

Research and Implement on Intelligent Scheduling of Coal Ash Delivering

Na Zhang, Yuyan Zhang, Wenbo Yu and Libo Xu

*School of Automation Control Engineering, Shenyang Institute of Engineering,
Shenyang China
Zhangna_sie@163.com*

Abstract

The coal ash sales process in our country is cumbersome, inefficient, lack of effective management and vehicle guidance policy, which leads to frequent traffic jams, ash loss, monitoring difficult and other issues, this paper presents a valid intelligent scheduling strategy for coal ash shipping to design and implement a new coal ash sales system, which proposes a good solution to the problem of coal ash vehicle indiscriminate disorderly, chaotic management

Keywords: *Internet of things, coal ash delivering, intelligent scheduling, radio frequency identification*

1. Introduction

As the abandoned object thermal power plant, coal ash takes up a lot of arable land and money, sell thermal power plant coal ash not only saves storage costs but also generate economic benefits. There has long been many problems in sales management as data scattered, long time statistics, monitoring difficult, low level of automation, human intervention and other serious problems, for ash violations and the private ash there is no effective limit means and exists a big regulatory loopholes, resulting in large losses of sales of power plants [1-5]. Currently, some thermal power plants use sales management system to take over the coal ash sales, but these systems are only conducted research in information management, and the ash assembling also are using manual operation, the operator take the remote control with the naked eye to estimate the degree of coal ash loading, that is not accurate, but also make the staff contaminated by coal ash [6-8]. In addition, these commercially available systems do no have the user interface for customer development, which is not conducive to self-operation to achieve a true unattended.

The application of the technology of Internet of Things in thermal power plant coal ash sales system, could standardize business processes, provide a powerful statistical data and analysis capabilities for the sales system, and provide data support for business leadership to make decision [9-12]. Using the touch-screen design for the operation screen can realize user self-operation, automatic information management, ash yard unattended, which can not only save personnel costs, but also avoid contamination of the ash operator. Using PLC to design the automatic loading program, from the car into the ash to ash loading end, the ash field fully realized automatic control. The specifications and amount of ash loading are automatically obtained, which avoid artificial input, and can eliminate the phenomenon of illegal gray dress, secretly installed ash, ash exchange, also block the loopholes in management, increase sales revenue.

This paper develops a system of high reliability, low maintenance, flexibility, user-friendly and low-cost equipment. In this paper, the current popular networking technology is introduced, the IC card vending systems applied to coal ash sales can standardize business processes, provide a powerful statistical data and analysis

capabilities for the sales system, and provide data support for business leadership to make decision. Touch-screen with a durable, fast response, space-saving, easy to communicate and many other advantages, human-computer interaction is more straightforward, we use the touch screen greatly facilitates the users who do not understand the use of computer operation. Autoloader ash, automatic measurement procedures designed to achieve real fully automated ash sales system, which not only can improve production efficiency, reduce employment costs, and also can reduce the employer to reduce the harmful effects of coal ash. The automation of current sales thermal power plant of coal ash is not high. There is a great market space. Because of the thermal power plant conducted field research, after successful development, just under the specific conditions of different thermal power plants can be applied to a simple procedure. This system is not only used for coal ash vending of the thermal power plant, but also can extend to the application of automatic water dispenser, student attendance and other aspects of application.

Domestic research in this area of our country is little, only a few are also focused on information management, the automatic loading of research is little and the shortcomings of existing system can not be achieved by the ash automation, there must be human intervention.

2. Hardware Design of Coal Ash Sales System

2.1. Design of RF Dispatch Management System

In order to solve the management scheduling difficulties of shipping coal ash, the issues of stealing material and loading wrong material, the radio frequency (RF) dispatch management system is designed, which uses the IC card management, RFID radio frequency identification, control barrier and a sense of emerging networking technologies, to achieve the automatically enterprise management and intelligent control.

Table 1. Main Parameters of IC Reader

Name	Parameters
Power supply	+9V~+15V DC
Rated current	< 200mA
Output	Red LED, buzzer
Interface	Ethernet
Operating Environment	-20 ~ 50°C (Temperature) , 0~90% (Humidity)
Operating Frequency	13.56 MHz
Type	Mifare one
Sensing distance	6~10 cm

The IC card reader of fly ash shipping system is a reader communication based on Ethernet, which takes UDP protocol as the communication protocol application layer. The IC card reader has less network load and higher communication efficiency, and is ease of expansion. IC card reader has integrated LCD screen, relay, buzzer, door button and door sensor detection. In order to be adapted to the industrial field, 1uf capacitance is added in

Magnetic detection side and 0V side to make it more stable and reliable, which avoids the electromagnetic noise interference generated by the high-power equipment.

Brake controller is a dual-use remote control device designed by intelligent multi-function, digital technology, both manual and wireless remote control, which has a good smart decision function and high reliability, and is the first choice of current automatic control equipment for electric Brake system. The brake is controlled through the IC card reader of fly ash system, when the vehicle passed, the ground sense coil automatically control brake down.

Table 2. Main Parameters of Brake Controller

Name	Parameters
Power supply	AC220V/2A 300W
UP and down time	1.5 ~ 6 second
Operating Temperature	-20 ~ 85 °C
Operating Humidity	5 ~ 95%
Rod length	1 ~ 6 m
Size	330*280*1030 cm

Therefore, we must establish a connection with the IC card reader and Brake controller, a sense Brake controller and ground sense controller, the Brake control principles as shown in Figure 1. The ON normally open relay of IC card reader and the common terminal COM is connected to UP Brake controller and the common terminal GND, M_C Off Limit relay 0V of IC card reader is connected to the normally closed end brake, closed limit Barrier controller is connected to the common terminal common limit V + and 0V of IC card reader port, Barrier ON normally open connection limit Barrier controller off limit CL end, Barrier closed limit normally closed terminal OFF is connected to Magnetic detection ports M_C of IC card reader.

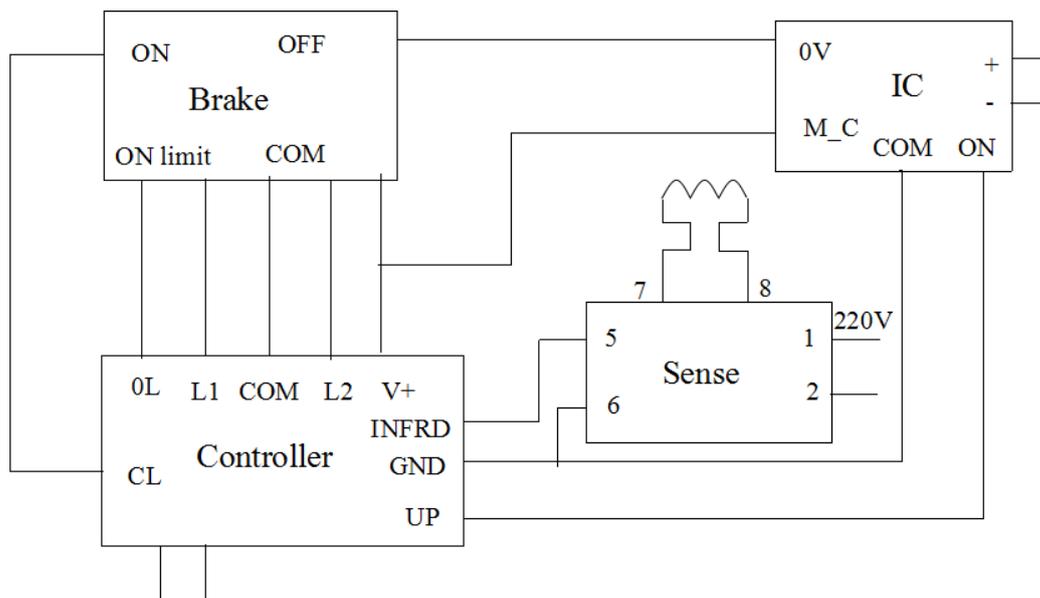


Figure 1. The Principle of Brake Controller

When the IC card reader relay timely pulled, the controller was drive to open the Brake, as while the OFF limit of the normally closed end stop OFF pull, tamper detection port detecting of IC card reader received M_C Barrier open signal, and the signal is uploaded to the server to complete the brake open action. When the vehicle passes a sense, the sense of 5, 6 end to pull the controller, the controller will signal to the Brake to close the Brake, Barrier triggered off when the limit, closed limit normally closed terminal OFF, detection ports M_C of IC read Magnetic card Reader receive Brake off signal, and the signal is uploaded to the server, complete the barrier closing operation.

For the situation of stealing material and installing the wrong material by artificial regulation of fly ash vehicle, fly ash vehicle RFID radio frequency identity authentication system was added, when the bulk of the vehicle to the feed opening charge, RFID radio frequency was firstly identified, and at the same time with IC card information for comparison. After the success of comparison, system allowed vehicle to load, which avoid stealing material and installed the wrong material situation fundamentally. The RF certification system used RFID tag identification technology, and support network communication protocol, with the advantage of fast reading speed, long reading distance, stable, water-proof design and so on

Key switch can switch the manual mode and automatic mode. Under the automatic mode, RFID RF certification was first taken, then compare via RFID tags and IC cards, after the successful of authentication and comparison, the relay end of IC card reader pull, and ON end and COM end turns on, then the relay K acted, 9 and 5 end conducted, 12 end with 8 side is turned on, allows cutting H indicator lights, the control circuit may control the feed opening charge. When cutting off the shutter closed limit, the relay K1 off, IC card reader Magnetic detection ports shutter opening signal is detected. When charging is completed off the shutter control circuit, triggered off limit, K1 relay, IC card reader Magnetic detection ports M_C bezel off signal is detected. Under the spout to achieve automation and intelligent management, eliminating the need for manual alignment supervisor with members link.

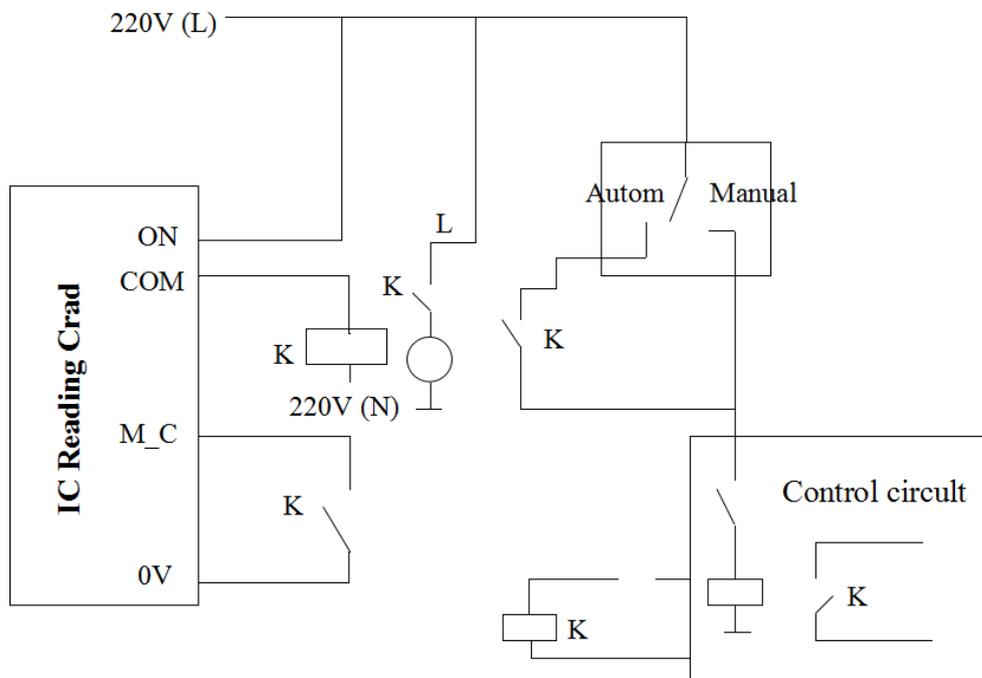


Figure 2. The Electrical Design Schematics

2.2. Design of Guidance System

Coal ash shipping system uses LED technology and regional radio technology for the job guide to factory vehicle, and adopts the technology of cluster control LED display for controlling system, each LED screen in the LAN connection is established via TCP / IP protocol with a server, eliminating the need for dedicated computer. Through the server, people can sent texts and pictures by all unified LED screen or a single LAN issuing, greatly reducing the workload of stand-alone operations of the network. Regional radio noise technology uses IP network broadcasting technology, under existing computer network construction, installation requires no separate cabling, transmission of the program based on IP address, is pure digital network broadcasting system in the true sense, can be played simultaneously in different regions of different voice, and do not mutual interference.

The control system of cluster control LED display network includes a door guide LED large screen, eight truck LED guide screen and eight-digit display libraries. Wherein the door guide LED large screen, choose outdoor color screen with a resolution of 416*240 for displaying all factory vehicle license plate number, variety and vehicle loading state, which make the vehicle outside let into the plant to value the number of vehicles and vehicle factory status .Eight Truck boot screen is used outdoor color screen with a resolution of 96*64 for display weighing information and wait for a vehicle inspection pounds information. Eight-digit display screen, is selected of outdoor color screen with a resolution of 352*48 for displaying the feed opening number, charging and waiting information, providing an indication of the role of vehicle loading. Navigation system automatically synthesized speech, partition load, and the whole vehicle navigation. Each zone can play different background music program, the system may at any time terminate the automatic playback, switch to manual control, to advise, to find someone, find things and other matters of broadcasting. Available for propaganda notification for each region or area broadcast through intercom paging desktop microphone, enabling paging and intercom functions between desktop intercom paging microphone.

Regional radio terminals using the wave of IP network adapter, wave-based IP network broadcast exists computer network construction, requires no separate cabling at installation, IP network-based program delivery is a pure digital network broadcasting broadcasting in the true sense. The system simulation part chooses cable constant pressure transmission mode, the transmission voltage of 70V or 100V.

2.3. Anti-Cheating Alarm System

Fly ash shipping infrared grating anti-cheating alarm system is used to ensure complete parked vehicle to be weighed on the truck scale. When the vehicle exceeds the truck scale, the electronic wall by infrared raster will be block, and system collects the signal, at this time does not allow for its weighing operation. Its infrared radiation device whose detects distance is 50 meters, and has the three-beam outdoor active infrared detectors, integrated structure design, professional anti-jamming optical housing, lightning circuit design. The sensor speed: 50-700msec, alarm output: IC relay contact output, contact capacity DC30V / 0.5A MAX, power supply voltage: DC13.8-24V, AC11-18V.

Data acquisition card has 32 digital input functions, through 40-pin IDC header, J₃ and the field signal is connected to the board. PCI-6432 provides 32 digital inputs feature 40-pin IDC header J₃, PCI-6432 will insert and weighting computer's PCI slots, and quoted from J₃ interface LS245 interfaces to outside computers. Figure 3 is a schematic diagram of equipment installation, each truck scale front and back is installed of a set of infrared radio equipment, and relay output normally closed terminal are in series, one end connected to the positive 5V supply, the other connect one end to the seizure of 1 kg computer LS245 Interface pin DI0, the interface AGND LS245 connect power ground electrode. When the vehicle is not fully parked on the truck scale, the vehicle will block

the electronic wall of infrared radiation device, whose normally closed terminal of relay output is disconnected, system obtains the digital signal changes by PCI-6432 data acquisition card to stop pounds seized computer weighing operations, and its voice actually adjusted to eliminate the possibility of cheating fundamentally. When the infrared beam device ABE-50 or PCI-6432 data acquisition card fails, the system can not obtain the data of acquisition card normally closed signal, will alert system equipment failure, prevent the truck seized computer pounds weighing operations, to prevent the abnormal operation caused by equipment failure.

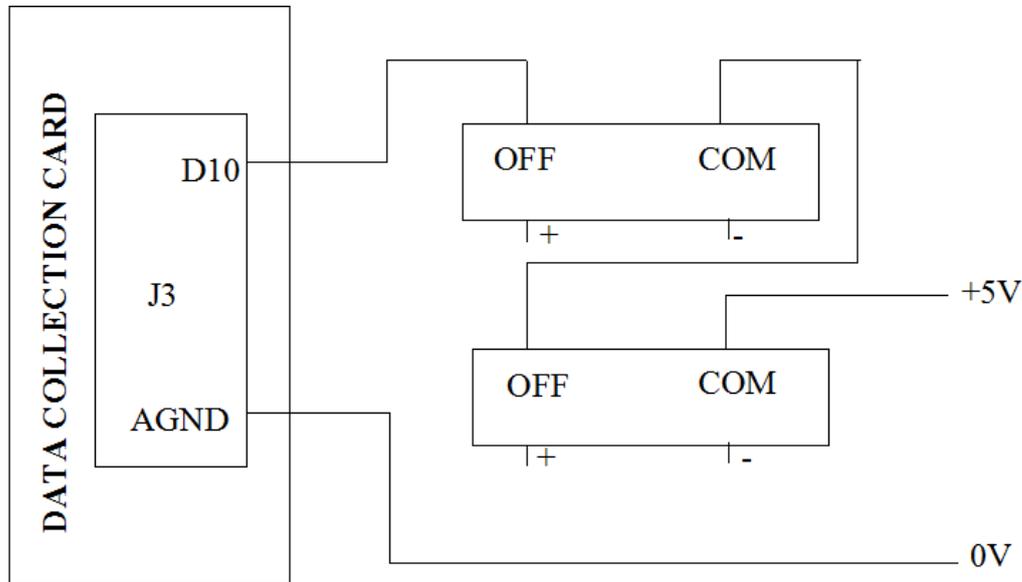


Figure 3. The Principle of Anti-Cheating Alarm System

3. The Simulation Experiments and Analysis

The process of coal ash sales system is shown in Figure 4:

1. When vehicle enter into the plant the issuance of IC cards will be carried out by the guard management software, as while the vehicle information and IC card information will be stored in the database. When bulk vehicle enter into the plant, first of all, RFID electronic tag will be issued by RFID RF card management software and will be pasted onto the windshield of a vehicle. The label can not be torn, also it is very difficult to peel off, which ensures that each car a fixed electronic RFID tags. When electronic tag accidentally is damaged or missing, the vehicle should apply the appropriate procedures for card reissue, and then complete the operation by guard management software.

2. When drivers swiping IC card to enter into the plant, the system automatically calls the entering plant and truck scale strategies, if the conditions of entering plant in accordance with the appropriate strategy, the appropriate truck will be prepared, the entering plant brake and the corresponding former Barrier of truck scale will be turned on, and vehicle will be guided by broad and LED. If the conditions of entering plant unmatched with the appropriate strategy, the voice prompt will be proposed for waiting vehicle, and the brake is completed automatically open when the normal flow into the factory if conditions are met.

3. There are voice prompts to the vehicle after the driver got off to swiping the credit card.

4. After swiping the IC card reader, weighting management software automatically read vehicle information and truck weight information, infrared grating anti-cheating alarm system detects that the vehicle is fully parked on the truck, if the vehicle position is

correct, infrared grating anti-cheating alarm system does not alarm, the system automatically load operation, a weight information stored in the database, and open the truck after its barrier, while voice prompts its next step.

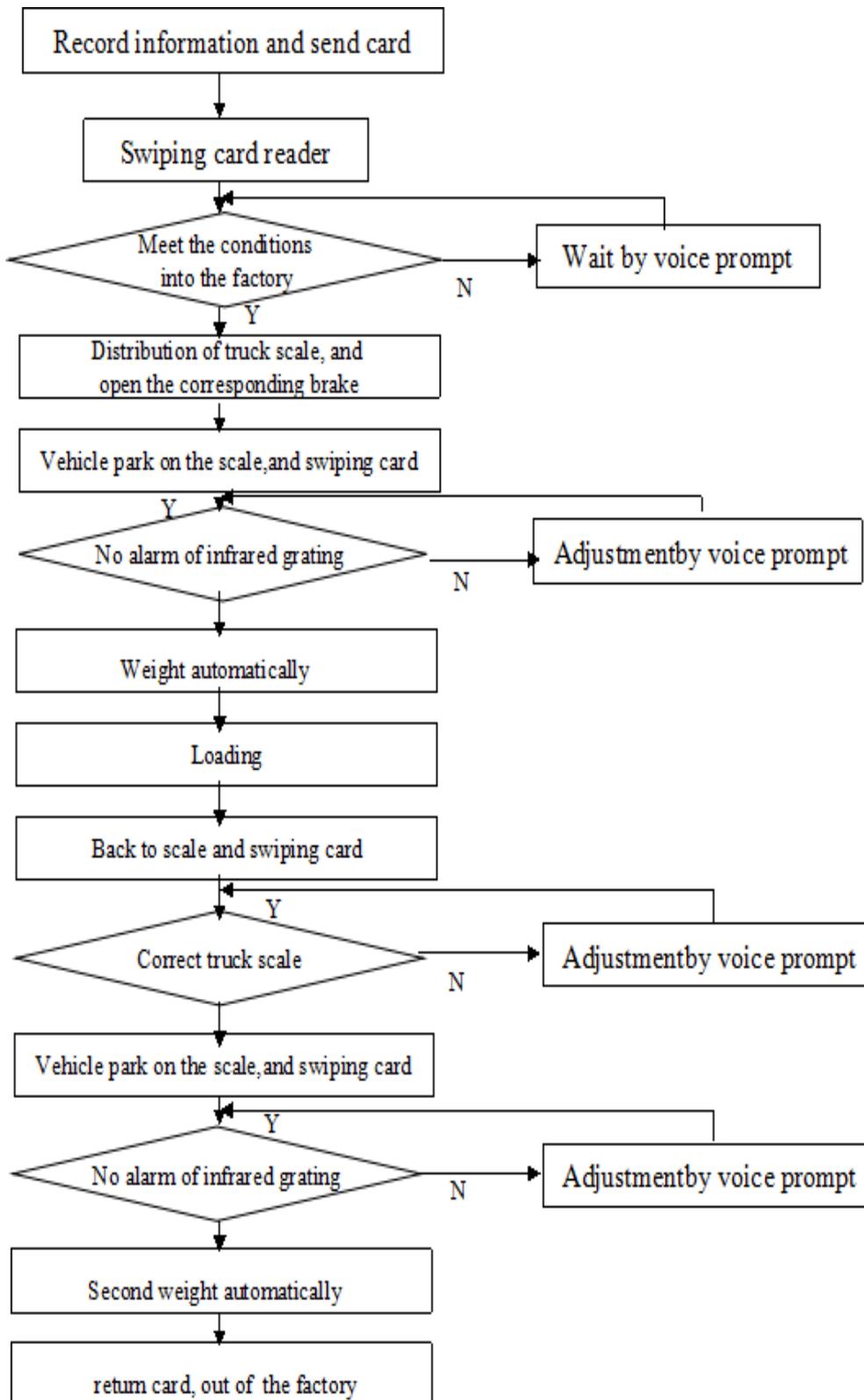


Figure 4. The Process of Coal Ash

5. the vehicle reaches the corresponding feed opening to load fly ash, the comparison of RFID authentication and IC card information is carried out first, after the success of comparison, the system control the feed opening under electrical circuit of feed opening, which allows LED light, the staff of feed opening can operate the spout machine to start loading. When the current discharge port shutter is closed, the system will save the feed opening, which allows some time for pot changing and car shaking, the time can be set, and it is facilitate to the vehicle shaking or change pot to continue loading. When vehicle exceed a predetermined time or RFID reader reads RFID information of other vehicle halfway, vehicle needs to be compared RFID authentication with IC card information again and apply to the dispatcher, the dispatcher will continue loading after confirmation by scheduling management software.

6. When heavy vehicle back to truck scale over the second time, RFID RF reader get RFID tags in bulk vehicle or other vehicle swiping the IC card reader after reaching the truck scale, first determine whether the correct truck scale, when the truck scale is correct, the back brake of truck scale is automatically opening, which allows vehicle back to truck scale for secondary weight. When the truck scale is not a system designated one, LED and voice prompts will guide proper vehicle truck.

7. After the vehicle fully park on the truck scale, drivers get to the IC card reader before the truck scale to swipe IC card. At the same time, the weighting management software automatically read vehicle information and truck weight information, infrared grating alarm system detect whether the vehicle is completely parked on the truck scale, if the vehicle position is correct, infrared grating system does not alarm, the system automatically carries out re-secondary operation. There are three cases: First, if the vehicle data is normal, the system automatically opens the former brake of truck scale, and voice prompts completion of secondary weight. Second, if the weight of fly ash vehicle exceeds the remaining tonnage of shippers notice, the weighting computer of control room will print replenishment orders, and open the back brake of truck scale, let the vehicle to roll back into the plant, and the voice prompt to apply for vehicle replenishment formalities. Third, the weight of fly ash Vehicle is not equal to requested tones, and exceeds the error range eight thousandths, vehicles need to return to fly ash site for re-check, the system automatically opens the back brake of truck scale, and voice prompts vehicle to coal ash site for re-check.

8. The IC card is returned to the guard officers, and the drivers swiped the factory-out reader, guard management software displays information such as vehicle and seized pounds, while automatically print a single check pound. After confirmation the vehicle are allowed to be out of factory, the open the factory Brake to complete the process.

4. Conclusion

In this paper, IC card management, RFID radio frequency identification, noise regional radio, infrared anti-cheating alarm and other networking technology is applied to design a new type system of fly ash sales, and we also design and develop of hardware and software systems, which solves the time-consuming process, inefficient problem very well, and put an end to the loss of coal ash from happening at all.

Acknowledgements

This work is supported by National Nature Science Foundation of China under Grant 61371200.

References

- [1] F. R. Caballero, S. A. M. Ovalle and M. M. Gutiérrez, “Mössbauer characterization of feed coal”, ash and fly ash from a thermal power plant [J], *Hyperfine Interactions*, vol. 24, no. 1140, (2015).
- [2] W. Wagenaar and J. Groeneweg, “Accidents at Sea: Multiple Causes and Impossible Consequences”, *International Journal of Man-Machine Studies*, vol. 27, no. 586, (1987).
- [3] K. T. Erickson, “Programmable Logic Controllers”, [C]. *Potentials, IEEE*, vol. 15, no. 14, (1996).
- [4] D. Zimer and D. Rhode, “Human-machine Interfaces”, [C]. *IEEE Industry Applications Magazine*, vol. 12, no. 29, (2006).
- [5] J. J. Sudano and M. Marietta, “Minimizing Human-Machine Interface Failures in High Risk Systems”, [C]. *IEEE Aerospace and Electronic Systems Magazine*, vol. 9, no. 17, (1994).
- [6] F. A. Radwan and T. W. Martin, “Real-time monitoring and controlling of an Allen—Bradley SLC 500 through the Internet”, [J]. *Industrial Technology*, vol. 1, no. 387, (2003).
- [7] S. Zhu and X. Huang, “Oil tanker intelligent weighing systems distribution”, [J]. *Gansu Science and Technology*, vol. 30, no. 24, (2014).
- [8] X. Hou and Z. Lu, “The application of intelligent weighing control technology in the field of fertilizer compounding”, [J]. *Weighing Instrument*, vol. 3, no. 11, (2013).
- [9] L. Atzori, A. Iera and G. Morabito, “From "smart objects" to "social objects: The next evolutionary step of the internet of things”, [C]. *IEEE Communications Magazine*, vol. 1, no. 97, (2014).
- [10] C. Perera, A. Zaslavsky, P. Christen and D. Georgakopoulos, “Sensing as a service model for smart cities supported by Internet of Things”, [J]. *IEEE Transactions on Emerging Telecommunications Technologies*, vol. 25, no. 81, (2014).
- [11] J.A. Stankovic, “Research Directions for the Internet of Things”, [C]. *IEEE Internet of Things Journal*, vol.1, no. 3, (2014).
- [12] C.-W. Tsai, “Data Mining for Internet of Things: A Survey”, [C]. *IEEE Communications Surveys & Tutorials*, vol. 1, no. 77, (2013).

Authors



Na Zhang, She received the master's degree in control theory and control engineering from Northeastern University, China, in 2010. Her main research direction is detection and automatic control.



Yuyan Zhang, Yuyan Zhang received her Ph. D. degree in detection technology and automation from Northeastern University, China, in 2014. Her main research interests include new material testing, fiber inspection, and automatic control.



Wenbo Yu, She received the master's degree of engineering from Shenyang University of Technology, mainly engaged in electric power system and its automation. Now work in college of Electric Power of Shenyang Institute Engineering.



Libo Xu, He received the master's degree of engineering from Shenyang Aerospace University, mainly engaged in computer application. Now work in fundamental computer science teaching department of Shenyang Institute of Engineering.