The Integrated Application of Web-based and Spatially Construction Management System

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KEY WORDS : Internet, Construction Management and Evaluation, GIS, PDA, Server, hazard of slope lands

ABSTRACT

The purpose of this study is to apply the internet technology spatially to develop “Digital Construction Management and Evaluation Systems”. It uses GIS to spatialize the site of slope land constructions which were built by Soil and Water Conservation Bureau in Taiwan. Among these, ESRI’s ArcIMS, ArcSDE and SQL Server were used to make users to access the geographical distribution of constructions, control scheduled progress and the status of construction from internet service easily.

At on-site survey, it integrates PDA and GPS devices to take down constructions position and quality and via internet it can transmit the information to database server directly. Besides, this system also integrates mobilized management by using i-mode cell phone to query construction progress and disaster news in anywhere and anytime. This study provides a convenient mean to update and maintain the construction database, and improves the efficiency of disaster management on slope land.

1.Project Background

Taiwan is an island located on the Pacific Ocean earthquake belt known for its mountainous and populous environment. Mountainous areas take up approximately three fourths of the total land area. The particular geographic and climate environment such as steep topography, short and rapid rivers, dense distribution of torrents and gullies, and frequent earthquakes, coupled with torrential rains caused by the annual monsoon season and typhoons, contribute to disaster occurrence probability such as collapses, landslides, debris flows, and so on. Especially after the major earthquake in Chichi on September 21st 1999, as long as typhoon season coming, serious damage and a heavy toll on lives and property will be cost. To effectively resolve slopeland disasters, preventive treatment and slopeland conservation should be undertaken.

2.Management Challenge in Slopeland

The Soil and Water Conservation Bureau (SWCB) is the main authorization who is in charge of all affairs of slopeland conservation in Taiwan. They took a large expense in budget every year to construct the slopeland treatment construction and it also meant more and more constructions had been built in Taiwan slopeland. According to the statistic, there are nearly 4,000 to 5,000 works had been done a year. Over time, managing the substantial number of documents, data files, and related information produced from treatment construction and maintenance became increasingly difficult. Furthermore, because of lack of information management mechanism, SWCB couldn't know well of all the construction spatial distribution so that they are unable to supervise how the works are going in the critical area efficiently and do spatial analysis to find the influencing area by disaster. Therefore, how to manage a growing volume of construction information will be a challenge to the staff of SWCB.

3. Goals and Benefits

To effectively handle the treatment construction projects of SWCB, and to achieve the goal of e-government, we build the "Soil and Water Conservation Construction Management System" upon world-wide-web technology. Every engineering office can browse the system through WWW to report the progress of all constructions. The management department of SWCB can Real-Time handle every construction progress and situation by this system; therefore, fewer paper wastes, better effectiveness promotes.

The "Soil and Water Conservation Construction Management System" uses the feature of GIS concept to process construction data. The locations of all constructions are spatial processed and co-operating with disaster-database (built by SWCB over the years, including debris flows and landslides potential damage flow survey, collapse survey, the conformation of precaution against natural calamities …etc). Every engineering office can control locations, progress, and working situations of all constructions by this integrated system.

Investigators who work in the field can use PDA combined GPS to locate and query related attribute data of the constructions from the system which was developed for PDA. They can also upload the investigation to the server into disaster database. This function provides a convenient way to upgrade and maintain database. Depending on the functionalities described above, the system can greatly raises the efficiency of slope disaster management, and accomplishes to mobilization the construction management.

4. Approach

4.1 Database Structure

This system uses the existing GIS database which was built by SWCB as its database and it includes road database, hydrology database, administrative division maps, surface database, index maps, basic images, disaster prevention maps, and treatment construction maps.

- Road database: highway map, forest road map, agriculture road map, etc.
- Hydrology database: river map, basin map, etc.
- Administrative division maps: county map, town map, village map, landmark map, etc.
- Surface database: cadastral map, soil map, geology map, collapse map, contour map, land use map, etc.
- Index maps: 1/5000 index map, 1/25000 index map, 1/50000 index map, cadastral section index map, tc.
- Basic images: satellite images, photographic map, topographic map, etc.
- Disaster prevention maps: potential debris flow map, rainfall measure station map, observation station map, etc.
- Treatment construction maps.

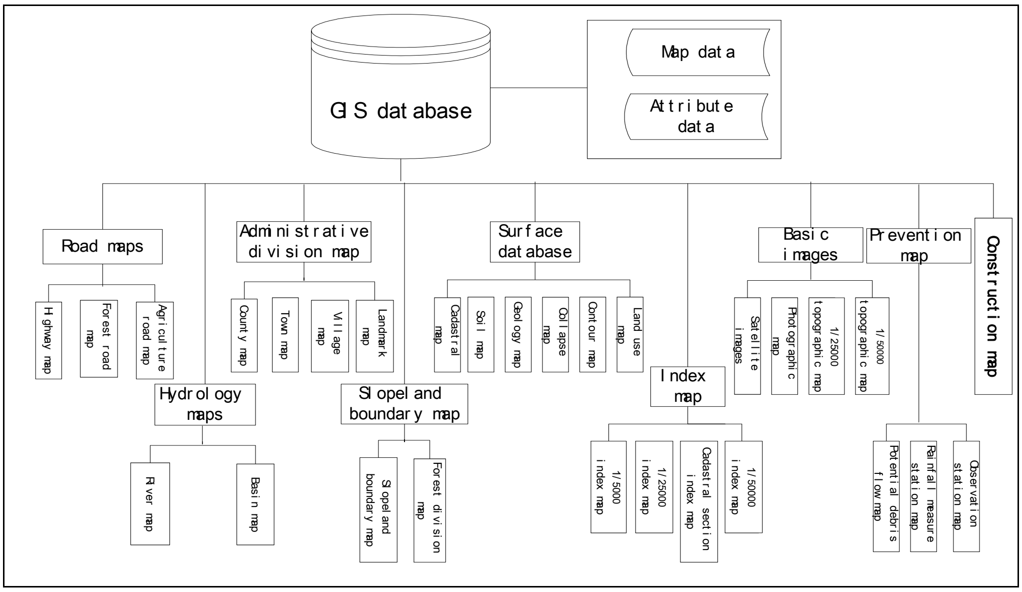


Figure 1.GIS database structure

4.2 System Configuration

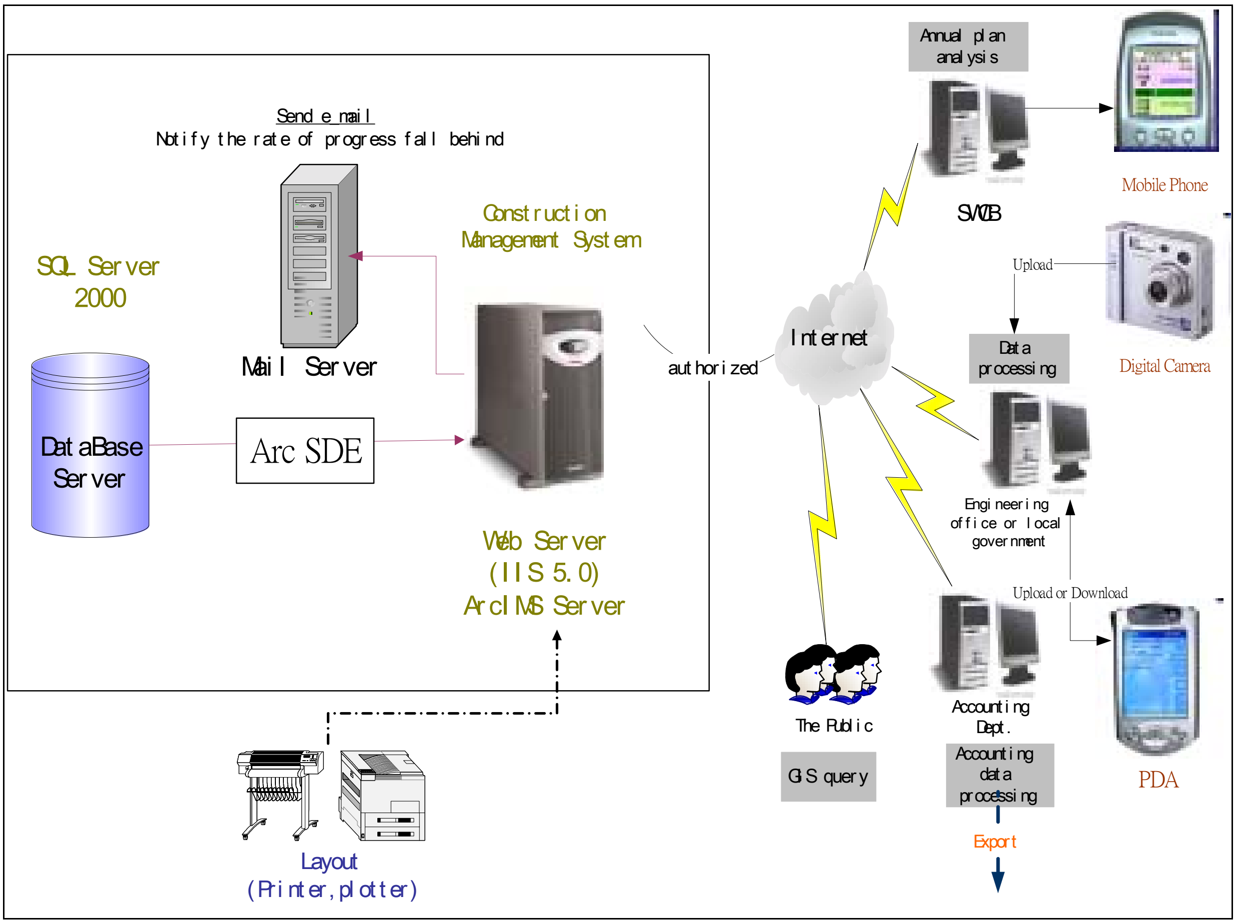


Figure 2. System configuration

1) The Soil and Water Conservation Construction Management System is based on Web Server rendered through ArcIMS to the staff of SWCB, related departments and the general public. It is a 3-tier structure and user need the authorization to use this AP.

2) The application data is stored in a SQL Server database using ArcSDE software.

3) The Mail Server will offer the service to send e-mail automatically when the rate of construction progress falls behind.

4) This is an integrated system structure combines with the latest and greatest technologies. PDA, GPS with digital camera can help the staff to investigate and record directly in the field. And mobilization technology is also employed. The commanding officer can get the real-time information through mobile phone.

4.2 Soil and Water Conservation Construction Management System

To address the issue of managing construction information in an efficient and timely manner, SWCB employed "Soil and Water Conservation Construction Management System" which was developed by GIS software and internet technology.

Each engineering office can use the system to type construction schedule over Internet, and reports the construction situation regularly; moreover, the information saved in database of SWCB server for the undertaker to conveniently control the schedule and geographical distribution.

This application provides several useful functions for the staff of SWCB and local engineering departments to maintain and control the construction. The following is the brief introduction of main function in this application.

1) GIS in construction management

According to the coordinates recorded in each construction data, the construction location is converted to a shapefile via internet and displays on WWW GIS interface as a point feature. In this map system, it offers many useful functions to browse GIS map, such as layer overlay, query, picture linking, statistic, locating, etc. Users can query the construction location by plan name, by construction serial number or by execution unit, etc. Each construction feature is colored by its progress status (divided into several phase such as under planning, under construction, completed, etc.), therefore, it can reflect the phase the construction is at present on real time. And its purpose is to provide the commanding officer totally control and manage all construction proceeding.

The main functions and its benefits describes as following:

- Overlay the raster data

  The raster data is such as satellite image, photographic map, topographic map. User can choose what he need and then system will display the image data according to the current displaying extend.

- Overlay the vector data

  The vector data is such as cadastral map and land use map, etc. From the overlay results of cadastral map and potential disaster area maps, the government can make warning in advance to the local residents and policy maker can make precautionary measures to avoid large loss happened. And the results also can be powerful references for SWCB officer to choose the location to do slopeland treatment construction.

- Positioning

  This system offers a lot of positioning ways to the user, such as by administrative division, by coordinates, by landmarks, by index map code.

- Inquire data

  User can inquire debris flow data, tumble data, cadastral data, land use data from this system through web site. For example, people can set multiple conditions to inquire debris flow data through setting county name, name of watershed, and level of risk.

Figure 3. Cadastral map and attribute data query

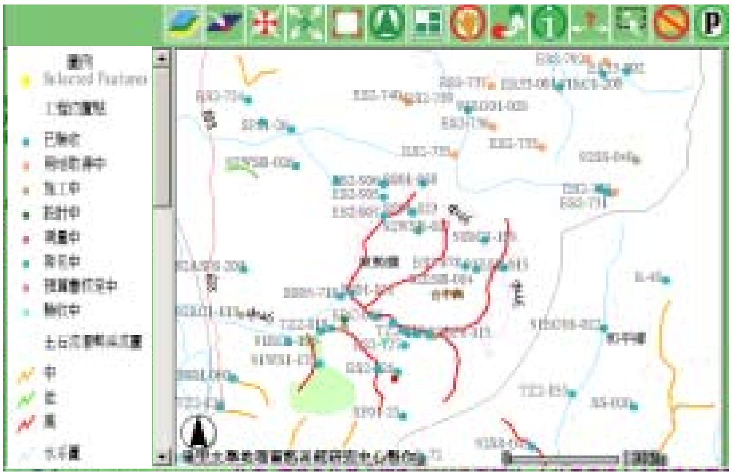


Figure 4. Construction location Query (construction phase is illustrated with different color)

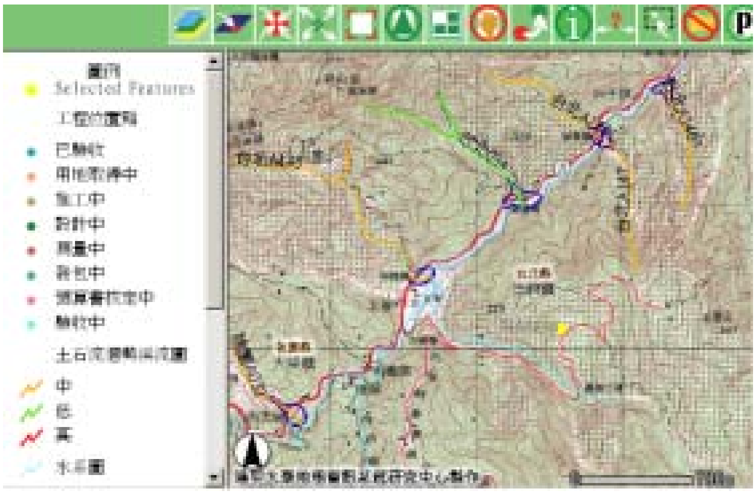
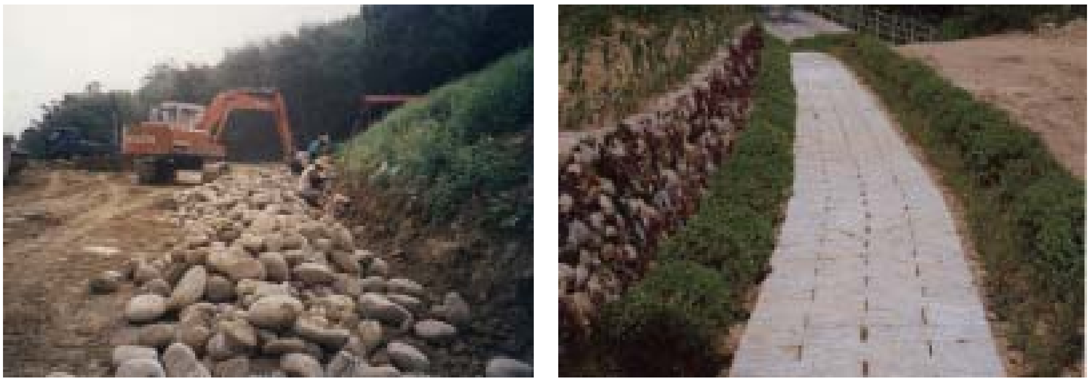


Figure 5. Construction location overlay 1/25000 topographic map



Under construction Completed

Figure 6. Construction pictures linkage from each construction attribute

2) Plan Management

To provide all levels of Soil & Water Conservation Bureau management departments to handle every plan progress and budget accounting, the system provides users to export data into MS-Excel format and produces budget pie and Progress-Curved-Line simultaneously, shown as Figure 7 and Figure 8.

計畫執行狀況統計表

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1	92	[illegible]	[illegible]	609,000	259	600,500,000	76,361,440	0	259	0.00%	11.77%	0	259	0	14	225	[illegible]
2	92	[illegible]	[illegible]	1,182,000	647	852,450,000	99,737,951	0	647	0.00%	[illegible]	0	647	0	0	647	[illegible]
3	92	[illegible]	[illegible]	[illegible]	382	826,220,000	116,623,475	1	381	0.26%	11.04%	1	381	0	35	347	9.16%
4	92	[illegible]	[illegible]	11,784	6	6,600,000	901,303	0	6	0.00%	2.82%	0	6	0	1	5	16.67%
5	92	[illegible]	[illegible]	62,100	119	40,006,000	7,230,146	78	41	65.55%	41.16%	0	119	0	82	37	68.91%
6	92	[illegible]	[illegible]	45,810	25	53,226,000	5,297,776	1	24	4.00%	8.05%	0	25	0	4	21	16.00%

Figure 7. Statistic Table of Plan Executing Progress

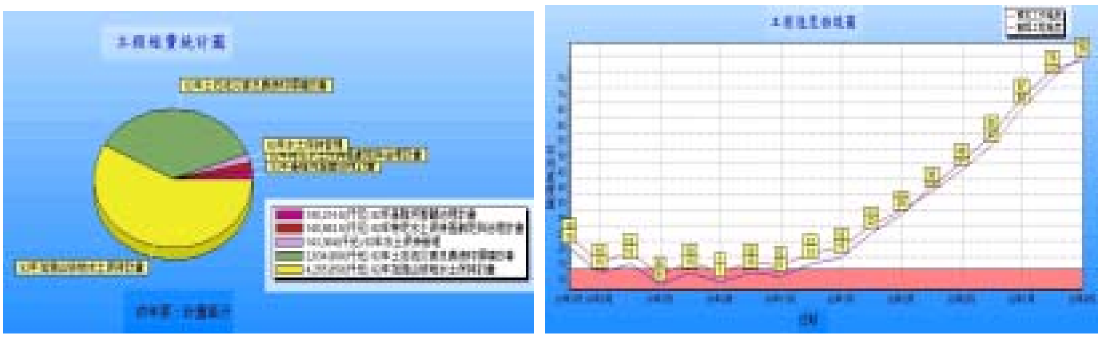


Figure 8. Graph & Table Analysis

3) Construction Management

Users can write in construction data, progress situation per month, budget enforce, upload construction picture, etc via the Internet. The system automatically checks whether the data is correct or not by seeking construction location and user input. After a record is inserted, the system will automatically calculates the month accounting table base on the newest data record-set, and shows each construction contents belonged to the construction.

Figure 8. Construction Executing Contents

4) Accounting Management

The main purpose of this system is to make construction management and assess automatically. According to accounting flowchart, accounting user can propose budget, register accounting reports, control expenditure, and reserve budget at the end of the year. And the most convenient design in this system is to integrate Government Budgeting and Accounting Information System (GBA). Therefore, it could get a large benefit from registering data at one time and simplify the procedure.

年度歲出保留經費明細表

保留	工程編號	工程名稱	工程款 預算數	工程款 實付數	自辦工程費(含空污費) 預算數	自辦工程費(含空污費) 實付數	委外設計監造費 預算數	委外設計監造費 實付數	完工比	保留原因
保留 / 不保留	91W111-090	[illegible]	2,520,000	2,520,000	22,000	7,412	34,339	34,250	100%	[illegible]
保留 / 不保留	91W111-091	[illegible]	2,635,000	2,635,000	13,500	7,729	43,229	43,229	100%	[illegible]
保留 / 不保留	91W111-092	[illegible]	2,310,000	2,310,000	20,465	6,760	54,637	54,637	100%	[illegible]
保留 / 不保留	91W111-093	[illegible]	2,077,000	2,077,000	15,000	6,385	31,587	30,141	100%	[illegible]
保留 / 不保留	91W111-094	[illegible]	1,430,000	1,430,000	9,500	4,193	20,618	20,617	100%	[illegible]
保留 / 不保留	91W111-095	[illegible]	1,830,000	1,830,000	10,800	5,343	32,906	32,906	100%	[illegible]
保留 / 不保留	91W113-002	[illegible]	2,250,000	2,250,000	13,800	6,834	41,595	41,595	100%	[illegible]

Figure 10. Reserved Budget Detail Table

4.3 Mobil information management

1) Integration of PDA, GPS and Digital Camera

The Soil and Water Conservation Bureau has made the full system on-line. This running system integrates with the PDA, GPS and digital camera to achieve economy, convenience, and powerful functionality. The engineering departments can write in data through the web site, download construction data into PDA, take the PDA to the construction in the field to record status directly, then upload those newest data onto server side; greatly increase manage effectiveness.

Figure 11. Mobilized survey system with PDA

2) Mobil information via cell phone

To provide commanding officers can query the progress and the rate of plan execution at any time and any place, a small system which is suitable for cell phone was developed by compatible HTML. Hence the commanding officers can use cell phone to enter this system via GPRS internet.

Figure 12. Mobil information via cell phone

5. System usage analysis

Soil and Water Conservation Construction Management System has already been on-line since 2002. There are 63 plans have been built until 2004 and the construction data built from every engineering office have amounted to 14,631 works. Figure 13 is illustrated the on-line flow from statistics every day between 2003/4 and 2004/2. This shows the application has replaced the traditional procedure to realize the computerlization and indeed has a great help to improve the work efficiency. The commanding officers don't rely on the official documents to go and back any more and they could get the latest news via internet at any time and any where.

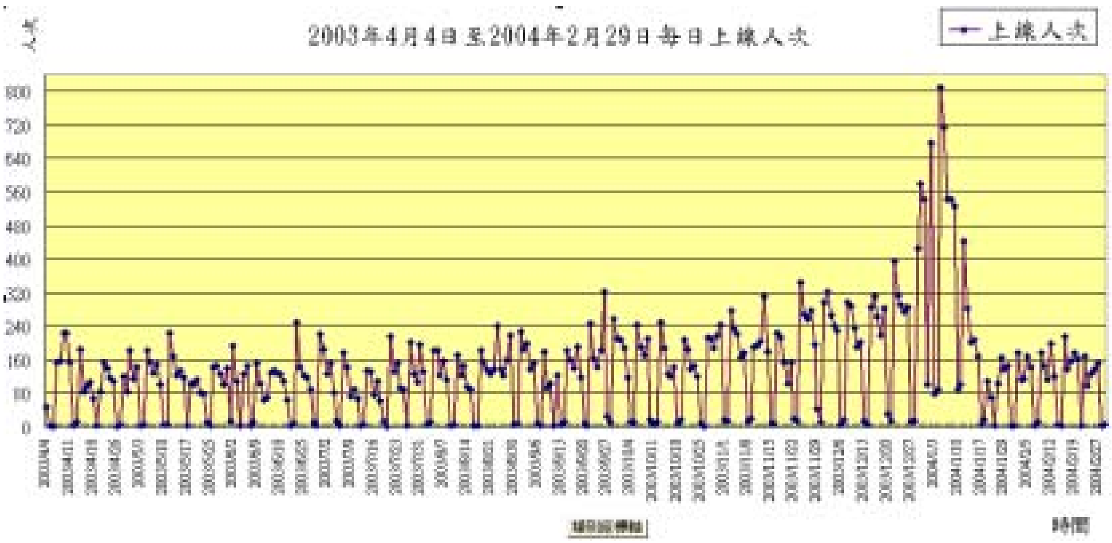


Figure 13. On-line flow

6. Conclusion

Integrating whole processes of SWCB's construction plan and commission plan by building business functionality with informational operating model, each engineering office can record the schedule on time via internet to save the data in the database of SWCB server, inquire the related data or print the forms on line, and reduce data write in with repetition; therefore, commanding officers can handle the executive rate and geographical distribution, and full-fill the construction schedule management.

The system also integrates PDA , GPS and digital camera to carry on-the-spot survey out, so that the executive units can write in survey data on time and on site; besides, this mobile survey system integrates with "Construction Management System" ,therefore it could shorten the time of data processing, and raise the efficiency of construction survey and management.

The other contribution of this system is linkage with Government Budgeting and Accounting Information System (GBA), it designs an integrated function to do accounting jobs that connects to GBA directly and keep off a lot of manual works. Consequently, it simplifies the process and traditional jobs in former days and lightens the load of the undertakers.

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