Development of Novel Gas Brand Anti-Piracy System based on BP Neural Networks

To cite this article: L Wang et al 2006 J. Phys.: Conf. Ser. 48 611

View the article online for updates and enhancements.

You may also like

- Application of BeiDou Navigation Satellite System in Anti-Drowning System
  Yong Lei, Minghao Chen, Tianran Sun et al.

- Application of wireless communication technology in safety monitoring system of Guandi Hydropower Station
  Jiaxiang Tao, Tian Wang and Jinwen Li

- Design of Remote Terminal of Air Compressor Based on STM32 and GPRS
  Menglong Cao and Junlei Fang
Development of Novel Gas Brand Anti-Piracy System based on BP Neural Networks

L Wang¹, Y Y Zhang² and L Ding³
¹School of Aeronautics and Astronautics, Tongji University, Shanghai, China
²Chinese-German School of Postgraduate Studies, Tongji University, China

E-mail: leiwang@mail.tongji.edu.cn

Abstract. The Wireless-net Close-loop gas brand anti-piracy system introduced in this paper is a new type of brand piracy technical product based on BP neural network. It is composed by gas brand piracy label possessing gas exhalation resource, ARM embedded gas-detector, GPRS wireless module and data base of merchandise information. First, the system obtains the information on the special label through gas sensor array, then the attained signals are transferred into ARM Embedded board and identified by artificial neural network, and finally turns back the outcome of data collection and identification to the manufactures with the help of GPRS module.

1. Introduction
Nowadays, counterfeit trade reaches 1500~1600 billion dollars, about 5%~6% of the international trade sum. In China, the loss caused by counterfeits is more than 200 billion RMB, which destroy the well-known brands, incurs tremendous economic loss, so that hampers the economic development, even jeopardizes the country credit. It makes sense how to strike the piracy manufacture, production and sales. Anti-piracy is attached more and more importance.

Our lab started the research 2 years ago, and has finished the system debugging. According to the piracy test, all the properties meet the index requirement.

2. System structure
The system is constituted gas brand anti-piracy label possessing gas exhalation resource, ARM embedded gas-detector, GPRS wireless module and data bank of merchandise information. The system structure shows in figure 1.

First, the system obtains the information on the special label through gas sensor array, then the attained signals are transferred into ARM Embedded board and identified by artificial neural network, and finally turns back the outcome of data collection and identification to the manufactures with the help of GPRS module.

The system is capable of detecting gas brand piracy label fleetly and precisely, and presenting identification results without reading the data by professional or checking the results by additional facilities.

1 Chinese-German School Room509, No.50 Chi Feng Rd. Shanghai (Postalcode:200092) ,China
2.1. Preparation of gas anti-piracy label
A fine anti-piracy label could be liquid volatilizing compound, which is convenient for package, sensor check, hard to copy. Based on the analysis, gasoline, alcohol and ammonia are chosen to be the basic component of the gas source and cover the modified carrier with bar code to obtain the ultimate label.

2.2. Gas sensor array and the adapter circuit
In this system, we cooperate with JENASENSORIC E.V in Germany to develop GGS gas sensor series, which are obtained by sputtering technology and mixed thin film technology. The inner structure shows in figure 2 (a).

The sensitive layer is SiO\textsubscript{2} thin film [1]. According to the test, at 300\textdegree C layer shows better sensitive identify.

**Table 1.** The function table of GGS series gas sensor.

| Categories of Sensors | Function |
|-----------------------|----------|
| GGS1000               | High sensitive for CH\textsubscript{4}, wide band |
| GGS2000               | Sensitive for CH\textsubscript{4} , high sensitive for CO ,H\textsubscript{2} and Ethanol |
| GGS3000               | Sensitive for CH\textsubscript{4},Ethanol,H\textsubscript{2},NH\textsubscript{4},low cross sensitivity for CO and Ethanol |
| GGS4000               | Sensitive for NH\textsubscript{4} , low cross sensitivity for CH\textsubscript{4},CO 和 H\textsubscript{2} |
| GGS5000               | Sensitive for O3,NO |
| GGS6000               | Sensitive for H\textsubscript{2} |
| GGS7000               | Sensitive for NO |

In this system, based on gas brand anti-piracy label GGS1000, 2000, GGS4000 are chosen from Table1. MEMS (Micro Electro Mechanical Systems) technology is adopted to encapsulate those sensors to make up gas sensor array [2], which is showed in figure 2 (b).
2.3. Embedded master control module and GPRS wireless communication module
The core of master control module is S3C44B0X chip provided by SAMSUNG kernel (figure 3), which is based on ARM technology.

In this system, the Q2403A chip provided by WAVECOM Company is used as core of the wireless communication module. The module communicates with master control module by serial interface. UDP Protocol has been chosen.

3. Pattern recognition based on BP neural network

3.1. Pattern recognition
Pattern recognition is the procedure designed to distinguish and classify the modified information by computer technology. It makes it quick and convenient when dealing with abundant information without interference from other factors, and also optimizes the process of searching object [3].

3.2. Artificial neural network (ANN)
Neural network is composed by magnitude connecting neural cells. ANN is a nonlinear mechanical system consists of simple neural cells, stimulating the structure and function of neural network in human brain. First of all, ANN takes on high fault tolerance because of the existence of process mechanism and redundant structure. Second, a mass of cells in ANN are capable of dealing with information simultaneously [4]. Also, ANN has the ability to study and nonlinear mapping
approximation. Consequently, the neural network after adapt training is potentially functional to adaptive pattern matching, as well as memorize the information.

3.2.1. BP neural network. ANN can be classified as feed-forward network, feedback network and self-organizing network according to their transmission ways. Feed-forward multilayer network with back propagation error is called BP network, which is a kind of ANN used most widely [5].

BP is also called Back Propagation algorithm. It sends back the error information oppositely, amends the neural cell weight coefficient in each hidden layer and finally minimizes the error information.

3.2.2. The result of experimentation. BP network is applied in the practice. The structure contains three layers: input layer with 3 nodes, hidden layer 10 nodes and output layer 3 nodes. For each node the transfer function is Sigmoid; the learning regulation is gradient descent regulation with momentum; error function is by least mean square error function evaluated [6].

Desired error is 0.001, gradient coefficient 0.01, momentum coefficient 0.95, linked weight value and threshold value are stochastic created in [-0.1, 0.1].

The volume ratio of training gas samples prepared by alcohol, ammonia and gasoline are 10:1.5:1.5(1#), 10:2:1(2#), 10:1:2(3#) respectively. Testing the three samples under same circumstance, 18 data groups are obtained. Then, pick the former 12 groups to make up studying sample series, and the later 6 groups testing sample series. When training network, the studying sample data are input into network randomly each bout. The simulate result in MATLAB7.0 is showed in figure 4, indicating that the output error meets the requirement after about 450 bout. The training is considered complete.

From the table 1, 2, 3, it can be concluded that the pattern recognition result of 1# is relatively excellent, while that of 2# and 3# are worse except some individual samples. We analyzed, in one aspect, that few hidden nodes are chosen. They don’t achieve good recognition effect despite of quick convergence rate. In another aspect, the characteristic of three samples is similar, making it hard to distinguish.

![Figure 4. The simulation result of Artificial Neural Network.](image)

| Testsample1 | Testsample2 | Testsample3 | Testsample4 | Testsample5 | Testsample6 | Set point |
|-------------|-------------|-------------|-------------|-------------|-------------|-----------|
| 0.9773      | 0.9902      | 0.9935      | 0.9770      | 0.9007      | 0.9762      | 1         |
| 0.0039      | 0.0031      | 0.0030      | 0.0475      | 0.0400      | 0.0379      | 0         |
| 0.2745      | 0.2072      | 0.1739      | 0.0462      | 0.1760      | 0.0614      | 0         |

Table 2. Test result of 1# gas sample.
### Table 3. Test result of 2# gas sample.

| Testsample1 | Testsample2 | Testsample3 | Testsample4 | Testsample5 | Testsample6 | Set point |
|-------------|-------------|-------------|-------------|-------------|-------------|-----------|
| 0.0014      | 0.0223      | 0.0022      | 0.0003      | 0.0022      | 0.0003      | 0         |
| 0.5851      | 0.8620      | 0.5323      | 0.9606      | 0.4301      | 0.9309      | 1         |
| 0.5130      | 0.0600      | 0.5454      | 0.0963      | 0.6124      | 0.1505      | 0         |

### Table 4. Test result of 3# gas sample.

| Testsample1 | Testsample2 | Testsample3 | Testsample4 | Testsample5 | Testsample6 | Set point |
|-------------|-------------|-------------|-------------|-------------|-------------|-----------|
| 0.0000      | 0.0003      | 0.3803      | 0.0013      | 0.2019      | 0.0008      | 0         |
| 0.8812      | 0.4522      | 0.1190      | 0.2479      | 0.1441      | 0.2850      | 0         |
| 0.2399      | 0.6763      | 0.3435      | 0.8051      | 0.4197      | 0.7876      | 1         |

### 4. Conclusion

At present, artificial neural network is applied widely in every field, in which BP is most common. It’s applied in data compression, approximating function, pattern recognition and so on. The paper introduces a new type gas brand anti-piracy label based on BP neural network technology. The function of BP in this system is to carry out pattern recognition of gas signals, which recognizes its application in ARM flatbed and nonlinear system classification.

### References

[1] Wu C.R, Qu J.Z, Lin H.A and Chen X. 1991 A new alcohol vapour sensor based on thin film SnO$_2$. *Tech.Digest,STC* Vol 91 pp 466-469

[2] Zhang Y.X., Ji B.H., Wang S.B and Li X.Z. 1991 The characteristic analysis of a high reliable alcohol gas sensor *Tech.Digest,STC* Vol 91 pp 611-613

[3] Huang D S 1996 *Systemic Theory of Pattern Recognition in Neural Network* (Beijing: Electronic) p 37

[4] Wen X. and Zhou L. 2003 *Matlab Simulation and Application of Artificial Neural Network* (Beijing: Science) pp 4-31

[5] Ding L 2005 Wireless-net Close-loop Gas Brand Piracy System based on GPRS Module and ARM Kernel *Proc.Tongji University* (Shanghai: Tongji Proceeding) p 56