Machine Learning Techniques with Clustering method for LPG Detection

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Abstract—- This paper has been proposed to examine thick film gas sensor recognition for LPG. 1" x 1" alumina substrate was artificial for a thick film gas sensor. Its selection of the basic gas perilous laminated surface TiO_2 based on CuO doped thick film gas sensors was devised in such way electrodes for the gas perilous laminated surface. The contact pad interacts with the sensor. The sensitivity of the sensor has been studied at different Pd-doped concentrations (1 % CuO doped) at an everlasting temperature 150C upon exposure LPG. The proposed paper emulates in anaconda software through spider tool(spyder-3) exploitation python programming language. Python programming language scripted in machine learning using clustering techniques for appreciated of toxic liquids. Emulative result suits with hand on results with simulated results at dissimilar operating temperature

Keywords: ***Thick film gas sensor, Sensitivity, Clustering***

1. Introduction:

The sensor is the device, which senses the input signal. Nowadays, there is a general opinion in both scientific and engineering community that there is an urgent need for the development of cheap, reliable sensors for the control and measuring systems, for the automation of services and for the industrial and scientific apparatus.

For the development of sensors, interest has been increased to study the transduction principles, simulation of systems and the structure investigations of the most suited materials and proper choice of technology.

Presently the atmospheric pollution has become a global issue. Gases from auto and industrial exhausts are polluting the environment. The reducing gases such as: CO [1], H2 [2], oxygenic gases such as: CO2 [3], NOx [4], odorous gases such as: NH3, H2S [5], explosive gases such as: C3H8, LPG [6] and, toxic gases such as: Cl2,NO2 [7] etc. have to be controlled for the healthy survival of the living beings.

Thus, there is an increasing concern about minimization of the emission of autointoxication and also to reduce emission of such unburnt hydrocarbons from automobile and industrial exhausts. Thus the need to monitor and control these gases has led to the research and development of a variety of sensors using different materials and technologies.

TiO_2, like many other transition metal oxides, is a high resistive n-type semiconductor with rather poor conductivity to be adopted for sensing oxidative gases. To overcome this disadvantage, the electronic structure should be altered into p-type by the addition of foreign atoms.

A few works that show how the addition of Cr to TiO_2 alters the electronic conductivity from n to p-type have appeared, opening the development of novel gas sensors. The p-type materials obtained under appropriate conditions responded with a sharp decrease in its resistance upon exposure to diluted NO_2.

The advantages of TiO_2 are that it is a highly stable material at high temperature and harsh environment and has thermal expansion coefficient matching with alumina [49], making it suitable for the fabrication of thin film based sensors.

The metal oxides, such as SnO_2, TiO_2, Ga_2O_3, WO_3, Nb_2O_5 or MoO3 are used for gas detection [4-7]. Among these, TiO_2 exhibits probably the best chemical stability at high temperatures and harsh atmospheres.

TiO_2 is a native oxygen deficient metal-oxide therefore is n-type semiconductor [8-11].In the past decade, one- dimensional (1D) nanostructures, such as carbon nanotube [12, 13],

ZnO [14, 15], In_2O_3 [16, 17], and SnO_2 [18, 19] have attracted much interest because of their potential applications in many fields and theoretical importance. Recently, gas sensors based on single carbon nanotube [20], SnO_2 nanowire [21] and TiO_2 included carbon nanotubes [22] were reported. There are several ways of preparing TiO_2 nanoparticles [23-26] for gas sensing application.

The TiO_2 exists in three different crystals formation phases, these are anatase (tetragonal crystal structure with 3.2 eV energy gap [27]), rutile (tetragonal crystal structure with 3.2eV energy gap), and brookite (orthorhombic with 2.96 eV energy gap).

K. Del Ángel-Sanchez et al prepared TiO_2 nanotubes by using hydrothermal method [28]. The synthesis was carried out in NaOH solution.

The nano tubes of TiO_2 was also prepared by using solvothermal method [29] and microwave synthesis method [30] in NaOH solution. Bulakhe et al [31] reported the TiO2 nanoparticles prepared by using $TiCl_3$ source materials gives gas response to LPG gas but and the gas concentration is 500 ppm while Shivaji D et al [32] reported the hydro thermal synthesis of TiO_2-SnO_2 used to produce Nano needles, thick films of these composite materials gives gas response for LPG (500 ppm) gas.

2. Experimental details:

1.5 gm of commercial anisate TiO_2 was dispersed in 160 ml of 10M NaOH aqueous solution and stirred for 3h in air. The mixture was placed in 250 ml capacity Teflon-lined autoclave maintained in an oven at 180oC under autogenous pressure for time 6 h, 12 h and 24 h, and then cooled to room temperature naturally. The white precipitate were alternatively washed with HCl solution (≈1M) and de-ionized water at least three times and dried at 100oC for 7 h. The thixotropic paste [33, 34] was prepared by mixing the fine synthesized power of TiO_2, ethyl cellulose (100 mg) and organic solvents. The paste was screen printed on glass substrate in desired patterns. The prepared films were fired at 550oC for 30 min. to remove the temporary binder. The sensing performance of the thick films was examined by using a static gas sensing system [35-36].

3. Proposed Work:

The presented instances in HD dataset using various clustering techniques K-Mean clustering and hierarchal clusteringwhich are discussed below:

K-Means Clustering

K-means clustering technique which identifies mutual exclusive clusters of circular shape. In addition, a particular number of disjoint, flat (non-hierarchical) clusters are created.

The statistical models are applied for assigning rank values to the group categorical values. The categorical values are transformed to numeral values through the allocation of rank values. K-Means clustering model organizes the objects to k – partitions where every partition indicates a cluster. Researchers begin with the preliminary collection of mean sand categorize cases depending upon the distances to the centers. Next, the cluster means will be determined by the use of cases which undergo assignment of instances to the clusters. Finally, the cluster is again calculated and allocated the instances to the lasting clusters.

4.Results & Discussions:

Performance Characteristics of the Sensor

The concept validation graph accomplished between Concentration Vs Sensitivity at different temperatures for Propanol in shown Fig.1. The temperature for the sensitivity of LPG for 1% CuO doped TiO_2 based thick film gas sensor was quantitative evaluation.

It was celebrated that the graph, sensitivity first increases and after some time reached an impregnation quality This sampled data set shown in Fig.1 at 150°C and respected the simulation clustering k- mean result illustration in Fig 2.

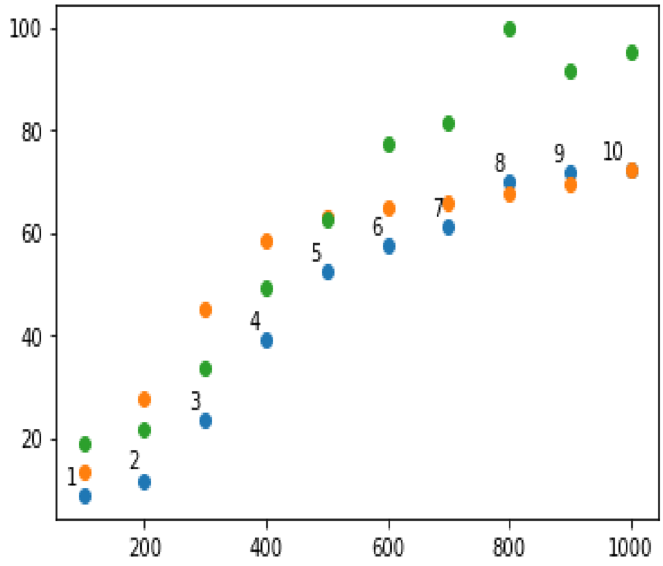
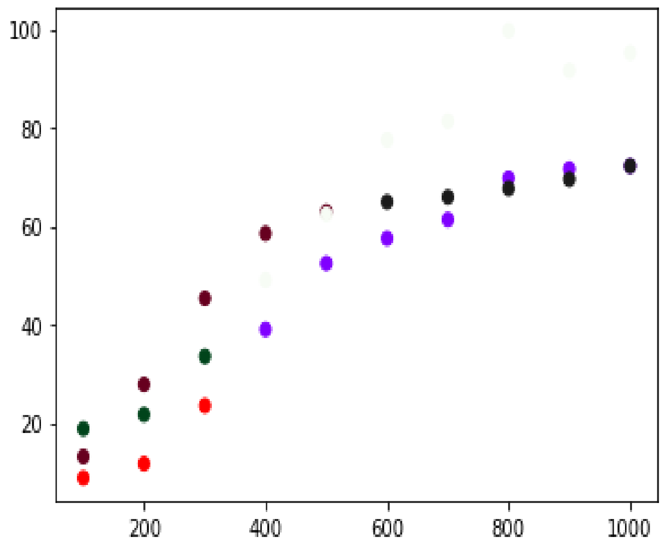


Fig. 1. Response of TiO2 sensor (1% CuO doped on clustering k- methods on the exposure of LPG at 150℃ at Clustering two Method

[1 1 1 0 0 0 0 0 0 0]
[1 1 1 0 0 0 0 0 0 0]
[0 0 0 0 0 1 1 1 1 1]
[0 0 0 0 0 1 1 1 1 1]
[1 1 1 0 0 0 0 0 0 0]
[1 1 1 0 0 0 0 0 0 0]

Fig. 2 Simulated clustering k-mean result for 150℃



Fig, 3 .Sampled and trained data for 150℃ for two clustering Method

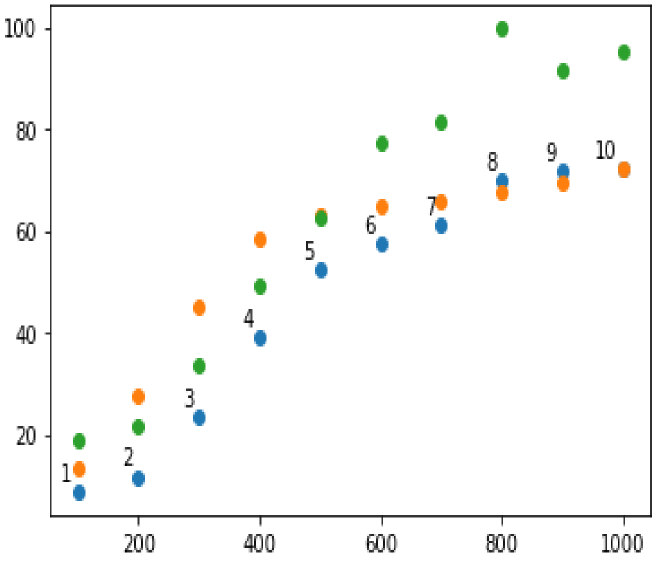


Fig. 4. Response of TiO_2 sensor(1% CuO doped on clustering k- methods on the exposure of LPG at 150℃ at Clustering three Method

[1 1 1 0 0 0 0 2 2 2]
[1 1 1 0 0 0 0 2 2 2]
[2 2 1 1 1 0 0 0 0 0]
[2 2 1 1 1 0 0 0 0 0]
[1 1 1 0 0 0 0 2 2 2]
[1 1 1 0 0 0 0 2 2 2]

Fig. 5. Simulated clustering k-mean result for 150℃

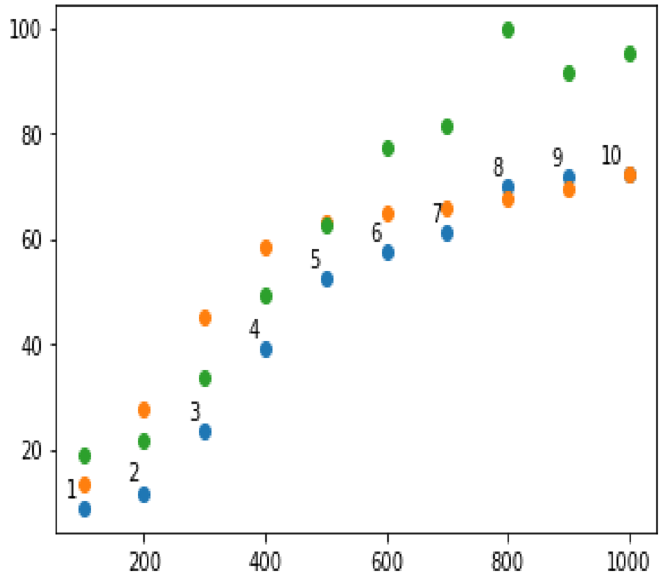
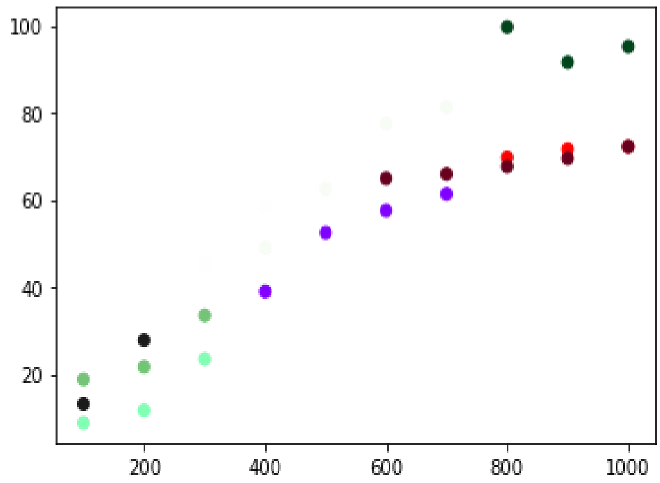


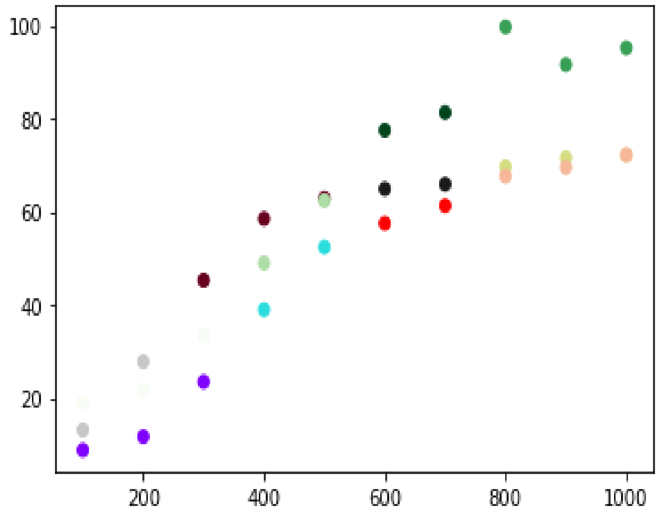
Fig. 7. Response of TiO_2 sensor(1% CuO doped on clustering k- methods on the exposure of LPG at 150℃ at Clustering Four Method

[0 0 0 1 1 3 3 2 2 2]
[0 0 0 1 1 3 3 2 2 2]
[2 2 0 0 0 3 3 1 1 1]
[2 2 0 0 0 3 3 1 1 1]
[0 0 0 1 1 3 3 2 2 2]
[0 0 0 1 1 3 3 2 2 2]

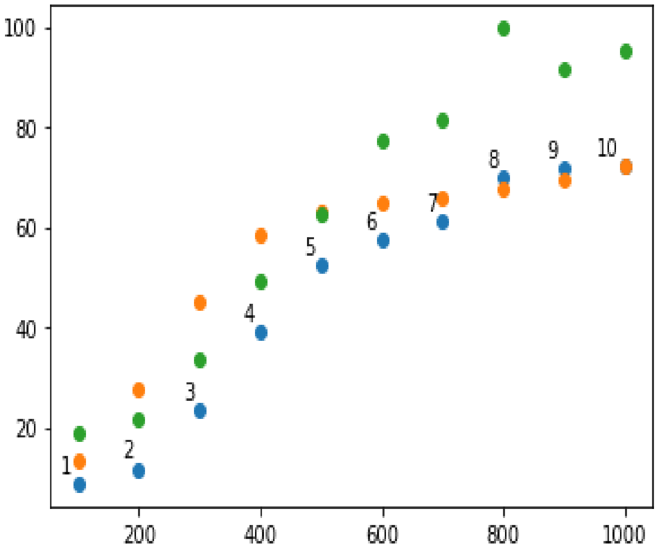
Fig. 8 Simulated clustering k-mean result for 150℃



Fig, 6 .Sampled and trained data for 150℃ for two clusteringMethod



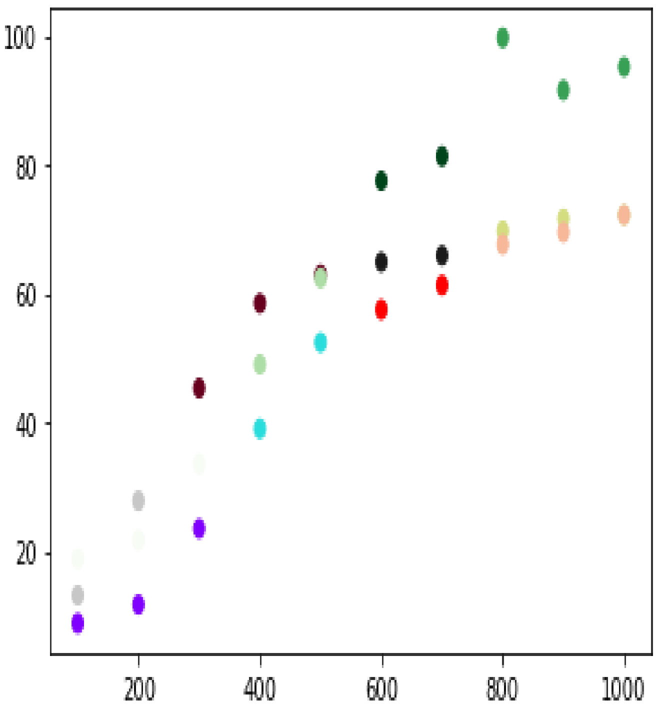
Fig, 9 .Sampled and trained data for 150℃ for four clusteringMethod



Fig, 10 .Sampled and trained data for 150℃ for four clustering Method

[0 0 0 1 1 3 3 2 2 2]
[0 0 0 1 1 3 3 2 2 2]
[2 2 0 0 0 3 3 1 1 1]
[2 2 0 0 0 3 3 1 1 1]
[0 0 0 1 1 3 3 2 2 2]
[0 0 0 1 1 3 3 2 2 2]

Fig.11 Simulated clustering k-mean result for 150℃



Fig, 12 .Sampled and trained data for 150℃ for fiveclustering Method

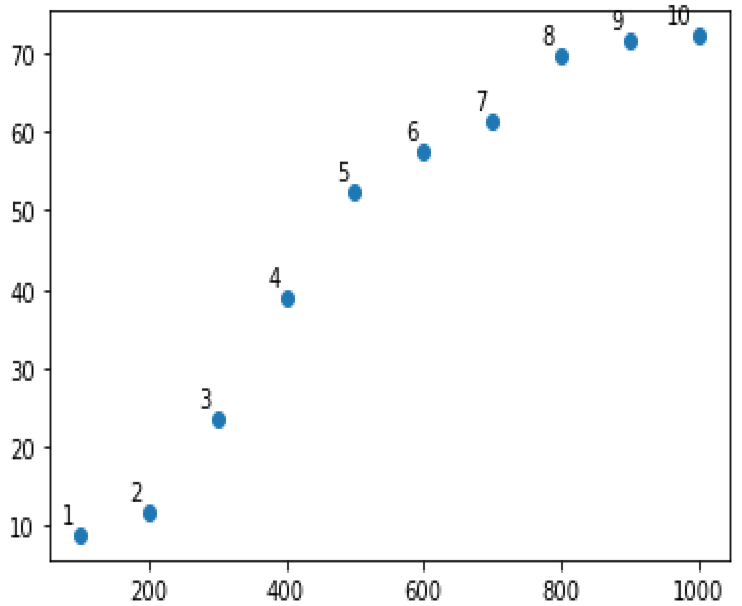
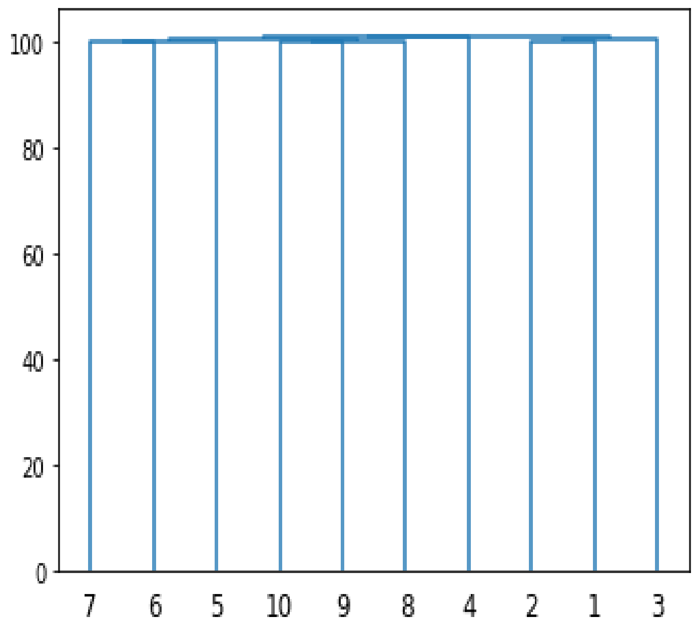


Fig. 13. Response of TiO_2 sensor (1% CuO doped on clusteringk-methods on the exposure of LPG at 150℃



Fig, 14 .Sampled and trained data for 150℃

The temperature for the experiment was preserved value at 150°C and 1% CuO doped TiO_2 based thick film amendment sensitivity of LPG gas sensor was quantitative valuation. It wasrealized that the graph of sensitivity foremost increases and subsequently similar time carries out a saturation value.

This sampled data set was demonstrated in Fig.13 at 150°C and respected the simulation clustering k-mean result for

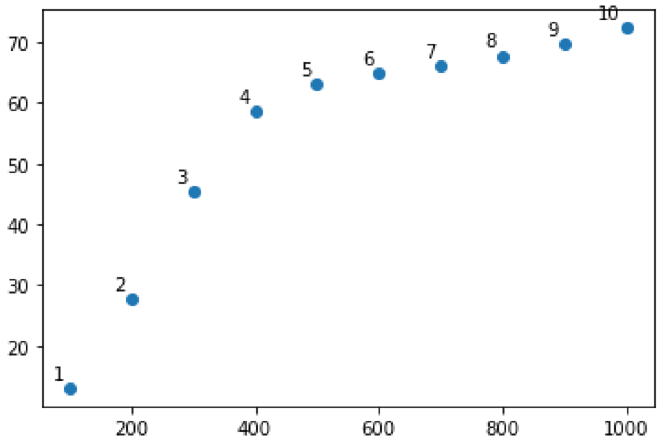


Fig. 15. Response of TiO_2 sensor (1% CuO doped on clusteringk- methods on the exposure of LPG at 150℃

Fig. 17. Response of TiO_2 sensor (1% CuO doped on clustering k- methods on the exposure of LPG at 150℃

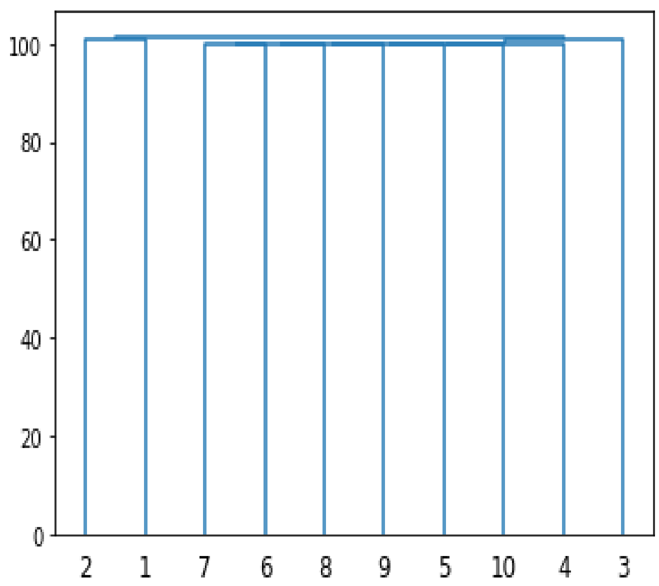
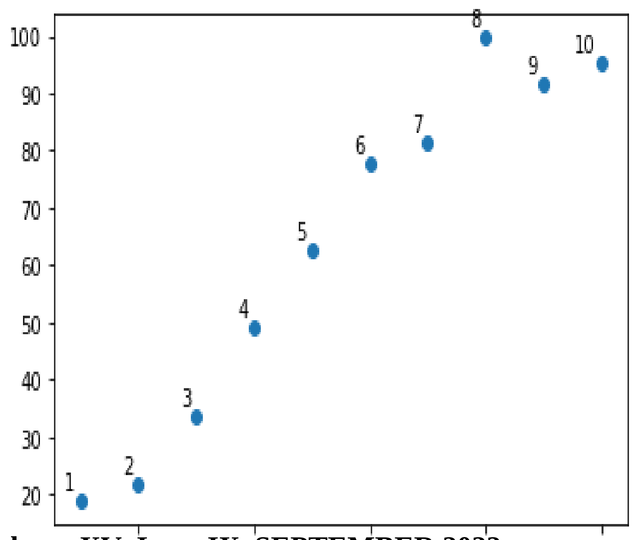


Fig. 16 .Sampled and trained data for 150℃



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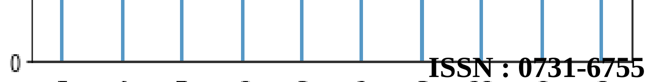

Fig. 18 .Sampled and trained data for 150℃

5. Conclusion:

The maximum sensitivity recorded for a 1% CuO doped sensor for LPG is 72.2 % at 150°C.Similarly, when a concentrationof LPG is transmitted to 1% CuO doped sensor at 200°C the Maximum sensitivity recorded is 72.3%. To see the furthervariation the temperature was increased to 250°C with the sameconcentration of propanol and 1% Pd doped sensor the sensitivityrecorded was 95.4%.

The fluctuations in temperature will affect the sensitivity to an extent but more or less Sensitivity remains almost constant with thevariation in the atmospheric conditions.

6. References:

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