Design and Realization of Site Investigation System for Hydraulic Engineering Based on WeChat Enterprise Account

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Abstract

Based on the powerful open interface of WeChat enterprise account features, a site investigation system is proposed for management of hydraulic engineering projects. The implemented functions include integrated photographing, GPS based positioning and information submission from handheld mobile devices. By leveraging cloud computing and mobile internet technologies, all the site investigation information is collected by designers on the unified mobile terminal including smart phones, tablets, and laptops. The proposed system provides various services, such as batch uploading, geological position mapping, data query and data downloading of the investigated information of specific hydraulic engineering project. Moreover, high level functions are realized through high-precision location based service, synchronous saving, resource sharing and quick search. Our system outperforms and changes the traditional working mode of site investigation of hydraulic engineering projects, as well as improves the working efficiency and accuracy for data collection in the whole life of the project management.

Keywords: site investigation, WeChat enterprise account, cloud computing, mobile terminal

1. Introduction

The site investigation, which means investigating the current status of the engineering construction site, is the indispensably significant link during the course of hydraulic engineering construction. It is beneficial for the designers to select engineering site and design plan, and is contributive for the constructors to confirm the accuracy of the written data, the plane layout of the construction and so on. Developing the current status investigation in detail and accurately is the premise of constructing excellent hydraulic engineering. Generally the investigation is carried out through image forensics and letter auxiliary explanation towards the key positions on construction site. Along with the wide application of digital camera and intelligent mobile terminal, the site investigation has realized electronic photo forensics completely. However, the sorting, classifying and positioning of electronic photos have consumed investigators' time and energy greatly, especially for the linear stretched engineering (such as channel improvement engineering) and district engineering (such as farmland water conservancy engineering), they are wide in scope and multiple in data collection site, so the investigators always need to spend a whole day, and the photos they have photographed are even more than hundreds of pieces. At present electronic equipments could not make the photographing, location and letter description proceed synchronously, hence the investigators would often sort out photos after return office and add letter description. The research by German Hermann Ebbinghaus indicates that human's forgetting process is very fast, and is fast at the beginning and then low, after the memory is finished for 20 minutes, the memory

capacitance only remain 58.2% of the total amount, one hour later it remains 44.2% and one day later is remains 33.7% [1]. On account of miscellaneous investigation data could cause memory easy to be confused, especially when two photos are relatively high in similarity, memory deviation is very easy to be produced. The wrong data not only could not play proper role in engineering construction, but a series of problems would be even caused. Whereas going to the site again for second confirmation not only would reduce working efficiency, the design cost will be also increased. How to classify, sort, positioning and share the site investigation data rapidly and accurately has become a problem to be solved for improving investigators' working efficiency.

With the popularization of mobile phone, PAD and other mobile terminals, it becomes a major trend for the future hydraulic industry to change to integrated photographing, GPS positioning and information submission at the mobile terminal, to realize synchronous processing among site investigation forensics, positioning and data collecting, as well as to make investigation data sharing come true. As the application program that provides instant messaging service for intelligent terminal, WeChat is easy and convenient for operate, and has extensive popularization. By developing the site investigation system of hydraulic engineering based on "WeChat official account", this working mode would be realized perfectly.

2. System Design

The design framework of site investigation system is shown in Figure 1. It is composed by five modules, which are system management, site investigation camera, batch data upload, and investigation data query, investigation data download. Detailed functions for each module are as below:
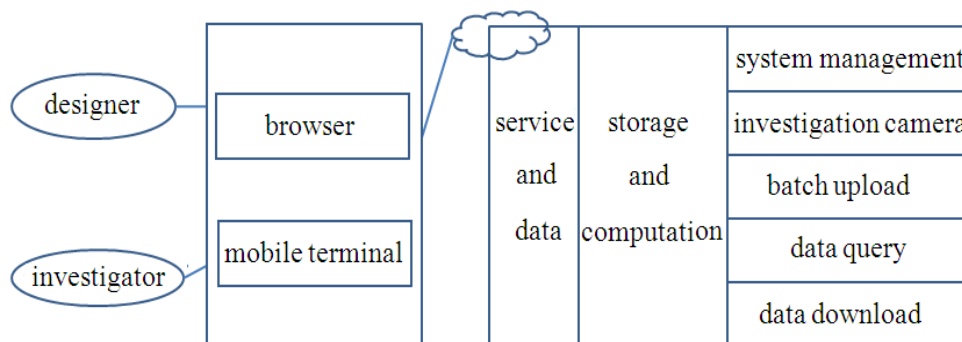

Figure 1. Frame Diagram of Site Investigation System

2.1. System Management

It mainly includes user management, project information management, data backup and restore, operating records in PC. The functions of user management covers user information editing, identification and authentication, authorization, access control. There are three permission levels to control system access, which are investigators, designers and project manager. Investigators have minimum permission, they can taking photos, editing picture captions, uploading investigation data. Designers have all of the investigator's right, and can dividing sub-project, setting bid-sections of project, editing project descriptions. Project manager holds the highest legal power and can adding project, deleting project, setting work standard besides of designer's right. Function of project information management ranges from adding and deleting project, inputting and

revising project descriptions, importing project map, dividing sub-project, setting bid-sections of project, establishing naming rules and photo framing rules.

2.2. Site Investigation Camera

Site investigation camera is used by mobile terminal. The functions of investigation camera cover GPS positioning and photo collection of the investigation site, as well as the descriptive information input and temporary submission of the engineering site [2]. When investigator activate the investigation camera by standing at the place where needs to record site data, Baidu map API will be startup, showed by maps or satellite images, as Figure 2 (a) and (b). It can made GPS positioning come true by Utilizing Baidu map API and the GPS module integration at intelligent mobile terminal, and by touch screen to move map to trimming position, the exact positioning for data collection could be defined when the site changed. By means of the JS interface offered by WeChat enterprise account, the photo collection calls the photographing module on mobile terminal to shoot pictures and preview when Click "take photos" button, as Figure 2 (c), select "use photo" it can back to previous page and the photo which has taken just now will shown in the map below. and you can take a lot of pictures or delete some on if you need. and also provides letter inputting function on photo preview page, inputs description of site condition. In addition, through the "temporarily save" submission button, the photo's auxiliary information could .be saved temporarily. as Figure 2 (d) shows.
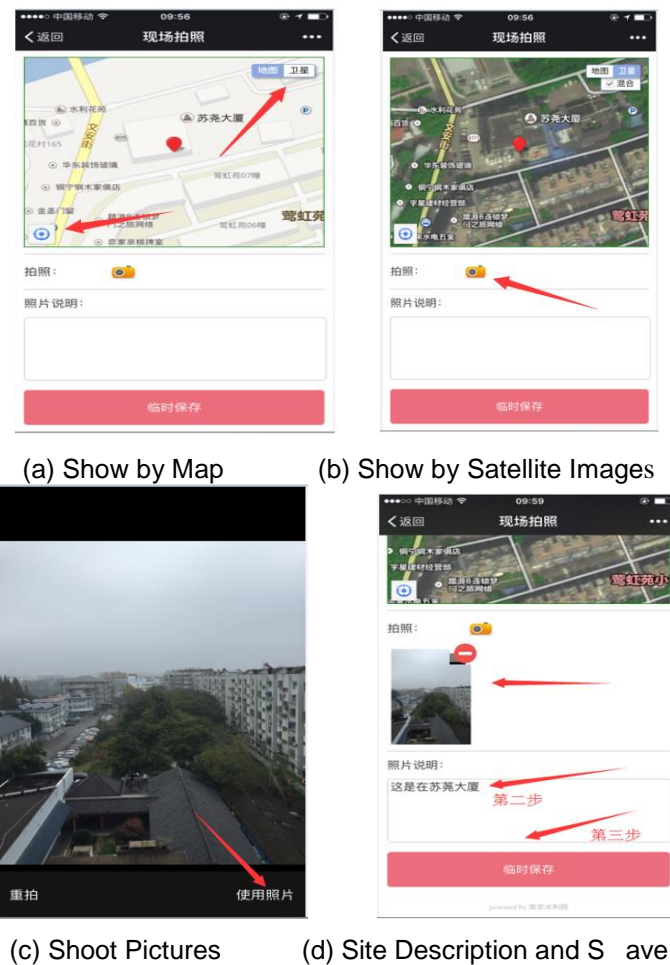

(a) Show by Map   (b) Show by Satellite Images

(c) Shoot Pictures   (d) Site Description and S ave

Figure 2. Use Site Investigation Camera to Collect Engineering Site Information by Mobile Terminal

2.3. Batch Data Upload

Because the photos photographed during site investigation are numerous, and the existing mobile terminals are high in photographing pixel, the data capacity for each photo is above 3M, uploading the original photo directly use mobile cellular network would be time-consuming and expensive with huge data. and it would spoil the using experience and prolong investigation time. For solving this realistic problem, this system designs that while the investigation camera is saving the photo, only the photo's auxiliary information (such as photo time, file name, file size, GPS coordination and site condition description) is submitted to database for storage except the picture itself, till the user connects to internet, batch uploading could be done as per the auxiliary information of the photo and the mapping relation of original photo.

According to the test, saving one photo, GPS coordination and other information temporarily with this system only consumes 100K data traffic. Therefore, by combining the data temporary saving function on the investigation camera module and this module, problem of data expense could be solved efficiently, and the response speed to the system while photographing could be accelerated.

2.4. Investigation Data Query

Through entering the investigation data query module via the mobile terminal or browser, the team members could access site investigation data by project name, location and other dimensions. By taking Baidu map or topographic map which is charted by measured data as the drive, during investigation data query, the data collection location could be indicated on map according to the photo's auxiliary locating information. The site descriptive information extracted from the photo's auxiliary information is displayed on each location. After click explanation, photos and site condition descriptions collected from site investigation will be popped up automatically, as Figure 3 shows. Through displaying site investigation photos via uploading photo layer on map, the designers could map the investigation photos and geological position rapidly and accurately. Meanwhile, the link of sorting photos in traditional working mode could be saved, and automatic classification and resource sharing of investigation data could be realized.

Figure 3. Investigation Data Query Load into Baidu Maps

2.5. Investigation Data Download

The investigation data downloading module in this system takes engineering project as unit to download investigation data. While downloading, the site descriptive information is attached to investigative photo by means of uploading watermark. In this way, when the user opens the photo, the image presentation and letter explanation to the engineering field could be seen at the same time, for the convenience of using.

3. Key Technology of System Implementation

3.1. WeChat Enterprise Account

The WeChat enterprise account is the mobile service provided to corporate customers by WeChat. It aims to offer mobile application a convenient entrance. Based on the uploading geological location, photo uploading, WiFi surfing, connecting hardware, image, voice, video and a series of native abilities that WeChat develops continuously, as well as more than 40 open interfaces possessed by WeChat exclusively, it is convenient for the enterprise or third party service provider to integrate the existing IT system in the enterprise and third party application, as well as launch functional development rapidly at low cost [3-4]. Meanwhile, it could realize mobilization of enterprise production, management, cooperation and operation, and thus simplify management flow effectively, improve informational communication and synergetic efficiency, promote service and management ability. Compared to APP development, WeChat enterprise account has obvious advantages, and is manifested in three aspects concretely:

The first advantage is that Wechat is a platform can cross mobile terminal. At present the intelligent mobile terminal has all kinds of operating systems, such as IOS, Android, WindowsPhone, *etc.* To develop APP, one needs to develop the APP that could be adapted to each kind of operating system of intelligent mobile terminal independently aiming at different operating systems. By using WeChat enterprise account, just one set of system application is required to be developed, and then the compatibility among different operating systems of mobile terminal could be realized. The main reason is WeChat platform has absorbed the differences among all operating systems of intelligent mobile terminal;

The second advantage is no threshold usage. Before use, user shall scan the two-dimension code with WeChat. While playing WeChat, the user could process the enterprise account information conveniently. Fluent usage for everyone without learning;

The third advantage is relatively low development cost. Smoothly jointing with the existing system could be realized by just calling the standard interface in WeChat enterprise account.

Through the wx object, system calls the interface in WeChat enterprise account, and uses AMD/CMD standard module on the page that demands calling JS interface to load jweixin-1.0.0.js file. By injecting permission validation configuration via config interface, it calls the interface that needs to be called during page load among the ready functions. For the interface that is called by user's triggering, it calls directly. Combining each functional module, the JS interfaces that is called by this system are mainly image interface, which is used for realizing choose image, preview image , upload image and other functions; equipment information interface, which is used for acquiring getNetworkType(); geological position interface, which is used for getLocation() for the geological position the user stays.

In addition, the user's authentication is realized by means of OAuth authentication interface and userid interchange interface. When the investigation camera API is paid attention, the member's identity could be acquired and user right could be defined through OAuth authentication interface, cookie could be generated, and then corresponding application interface could be entered. For the user who has already paid attention to investigation camera, he could possess userid, every time he opens it, the user information cookie is acquired, and the member's identity will be verified. In case the identity is invalid, the error prompt message will be returned.

3.2. Cloud Server (IaaS)

The cloud computation could be divided into three layers, which are cloud equipment service (IaaS), cloud platform service (PaaS) and cloud software service (SaaS) [5]. The cloud server, which means cloud equipment service (IaaS), is a host product in service system. Under the circumstance of owning specific constraint of service quality, it offers consumers to utilize all computing infrastructure, which covers CPU, RAM, storage, network and other fundamental computing resources. The consumers do not manage or control any cloud computing infrastructure, but they could control storage space, selection and deployment of operating system, and operate application software at will. In the meantime, perhaps they could acquire controlling the network modules with limit (for instance router, firewall, load balancer, *etc.*).

IaaS could be divided into public and private one. The public IaaS adopts public server pool on Internet, while the private IaaS uses a group of public or private server pools in the enterprise internal data center [6]. Amazon Elastic Compute Cloud, Amazon EC2 for short, Chinese native Huawei Elastic Cloud Server, Huawei ECS for short, Ali Elastic Cloud Server, Ali Huawei ECS for short, QQ Cloud Virtual Machine, QQ CVM for short, Baidu Cloud Compute, BCC for short and so forth belong to IaaS. The public IaaS not only possesses the guaranteed processing ability, but also reserves bandwidth for storage and Internet visit. It could assist us in establishing stable, safe operating environment of application system, and thus reducing the difficulty and cost for development and operating maintenance.

This system deploys each functional module and data storage on Ali Huawei ECS. It completes user registration on Ali Hawei ECS platform. After payment, the systematic cloud server could be possessed. By installing the operating system, database and fundamental application software on the cloud server via the user management function on cloud server, and also managing and deploying server via remote login, Telnet, FTP and other tools, it could realize human-computer interaction and data storage on the investigation system.

3.3. Baidu Map API

By concealing and packaging the complicated bottom logic, Baidu map provides the developers the followings for free, basic map, positioning search, peripheral search, public transportation and driving GPS, locating service, geocoding, reverse geocoding and other program interfaces with abundant functions. Aiming at the location accuracy and data problems that users concern, by virtue of base station, Wi-Fi, GPS and other multisource positioning technologies, as well as over 25 million data on base station and 0.2 billion hotspot data, he positioning SDK in Baidu map is able to realize the positioning service with Wi-Fi precision of 30m and overall positioning accuracy of 61m. Moreover, for each time positioning, only 0.3K data will be consumed, and under normal network condition, the positioning speed is lower than 1 second.

While positioning the data collection point on the investigation camera module, the system introduces Baidu map API. When the API is introduced, firstly loading JS file via API password applied by the developer shall be done, then establishing a HTML IMSMap element for revealing on the mobile terminal or browser. After carry out instantiation towards the map and complete initialization, human-computer interaction could be realized with the map. The appearance and conduct to the map object on API is very similar to the interactive map on Baidu map website. It supports mouse dragging, wheel zoom, and double-click for amplification and other interactive functions. By making use of panTo() method in Map class to move the map smoothly to new central point could realize manual fine tuning of GPS positioning.

By utilizing the open platform interface on LBS (Location Based Services) of Baidu map, the data query module on system combines the geological position data extracted from photo's auxiliary information with the mass data in Baidu map on LBS cloud. By utilizing the searching engine ability on Baidu map, it realizes real-time search &

computation of dynamic position data and concurrent search & computation of mass data position data. Meanwhile, it uploads photo and site descriptive information, completes data superposition reveal of mass position data through the rendering ability on Baidu map, and accelerates map's loading rate.

4. Development and Application of System

4.1. Development and Application Environment

System Development Environment is required that:
1) operating systems : linux
2) Web server : Apache Tomcat
3) Database : MySQL
4) Integrated Development Environment: Eclipse

All of the development environment configured are open source code, can easy to access a variety of technical supports from the network. Considering the system service for enterprises, there have higher demands on distributed and safety, using program language JAVA, which can avoid virus infection through its own security mechanisms. Because the system is developed on Ali Huawei ECS, we also need to install Telnet, FTP for remote log on to the application server to manage applications or configure the server.

Depending on the functions, the System would be used in mobile terminal and client computer system respectively. The application environment is required as Table 1.

Table 1. Application Environment

client	hardware configuration	software configuration	network
Mobile terminal	Has GPS and Camera	Wechat6.0 or above	3G or above
computer	Pentium IV or above	Windows XP, Chrome 40 or above	100mbps or above

4.2. Information Flow of Site Investigation System

The site investigation system connects information flow in series through four core functional modules, which are investigation camera, batch data uploading, data query and data downloading. The information flow of site investigation system is shown in Figure 4.

After the user pays attention to WeChat enterprise account and opens site investigation camera on mobile terminal, he could collect site investigation data, form information flow, visit the data storage space and save the information flow temporarily. After returns to the place with WIFI hotspot, he could launch the batch data uploading module, for uploading the investigative information in batch to the system. Through calling data query and data downloading module via WEB browser, the hydraulic engineering designer could visit the shared data, look up and download investigative information.
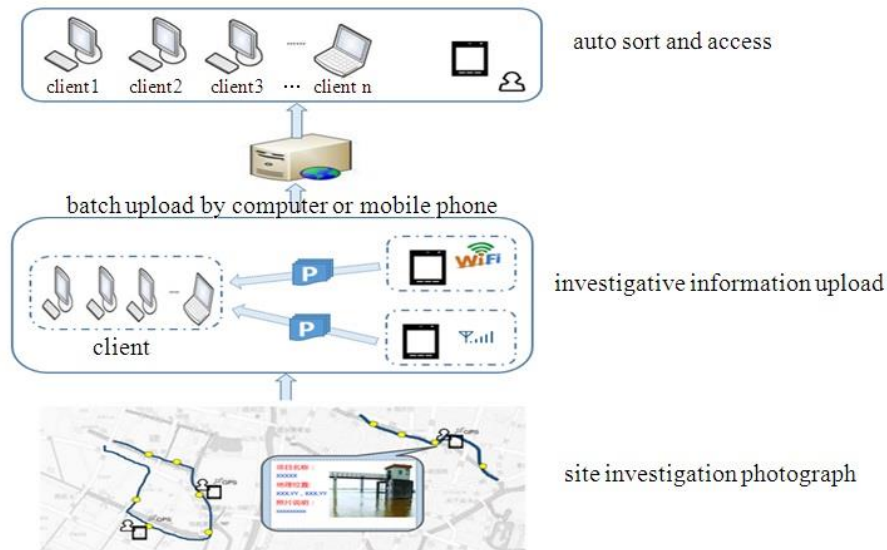
Figure 4. Information Flow of Site Investigation System

4.3. Analysis on Application of System

In order to verify the application effectiveness of the system, we would count times that the whole site investigation work spend with comparative trial by traditional work method. The work content of each step include is shown in Table 2.

Table 2. Work Content List of Each Step of Site Investigation Include

Work step	traditional work (T)	site investigation system (S)
preparation	Prepare a paper map	——
investigation	Location on paper map	Open the site investigation camera
	relocation	Relocation by GPS
	described site condition on paper map	relocation
	——	Input description of site condition.
	——	temporarily save
data reduction	Select and upload photos	System Login
	Start CAD	Select and upload photos
	Relates photos with measured data	——
	Input description of site condition.	——
Data access	Open folder	System Login
	Access photos and map	Select project
	——	Access photos and map

Considering the amount of linear stretched engineering's investigation data is different from point engineering, we counted time-using for each step of site investigation (not including walking) by take photos as amount of 1,10,5 and 100, the result shown in Figure 5 and Figure 6.
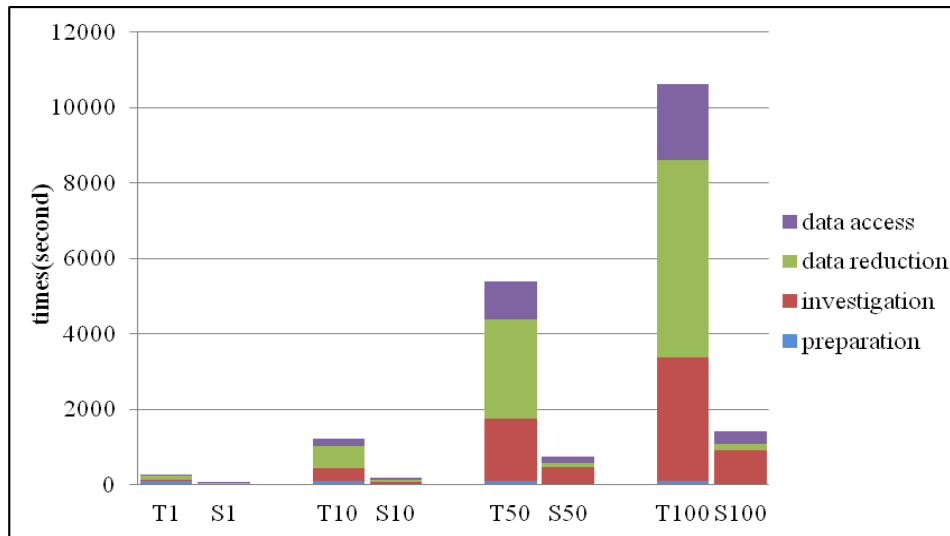

Figure 5. Time-using for Site Investigation by the Site Investigation System (S) Compared with Traditional Work (T) Samples of Take 1, 10, 50, 100 Photos
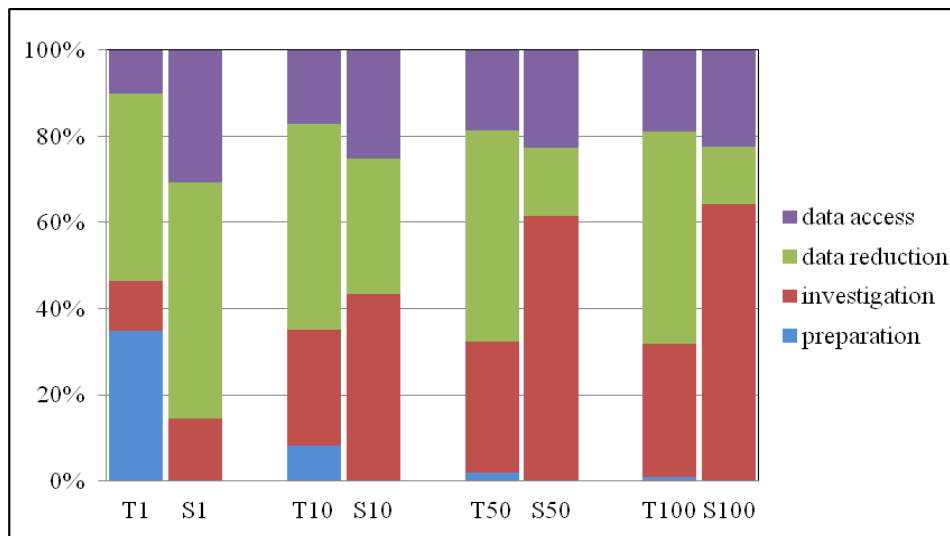

Figure 6. Percentage of Time-using for each Step of Site Investigation by the Site Investigation System (S) Compared with Traditional Work (T) Samples of Take 1, 10, 50, 100 Photos

From the Figure 5, we can see that complete the whole work of site investigation, using the site investigation system has the advantages of time-saving compared with traditional work. It can save 76.2%, 84.5%, 86.3% and 86.7% of times spending by take photos as amount of 1,10,50 and 100. As number of photos increasing, the advantages are more obvious. Figure 6 shows traditional work is spend much time on data reduction, one of the main reason is duplication of effort, such as location on map, add description of site condition. By contrast, the site investigation system do not need time spending on data reduction because the background system can automatic processing the data. The system

spend most time on site investigation, mainly use time for input description of site condition. The time-using of description is 53%~58% of total time-using of investigation. Nevertheles, traditional work spend more time on investigation than using the site investigation system, because of artificial location.

5. Conclusions

The site investigation system for hydraulic engineering based on WeChat enterprise account uses the idea of multiple& layer design to avoid excessive dependence between layers. It can reduce system design and debugging difficulties, and quicken developing speed. The system is simple interface, operation convenience, and has lowered the using threshold for users, reduced the time for sorting the investigative photos, avoided the manual operation of photo's geological positioning, improved the working efficiency and accuracy greatly for the designers to conduct investigative data collection on hydraulic engineering site (especially the channel improvement and other linear stretched functions as well as the farmland water conservancy and other district functions), realized the resource sharing, precise localization and rapid search of investigative data, and changed the traditional working mode of site investigation thoroughly.

It would certain to provide forceful support for the excellent hydraulic engineering. The designers in Nanjing Water Planning and Designing Institute CO., Ltd carried out application practice towards this system in terms of investigating multi-riverway, engineering planning of farmland water conservancy district and design project, with good effect in the real application. Based on the existing researches, we will further research on expanding the scope of system application to municipal engineering, railway engineering *etc.*, and research on application feasibility and function design of this system for engineering construction process management.

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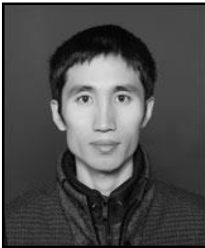
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