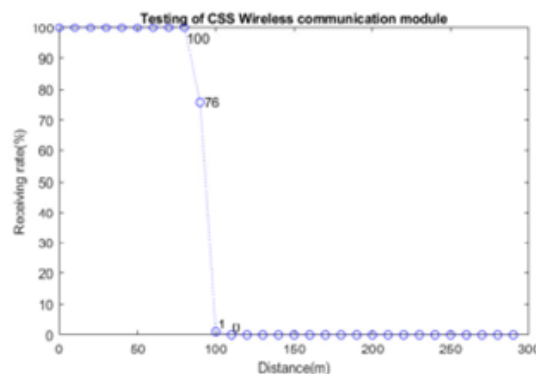


Fig. 8. Transmission test results for the CSS wireless communication module deployed in an underground tunnel.

B. System Verification

To examine the performance of the whole temperature monitoring system, the temperature sensing nodes were actually deployed in an underground cable tunnel where Shenmei Taipei Line passes through. The test system included a set of gateways and nine sets of temperature sensing nodes. The entrance of the underground tunnel was located at the basement level four of a three-story structure and the gateway set was placed on the central console of the third floor. In order to establish a chain topology with high stability, the temperature sensing nodes were scattered from the second floor to the basement as well as in the tunnel, and the longest distance between the gateway set and the temperature sensing node deployed in the tunnel was 510 meters. Figure 6 shows the actual temperature data collected by the proposed temperature monitoring system at 15:03:30 on April 17, 2017. Table 2 lists the node number, location, and measured temperature. It is clear that the temperature sensing nodes are able to successfully measure temperature in the tunnel and stably the transmit temperature data to the gateway set.

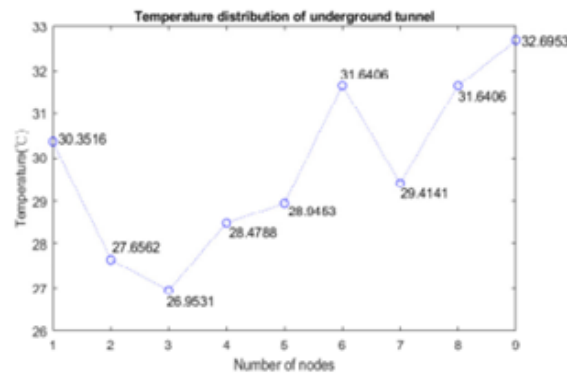


Fig. 9. Actual monitored temperature distribution in the underground tunnel at 15:03:30 on April 17, 2017.

C. Smart Cloud Service Platform

After the sensed data were transmitted to the cloud service platform, the cloud service platform would compile the temperature information and node number/location, as well as and the time at which the temperature data were collected, and show all the information on an GUI. In addition, the cloud service platform could also perform statistical analysis and use machine learning techniques to map out a large amount of information in a clear manner according to the power transmission requirements and specifications. An appropriate alarm threshold could be set based on the information. An alert would be issued, if the temperature in the tunnel was too high. Or, a cooling or an air circulation system would be activated, based on the threshold. In addition, the whole system could also be incorporated with databases established by the power company.

VII. FUTURE SCOPE

For the reason that there may be no stable electricity source inside the underground tunnel, the temperature size node in the system can handiest use the battery as the only source of power. therefore, node energy consumption is the key to the long-term operation of the machine. This observe is anticipated to reduce node strength consumption as the focal point of future studies. To obtain any such intention, the hardware circuit will want to be slightly changed, and from a software program attitude, efficient and energy-saving algorithms have to be evolved to lessen the power consumption of the sensing nodes. similarly to the sensor node change, it is necessary to reduce the frequency of battery replacement in the underground tunnel by way of enhancing the integrity of the network and the stability of records transmission.

This challenge handiest detects the exact fault area in Underground Cable from the base station. In destiny it could be feasible to do assignment on routinely clean the fault by using designing one robot.

VIII. CONCLUSION

In summary, this study proposes an IoT-based temperature monitoring system for underground cable tunnels, which is able to stably and reliably measure temperature in the tunnel in real time, and successfully transmit the sensed data to the gateway. All of the monitoring data can be analyzed by the smart cloud service platform to provide important safety-related information to management personnel. This system can be integrated with other monitoring functions, such as grid connection monitoring, dynamic thermal rating of transmission lines, voltage insulator monitoring, fault point detection, and power dispatching decision support platforms to solve long-term power grid safety problems.

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