CHEMICAL ENGINEERING TRANSACTIONS
VOL. 71, 2018

A publication of AIDIC
The Italian Association of Chemical Engineering
Online at www.aidic.it/cet

Guest Editors: Xiantang Zhang, Songrong Qian, Jianmin Xu

ISBN 978-88-95608-68-6; **ISSN** 2283-9216
DOI: 10.3303/CET1871122

Implementation of Chemicals Logistics Supervision Forewarning Platform Based on IoT Cloud Computing

Haisheng Li

School of Information Engineering, Zhengzhou Railway Vocational & Technical College, Zhengzhou 451460, China
lihaishengmail@163.com

Hazardous chemicals have their own intrinsic properties such as explosive, flammable, corrosive, toxicity, and radioactivity, which will lead to great threats and substantial security risks in the transportation, application and storage processes. Problems, if possibly arisen in the transportation and management processes, may cause a major accident. We have to fight through some troubles in the whole process. For this purpose, the paper designs and implements a chemical logistics supervision and forewarning system based on the Internet of Things (IoT) cloud computing, which integrates IoT technology to collect, merge and transmit geographical location information and operation conditions for chemical supply chain such as storage and distribution, environmental parameters for hazardous chemicals, monitor and analyze the transportation route safety and driver operation status. This is a real-time surveillance over the whole logistics chain for hazardous chemicals. Here analyze and aggregate the parameter thresholds of the feature elements that lead the hazardous chemicals logistics to accidents. When the platform detects there is a parameter that reaches the critical threshold, the system automatically issues a warning signal according to the preset forewarning decision program, and then takes measures for level-to-level troubleshooting against it, thereby realizing the monitoring and forewarning on the hazardous chemicals logistics. It is proved by the test that the function modules on the platform all fill the bill for the design and implementation. Given the above, this platform can well apply to monitoring and early warning for hazardous chemicals logistics.

1. Introduction

Now it is common thing for dangerous chemicals to cause the accidents. Why? There are some problems in off-site transportation: transport vehicles for dangerous chemicals violate relevant regulations; the overall quality of drivers is not high; the road transport safety is not strictly controlled; more information about transport personnel and transported goods are lack, which may deter us from the accident analysis and judgment, as well as the rescue process (Lei and Shang 2014)). The implementation of the hazardous chemicals logistics supervision and forewarning platform can reduce and avoid the occurrence of accidents in off-site transportation process, control the development of bad events, and mitigate the hazards caused by the accident; locate the map of the vehicles to make clear the vehicle's driving trajectory, and rationally dispatch the vehicle journey to ease the traffic pressure; provide the logistics companies with logistics information management for hazardous chemicals, which can facilitate them to arrange logistics transportation in a reasonable way. It is very handy services for those logistics companies. In general, there is a great need for investigating the supervision and early warning platform for hazardous chemicals logistics, so that it is essential for a good business (Xing et al., 2010).

2. Demand analysis and design program

2.1 Technological background

This platform proposed in this paper uses the total information sensing, reliable transmission, intelligent treatment of IoT technology to collect the underlying sensing data and transmit it to the application backend database, thus ensuring data accuracy and reliability (Zhong and He, 2014; Pan et al., 2017). The application

Please cite this article as: Li H., 2018, Implementation of chemicals logistics supervision forewarning platform based on iot cloud computing, Chemical Engineering Transactions, 71, 727-732 DOI:10.3303/CET1871122

of the IoT can be divided into three levels: the sensing layer, the network layer, and the application layer. See Table 1 for details.

Table1: Technical architecture of the Internet of Things

Level	Composition	Effect
Perceptual layer	Various sensors and sensor gateways	Identify objects and collect information
Network layer	Private networks, internet, wired and wireless communication networks, network management systems and cloud computing platforms	Pass and process information acquired by the perception layer
Application layer	Interface between the Internet of Things and users (including people, organizations, and other systems)	Integrate with industry needs to realize intelligent application of Internet of Things

Sensors, RFID (Radio Frequency Identification Device), short-range wireless communication, WAN wireless communication, GPS (Global Positioning System), information fusion and security, etc. are all key technologies that support the IoT to further expand (hakraborty and Newton, 2011; Shivani et al.2017). The attenuation of radio frequency communication signals when propagating in air is calculated by the following formula:

$$Los = 32.44 + 20\lg d + 20\lg f \qquad (1)$$

Where LOS is the transmission loss, dB; d is the propagation distance, kilometers; f is the operating frequency of the RF signal, MHz.
The length of the RF antenna is counted by the formula:

$$L = \frac{\mathrm{c}}{4f} = 17.2cm \qquad (2)$$

Where L is the length of the antenna; c is the speed of light; f is the frequency of the RF signal.
The key components involved in the active tag circuits are shown in Table 2.

Table 2: Key component details

Serial number	Name	Model specification	Technical Parameters	Manufacturer
1	MCU	FXTH8700xD	8-bit microcontroller, 512RAM,8kFlash Power supply voltage 3V	Freescale Semiconductor, Inc
2	Induction appliance	EPCOSB82450A7204A000	7.2mH @125KHz--3% SMD	EPCOS
3	Button Battery	CR2050HR	3V, 350mAh	MAXEL
4	Crystal oscillator	NX3225SA	26MHz	NDK

Cloud computing is an Internet service mode bred by a variety of advanced computing methods such as distributed computing and parallel computing, driven by scale economy. It features abstraction, virtualization, dynamic scalability, planning and manageability. It provides services to users via the Internet. User does not need to understand the infrastructure of the services or the details of the application (Stojanovic et al. 2014; Lee and Kang, 2015).

2.2 Program design

The system mainly provides several function modules including basic information management, electronic order process operations, vehicle in-transit monitoring, and data statistics.

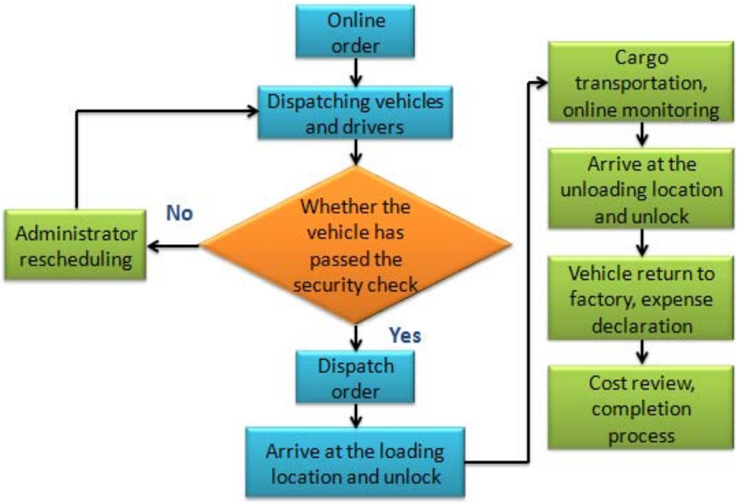

Figure1: Hazardous chemicals logistics process

As shown in Figure 1, it is the hazardous chemicals logistics process. In the “chemicals logistics supervision and forewarning platform” proposed in this paper, we intend to design five major function parts including the user management, equipment management, monitoring center, alarm management, statistical reports:
In order to easily distinguish vehicle-mounted safety protection equipment from logo signage, we have classified and encoded them, as shown in Table 3.

Table 3: Equipment and sign identification type number

Code	Name	Code	Name	Code	Name
01	Explosives	14	Have drugs	27	Fire extinguisher box
02	Explosives (1.4)	15	Harmful goods	28	Fire extinguisher box (1)
03	Explosives (1.5)	16	Infectious articles	29	Fire extinguisher box (2)
04	Flammable gas	17	Corrosive	30	Fire cover
05	Non-combustible	18	Miscellaneous	31	Gas mask
06	Toxic gas	19	Danger sign light	32	Dangerous card
07	Flammable liquid	20	Electrostatic tow zone	33	Protective fence
08	Flammable solid	21	Electrostatic tow zone (1)	34	Ground wire reel
09	Self-igniting articles	22	Electrostatic tow zone (2)	35	Handling hose
10	Wet flammable materials	23	Electrostatic tow zone (3)	36	Other items (1)
11	Oxidant	24	Fire extinguisher	37	Other items (2)
12	Organic peroxide	25	Fire extinguisher (1)	38	Other items (3)
13	Drug	26	Fire extinguisher (2)	39	Other items (4)

In addition to the conventional resistivity method for measuring the leakage of liquid hazardous chemicals, it is also possible to perform leak detection by the image processing (Arun and Jeyalakshmi, 2017). The image processing algorithm mainly includes three components: graying, threshold segmentation and interframe difference operation. The grayscale processing is shown in formula (3), where f represents the value after grayscale; R represents the value of the image in the red channel; G represents the value in the green channel; B represents the value in the blue channel; (i, j) represents the position of the pixel in the image.

$$f(i,j)=0.3(i,j)+0.59(i.j)+0.11(i,j) \tag{3}$$

The set of thresholds for the image segmentation is given in the formula (4), where m is the number of the pixel grayscale values; n is the number of the average grayscale values of neighbor domain; i is the pixel grayscale value; j is the average grayscale value of neighbor domain, i.e. the mean value of the grayscale values of the surrounding pixels; N_P is the threshold value of any image segmentation, as shown in formula (5).

$$N+\begin{Bmatrix} N_1, N_2 \\ \vdots \\ N_P, N_{\frac{m\times n}{2}} \end{Bmatrix} \quad (4)$$

$$N_p = \frac{i_k + j_l}{n}, 0 \le k \le m, 1 \le l \le n \quad (5)$$

Then, the 2D coordinate map built by the two features, i.e. the pixel grayscale value i and the average grayscale value of neighbor domain, is compared based on i+j and N_P, and then divided into the domains A and B, where, Pixel probability, P_A and P_B are calculated by the formulas (6) and (7), respectively.

$$P_A = \sum_i \sum_j P_{i,j}, i + j < N_p \quad (6)$$

$$P_B = \sum_i \sum_j P_{i,j}, i + j < N_P \quad (7)$$

Then, according to the formulas (8) and (9), the entropy values H_A and H_B in the domains A and B are respectively calculated.□

$$H_A = \frac{P_A}{\log P_A} \quad (8)$$

$$H_B = \frac{P_B}{\log P_B} \quad (9)$$

Finally, based on the set of thresholds for the image segmentation, the sum of H_A+H_B under all the N values is calculated, and N value at the maximum of H_A+H_B is the nearest segmentation threshold. Then the pixels of the grayscale image are binarized with the optimal segmentation threshold. When the absolute value of the luminance difference between the adjacent two-frame images after the inter-frame difference operation or between the current frame and the background frame images is greater than a preset threshold, this shows that the acquired image sequence has a moving and changing trend. Adjust whether there is a leak of hazardous chemicals in the acquired image.

3. Platform display

It often consumes a lot of computing time to make detection and an early warning on the accidents involving the leakage of hazardous chemicals. The Lagrangian particle diffusion model based on GPU parallel acceleration can provide a better speedup than the CPU-based serial method. This paper tests the performance of CPU programs under different simulation times. The total number of particles is set to 104, and the time step of each iteration cycle is 1 millisecond. As shown in Table 4.

Table 4: Execution time at different simulation times

Simulation time(s)	GPU’s time cost(s)	CPU’s time cost(s)	speedup
100	3.98	523.50	131.47
200	7.58	1300.64	171.69
300	11.36	2200.37	193.76
400	14.88	3095.77	208.10
500	18.51	4015.59	216.95
600	23.04	4950.35	216.95
700	26.04	5887.11	226.08
800	30.32	6817.88	224.88
900	33.73	7763.00	230.17
1000	37.96	8782.08	231.32

As shown in Figure 2, the execution and simulation time frames of both the GPU and the CPU program have an approximate positive linear relationship.

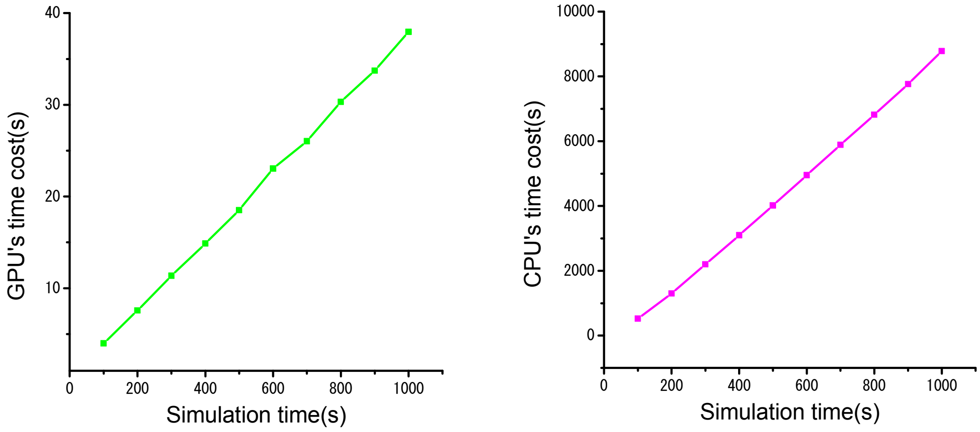

Figure 2: Comparison of execution time at different simulation times

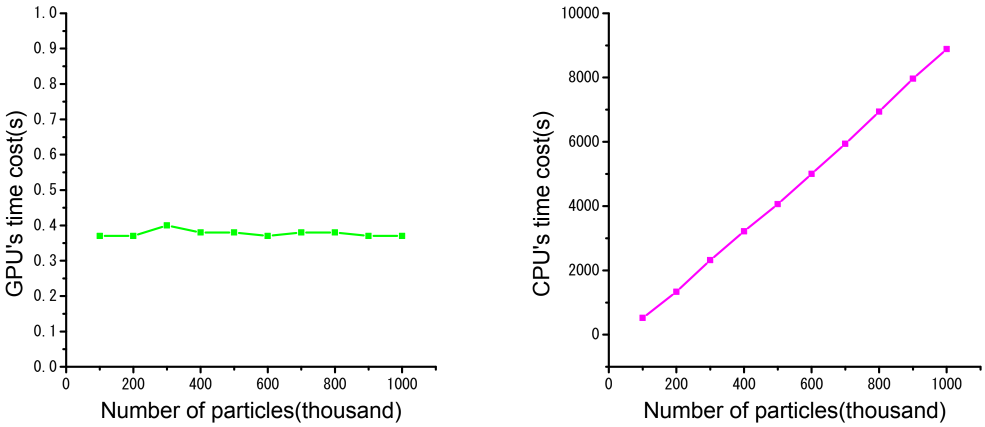

Figure 3: Execution time at different particle sizes

The execution time of the GPU system does not increase as the particle system enlarges. This paper tests the execution time of GPU program at different particle sizes. The simulation time is set to 10 s, and the time step of each iteration cycle is 1 millisecond. Test data is shown in Table 5.

Table 5: Execution time at different particle sizes

Number of particles(thousand)	GPU’s time cost(s)	CPU’s time cost(s)	speedup
100	0.37	521.03	1389.906
200	0.37	1335.70	3562.085
300	0.40	2321.20	5862.149
400	0.38	3216.11	8454.792
500	0.38	4064.93	10591.16
600	0.37	5004.14	13375.15
700	0.38	5936.96	15769.45
800	0.38	6938.24	18386.8
900	0.37	7964.39	21422.43
10000	0.37	8886.94	23993.08

As shown in Figure 3, there is a difference of execution time frames between the two methods at different particle sizes.
The main functions of the "Hazardous Chemicals Logistics Supervision and Forewarning Platform" are simply demonstrated. Accidents are also simulated. It turns out that the platform basically fits the bill for demand analysis, achieving a four in one thorough surveillance on real-time vehicle positioning and tracking, driving track query playback, environmental status monitoring, vehicle driving conditions, hazardous chemical environment, driving route and driver status. It enables the main functions and achieves the goal as expected.

4. Conclusion

After system survey and analysis, demand analysis, technology selection, design implementation and functional testing, the paper develops the specific functions of the IoT-based logistics supervision and forewarning platform for implementation. The system has accomplished the basic goal to timely find out the vehicle location and conditions; supervise the environment status of the dangerous chemicals on the vehicle in real time, establish an early warning mechanism for the hazardous chemicals logistics and realize the management for early warning configuration; manage the information about the carriers and logistics transport, thereby to make the transportation process very smooth; pre-judge and timely handle accidents, and reduce and avoid the occurrence of accidents. However, in the process of system implementation and test, it is also aware that the system still has some defects in functional design and application, and there is still much room for improvement in the future.

References

Arun R., Jeyalakshmi V., 2017, Enabling Secure and Efficient Data Transmission Over Multipath Routing Signature Protocol in Wireless Sensor Networks, Journal of Computational and Theoretical Nanoscience, 14(4), 1981-1988.

Chakraborty S., Newton A. C., 2011, Climate change, plant diseases and food security: an overview, Plant Pathology, 60(1), 2-14.

Lee J. G., Kang M., 2015, Geospatial big data: challenges and opportunities, Big Data Research, 2(2), 74-81.

Lei X., Shang Y., 2014, The design and implementation of resource monitoring for cloud computing service platform. International Conference on Computer Science and Network Technology, 2014, 239-243

Pan S, Sun W, Zheng Z., 2017, Video segmentation algorithm based on superpixel link weight model, Multimedia Tools and Applications, 76(19), 19741—19760, DOI: 10.1007%2Fs11042-016-3439-6

Shivani S., Tiwari S., Mishra K. K., Zheng Z., Sangaiah A. K., 2017, Providing security and privacy to huge and vulnerable songs repository using visual cryptography, Multimedia Tools & Applications, (6), 1-20.

Stojanovic N., Stojanovic L., Xu Y., Stajic B., 2014, Mobile CEP in real-time big data processing: challenges and opportunities. ACM International Conference on Distributed Event-Based Systems, 28 (4-5), 256-265

Wang G., 2018, A Study on Optimization of Chemical Logistics Route Based on Improved Genetic Algorithm, Chemical Engineering Transactions, 66, 1435-1440, DOI: 10.3303/CET1866240

Xing G., Wang J., Yuan Z., Tan R., Huang Q., Huang Q., 2010, Mobile scheduling for spatiotemporal detection in wireless sensor networks. IEEE Transactions on Parallel & Distributed Systems, 21(12), 1851-1866.

Zhong, J., & He, B. (2014). Medusa: simplified graph processing on gpus, IEEE Transactions on Parallel & Distributed Systems, 25(6), 1543-1552.