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E- NOSE CONCEPTUAL ROBOT FOR UNDERGROUND TRANSMISSION LINE

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***Abstract*-- As power had influenced in all means and modes of day today life. Each and every second of a human is connected with electricity. As transmission lines are used for carrying power to the required ends. They are sometimes unsecure and face problems in the transmission of electricity properly. It is required to give proper grounding for phase lines. If there is no proper grounding or earthing then it will cause major damage to transmission lines, the load connected to the station which provides the supply.In real time, the process of identifying the fault in the underground earth line takes up to 8 days or more. To reduce this time period, we are designing a robot which Identifies the fault place based on the odour that spreads in the soil. Even though the line is under the surface of the earth, it spreads a very high fumes to the top of the soil. Hence, based on sensing the gas without excavating the surface , fault can be easily identified.**

Index Terms: Gas sensor, acoustic signal, carbonization ,LT Cables, Earth return .

I. INTRODUCTION

Power line inspection and maintenance already benefit from developments in mobile robotics. The objective is todevelop the robot to develop more cost effective diagnostic techniques for determination the fault of power transmissionline. Transmission line faults (both transient and permanent) are a major cause of concern, particularly to those electricity customers who make use of continuous process plants. An underground cable essentially consists of one or more conductors covered with suitable insulation and surrounded by a protecting cover. The interference from external disturbances like storms, lightening, ice, trees etc. should be reduced to achieve trouble free service. The cables may be buried directly in the ground, or may be installed in ducts buried in the ground.

Our objective is to implement a robot for finding the fault in this route. It's fixed with the gas sensor for detecting the carbonised smell . The measured gas concentration level is compared with already stored values if the measured value exceeds the level then it alerts the alarm that the fault exists pinpointing the location**.**

II. UG CABLES & IT'S FAULTS

Electric power can also be transmitted by underground power cables instead of overhead power lines. Underground cables take up less right-of-way than overhead lines, have lower visibility, and are less affected by bad weather. However, costs of insulated cable and excavation are much higher than overhead construction. Faults in buried transmission lines take longer to locate and repair. Underground lines are strictly limited by their thermal capacity, which permits less overload or re-rating than overhead lines. Long underground cables have significant capacitance, which may reduce their ability to provide useful power to loads.

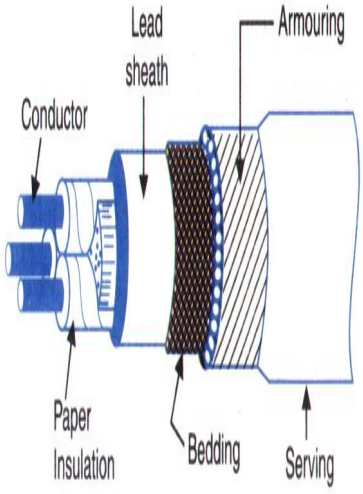

Fig 1. Cable structure.

a. LT cables

These cables are ment for use upto1,000v. For voltages upto 6,600V, the electric stresses developed in cables is very small& thermal conductivity is also of not much importance so no special construction required. The insulating materials used may be impregnant power, varnished cambric, vulcanized .

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they are either of single core or multi cored. They are usually used of distribution of power.

b. HT cables

For cables above 11,000V a special construction is adopted. For use upto 33kV , the cables where leakage currents are conducted to earth through metallic sheaths. Screened cables are of 2 types viz H-type and SL type. They are usually used in transmitting the generated electrical energy.

c. Faults in UG cables

cables are generally laid in the ground or in ducts in the underground distribution system. For this reason, there are little chances of faults in underground cables. Cable fault is referring to something that occurs current can't flow smoothly. It is because open circuit or short circuit that means the current flow is high value. Most faults are caused by dampness in the paper insulation of the cable due to porous or otherwise damaged lead sheath. The causes of damage to the lead sheath are: crystallization of the lead through vibration; chemical action on the lead when buried in the earth and insufficiently protected; and mechanical damage. However, if a fault does occur it is difficult to locate and repair the fault because conductors are not visible. Nevertheless, the following are the faults most likely to occur in underground cables

1) open circuit fault

When the conductor of a cable is broken or joint is pulled out there is no current in the cable.

2) short circuit fault

When the insulation between two cables or between two cores of a multicore cable gets damaged, the current starts flowing from one cable to another cable or from one core to another core of a multi-core cable directly (without passing through load)

3) Earth fault

When the insulation of the cable gets damaged, the current starts flowing from core to earth or to cable sheath.

III. EXISTING THEORY

The existing systems are manual excavation, TDR technique ,thumping method. This systems uses various methodologies in which their domains are based on time ,sound signals etc . In their domains they need an external source in order to detect the fault position in the underground transmission lines . Let us have overview on the techniques used from ancient days.

a. Arc reflectometer

Radar (Radio Detection And Ranging) was applied to the method of detecting distant aircraft and determining their distance and velocity by analyzing reflections of radio waves. This technique is used by airport radar systems and police radar guns where a portion of thetransmitted radio waves are reflected from an aircraft or ground vehicle back to areceiving antenna. For cable radar, when applied to underground cable, short timeduration pulses are transmitted at a high repetition rate into the cable between the phaseconductor and neutral. A liquid crystal display shows reflections of the transmittedpulses. Reflections are caused by changes in the characteristic impedance of the cable as determined by the following equation

$$r = \frac{z - z_0}{z + z_0} \quad (1)$$

Any reflections are displayed on the screen with elapsed time along the horizontal axis and amplitude of the reflection on the vertical axis. Since we can now measure elapsed time and if we know the pulse velocity as it travels down the cable, distance to the reflection point can be calculated. For airport radar and police radar guns the velocity of propagation (Vp) of the radio waves through air is the speed of light or 984 feet per microsecond. Pulses transmitted into the insulation of our underground cable travel at about half that or about 500 feet per microsecond. Eventhough this method is in existence certain wired connection needed for the powerto transmit from source and in this technique highly experienced engineers are needed.

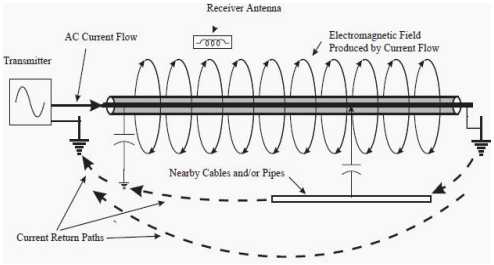

Fig. 2. Reflectometer

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b. Thumping method

To overcome the disadvantages of manual excavation we have another method called thumping method. The Digiphone works according to the principle of the coincidence or difference method. It automatically measures the time difference between the electromagnetic signal of the surge voltage and the acoustic bang of the arc flashover .The Digiphone operates like a stopwatch. The electromagnetic pulse starts a counter and the much slower propagating sound stops the counter afterward. The displayed time, or the time difference between the sound and the magnetic pulse ,corresponds to the distance to the fault. The shorter the time, the closer you are to the fault. The display shows the difference in time as a numerical value, while a bar graph shows the electromagnetic field strength. The field strength display also acts as a locating facility of the cable position. The bar graph display is broken down into individual segments to permit a very accurate definition of where the cable is running. As long as you keep your bearings on this maximum, your longitudinal axis is already exactly on top of the cable. As a result, the position over the cable ,so precise that you almost cannot miss the fault, even when faults are very difficult to hear .This location principle also works for secondary noises and is particularly useful in situations where cables are installed in protective ducts or under solid road surfaces (concrete ,asphalt, etc.).

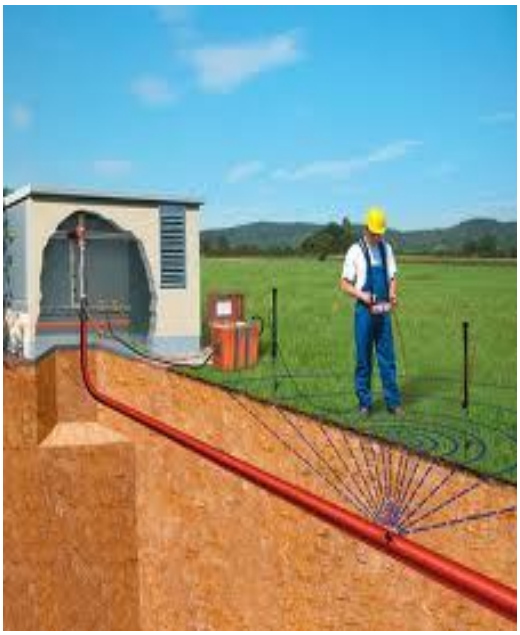

Fig 3.a. Effect on surface due fault

Eventhough this method has overcome certain difficulties it to have many disadvantage likethe previous technique. This cannot be done by a normal foreman in EB. The technical expierenced persons are needed in order to handle this equipments and it is even costlier too. Finally the greater disadvantage in using it in our country is our underground cables ie LT cables are not uniformlt constructed so it would be a greater problem to the technique.

c. Manual excavation

The manual excavation is one of the method used to find fault in the under ground transmission line of lt cables . This process is done by the foreman people who are from electricity board . In which this people would get the information from control room about the area where fault has occurred . Based on the information they start to excavate to find the fault.But they wouldn't be able recognize the actual point where the fault has occurred without excavating the surface for a long distance . due to this excavation in surface public would get the hindrance.

For a precise location of the fault it is essential to confirm its position along the cable, But the position and path of the cable in the ground, and thus the actual position of the fault, is only relatively inaccurately known from the control room of the particular area substation. An absolutely precise pinpointing is necessary to limit because of expensive excavation work and resulting surface damage to an absolute minimum. So this technique would be time consuming since we have no clear idea of pinpoint fault and it has many disadvantage in form of cost , damage of surface ,less efficient on the basis of accuracy.

Only this method is primarily and widely used for finding faults in LT cables whereas the other two methods come into action only when this method fails. Even though there are methods available as substitute, using the method of locating faults in HT cables for the same in LT cables , increases the cost. Hence we design a new system.

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Fig 3.b) fault detected by thumping method

the disadvantages of the existing system but also the induce a robotic revolution in the power system in finding faults of UG transmission cable. Fig depicts the model diagram of the proposed system.

IV. MODEL PROPOSED

In order to eliminate all the above said disadvantages, a mobile robot employing the concept of E- nose is modelled not only to reduce

a. Transmitter system.

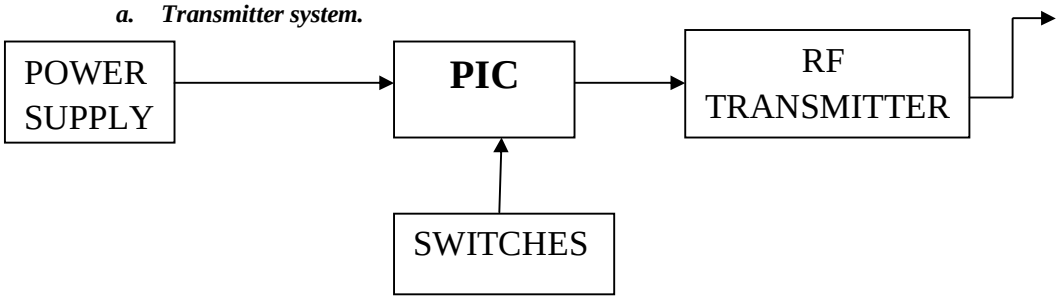

Fig.4. block diagram of transmitter system.

The components of the transmitter system and it's Functionalities are described below:

1. Power supply

Since the system does not consists of wires, we need to supply the power to the whole system through battery. Thence we use a Li-on battery here. A lithium-ion battery (sometimes Li-ion battery or LIB) is a member of a family of rechargeable battery types in which lithium ions move from the negative electrode to the positive electrode during discharge, and back when charging. Li-ion batteries use an intercalated lithium compound as the electrode material, compared to the metallic lithium used in the non-rechargeable lithium battery. Lithium-ion batteries are common in consumer electronics. They are one of the most popular types of rechargeable battery for portable electronics, with one of the best energy densities, no memory effect, and only a slow loss of charge when not in use. Beyond consumer electronics, LIBs are also growing in popularity for military, electric vehicle, and aerospace applications.[6] Research is yielding a stream of improvements to traditional LIB technology, focusing on energy density, durability, cost, and intrinsic safety.

2. Microcontroller

The micro controller, which we are using here is PIC 16F877. It consists of 5 ports, ADC, CLK & MCLR. It is PIC16F877 has 5 basic input/output ports.

They are usually denoted by PORT A (R A), PORT B (RB), PORT C (RC), PORT D (RD), and PORT E (RE). These ports are used for input/ output interfacing. In this controller, "PORT A" is only 6 bits wide (RA-0 to RA-7), "PORT B" , "PORT C","PORT D" are only 8 bits wide (RB-0 to RB-7,RC-0 to RC-7,RD-0 to RD-7), "PORT E" has only 3 bit wide (RE-0 to RE-7).
It consists of internal flash memory and is re-writable.

PORT-A	RA-0 to RA-5	6 bit wide
PORT-B	RB-0 to RB-7	8 bit wide
PORT-C	RC-0 to RC-7	8 bit wide
PORT-D	RD-0 to RD-7	8 bit wide
PORT-E	RE-0 to RE-2	3 bit wid

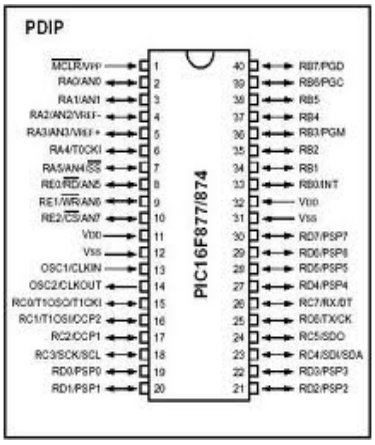

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Fig. 5. Pin diagram of 16F877

All these ports are bi-directional. The direction of the port is controlled by using TRIS(X) registers (TRIS A used to set the direction of PORT-A, TRIS B used to set the direction for PORT-B, etc.). Setting a TRIS(X) bit '1' will set the corresponding PORT(X) bit as input. Clearing a TRIS(X) bit '0' will set the corresponding PORT(X) bit as output.

3. *RF transmitter*

The RF Transmitter allows users to easily send serial data, robot control, or other information wirelessly. When paired with the matched RF Receiver, reliable wireless communication is as effortless as sending serial data. The power-down (PDN) pin may be used to place the module into a low power state (active low), or left floating (it is tied high internally).

The RF module, as the name suggests, operates at Radio Frequency. The corresponding frequency range varies between 30 kHz & 300 GHz. In this RF system, the digital data is represented as variations in the amplitude of carrier wave. This kind of modulation is known as Amplitude Shift Keying (ASK).

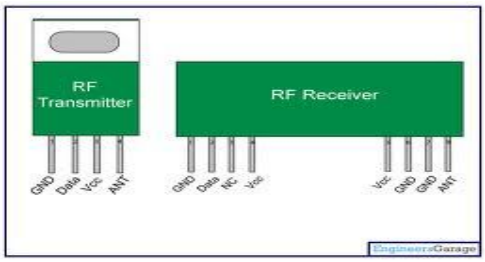

Fig. 6. RF circuit

Transmission through RF is better than IR (infrared) because of many reasons. Firstly, signals through RF can travel through larger distances making it suitable for long range applications. Also, while IR mostly operates in line-of-sight mode, RF signals can travel even when there is an obstruction between transmitter & receiver. Next, RF transmission is more strong and reliable than IR transmission. RF communication uses a specific frequency unlike IR signals which are affected by other IR emitting sources.

b. Receiver system

The components of the receiver system and it's Functionalities are described below.

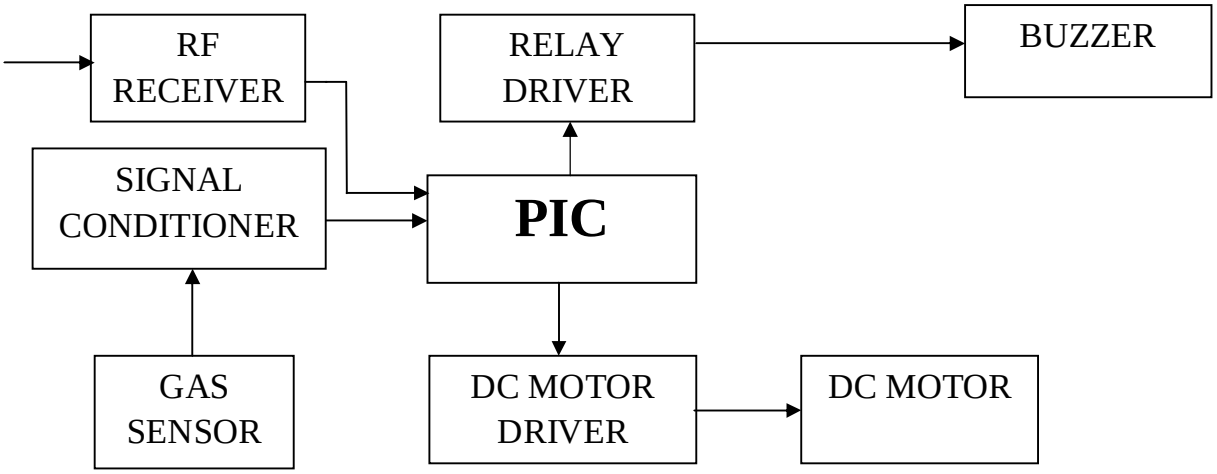

Fig. 7. Block diagram of Receiver system

1. *RF receiver*

The RF signals transmitted by the RF transmitter can be obtained perfectly only by a matched RFvreceiver.

2. *Buzzer*

Buzzer is an electrical device, which is similar to a bell that makes a buzzing noise and is used for signaling. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of

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user input such as a mouse click or keystroke.Fig. 1 shows how to interface the Buzzer to microcontroller. A piezoelectric element may be driven by an oscillating electronic circuit or other audio signal source, driven with a piezoelectric audio amplifier. Sounds commonly used to indicate that a button has been pressed are a click, a ring or a beep. When the input port pin from microcontroller is changed, the sound wave is changed in Buzzer.

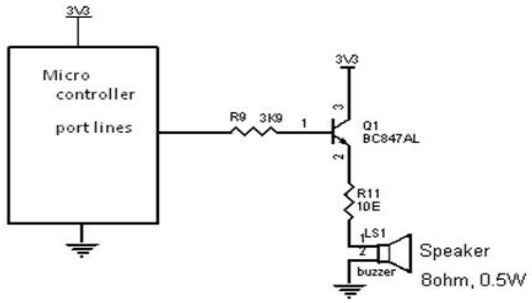

Fig. 8 Interfacing Buzzer to Microcontroller

A small piezoelectric buzzer on the PIC16F/18F Slicker Kit, by pulling pin PORTB.0 low, current will flow through the buzzer and a relatively sharp, single-tone frequency will be heard.The alternative INT feature of pin PORTB.0 (the INT signal) can be used to modulate the buzzer to oscillate around different frequencies. Then the volume of the sound will be changed by alternating the pulse width. The buzzer can be disconnected by removing jumper J6, and this is also the default position for this jumper since the buzzer sound can be quite annoying if always left on. Thus the buzzer beeps wen the Gas density exceeds the already stored value or matches with it.

3. Relay

A relay is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. It was invented by Joseph Henry in 1835. Because a relay is able to control an output circuit of higher power than the input circuit, it can be considered, in a broad sense, to be a form of an electrical amplifier.

4. Signal conditioner

A signal conditioner is a device that converts one type of electronic signal into a another type of signal. Its primary use is to convert a signal that may be difficult to read by conventional instrumentation into a more easily read format. In performing this conversion a number of functions may take place. They include:

5. Gas sensor

A gas detector is a device which detects the presence of various gases within an area, usually as part of a safety system. This type of equipment is used to detect a gas leak and interface with a control system so a process can be automatically shut down. A gas detector can also sound an alarm to operators in the area where the leak is occurring, giving them the opportunity to leave the area. This type of device is important because there are many gases that can be harmful to organic life, such as humans or animals.

Gas detectors can be used to detect combustible, flammable and toxic gases, and oxygen depletion. This type of device is used widely in industry and can be found in a variety of locations such as on oil rigs, to monitor manufacture processes and emerging technologies such as photovoltaic. They may also be used in fire fighting.

Gas detectors are usually battery operated. They transmit warnings via a series of audible and visible signals such as alarms and flashing lights, when dangerous levels of gas vapors are detected. As detectors measure a gas concentration, the sensor responds to a calibration gas, which serves as the reference point or scale. As a sensor's detection exceeds a preset alarm level, the alarm or signal will be activated. As units, gas detectors are produced as portable or stationary devices. Originally, detectors were produced to detect a single gas, but modern units may detect several toxic or combustible gases, or even a combination of both types.

The relationship between sensor resistance and the concentration of deoxidizing gas can be expressed by the following equation over certain range of gas concentration:

$$Rs = A[C]^{-\alpha} \qquad (2)$$

Where
Rs =electrical resistance of the sensor,
A = constant,
C = gas concentration,

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α=slope of *Rs* curve

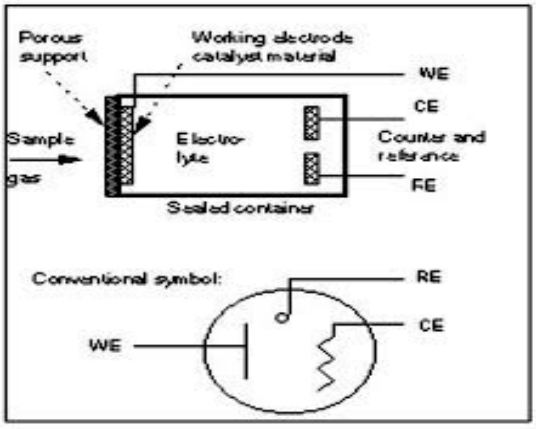

Fig. 9. Sensor circuit

A.Training for Classification of Odors

In order to classify the feature vector, we allocate the desired output for the input feature vector where it is nine-dimensional vector, since we have added the coefficient of variation to the usual feature vector to reduce the variations for odors. The training has been performed until the total error becomes less than or equal to $0.5 \times 10{-}2$ where η=0.3.

***B* .Classification Results and Discussion for Mixed Odor Data**

After training such that all the smells, A, B, C, and D,have been classified correctly, we have tested the mixed data sets such that two kinds of odors are mixed with the same rate where the data set of mixed smells are *{*A&B, B&C, C&D, D&A, A&C, B&D*}*. The maximum values show one of the mixed odors. But, some of them do not show the correct classification for the remaining odor. Thus, we have modified the input features such that $z = x - 0.9y$, where x is the feature, y denotes the top value of each, and z is a new feature. Using the new feature vector, we have obtained the classification results as shown in Table X. By changing the features according to the above relation, better classification results have been obtained. But, the coefficient 0.9 used in the above equation is not necessarily appropriate. The value might be replaced by the partial correlation coefficient in multivariate analysis.

6. DC motor

DC motors are non-polarized - meaning that you can reverse voltage without any bad things happening. Typical DC motors are rated from about 6V-12V. The larger ones are often 24V or more. But for the purposes of a robot, you probably will stay in the 6V-12V range. So why do motors operate at different voltages? As we all know (or should), voltage is directly related to motor torque. More voltage, higher the torque. But don't go running your motor at 100V cause thats just not nice. A DC motor is rated at the voltage it is most efficient at running. If you apply too few volts, it just wont work. If you apply too much, it will overheat and the coils will melt. So the general rule is, try to apply as close to the rated voltage of the motor as you can. There is a special case for DC motors that change directions. To reverse the direction of the motor, you must also reverse the voltage. However the motor has a built up inductance and momentum which resists this voltage change. So for the short period of time it takes for the motor to reverse direction, there is a large power spike. The voltage will spike double the operating voltage. The current will go to around stall current. The moral of this is design your robot power regulation circuitry properly to handle any voltage spikes.

Fig. 10. DC motor.

V. EVALUATION

parameters	Existing model	Proposed design
Time consumed	High	less
No. of workers	More	Less
efficiency	less	high

VI. CONCLUSION

At the end of a research we have designed a mobile robot with a gas sensor that acts as an E-nose in pin-pointing the fault location in the low voltage(LT) underground cables with an ease n less time consumption. This method enhances the efficiency of the staffs of TNEB in finding the faults and also works towards a greater vision of automation even in

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small sector of TNEB yielding a high profit to the sector involving a minimum installation cost.

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