

The establishment of a preservation stack environment monitoring system

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Abstract:

The National Library of Korea (NLK) owns a total of 10 million books and items in its collections. Currently, 44 preservation stacks are dispersed in four independent buildings, namely, the NLK's Main Building (12) and Digital Library (12), the National Library for Children and Young Adults (NLCYA) (5) and the National Library of Korea, Sejong (9). Quite a distance separates the NLK from the NLCYA (3.68 km) and Sejong (129 km), and thus an integrated system for efficiently managing the materials and stacks located in different regions became necessary.

In 2015, a monitoring system was established for measuring the temperature, humidity, levels of harmful gases and the distribution of microorganisms of all the preservation stacks. The temperature and humidity of all the stacks, which are geographically separated from each other, are measured every 15 minutes and transmitted in real-time to a central system, and the level of harmful gases and the status of microorganism distribution are measured and recorded twice per year.

The preservation stack environment monitoring system can be used for: maintaining an optimal preservation environment; comprehensively analyzing the environment in which the stacks are placed; preventing causes of damage; and statistically analyzing the preservation environment. Furthermore, since materials can be transferred to an optimal preservation environment after undergoing preservation and conservation treatments (such as fumigation, mass deacidification, repairing, dry washing, etc.), such treatments can be safely maintained, and the lifespan of the materials can be extended.

Data accumulated in the monitoring system will be analyzed and used as basic information to: establish mid- to long-term plans for improving the preservation environment in order to extend the lifespan of materials; and operate preservation environments that are customized to various media materials. Moreover, the system will enable a centralized control-type remote management system for managing the dispersed preservation stacks and their environments.

Keywords: environment, stack, monitoring, National Library of Korea

■ Introduction

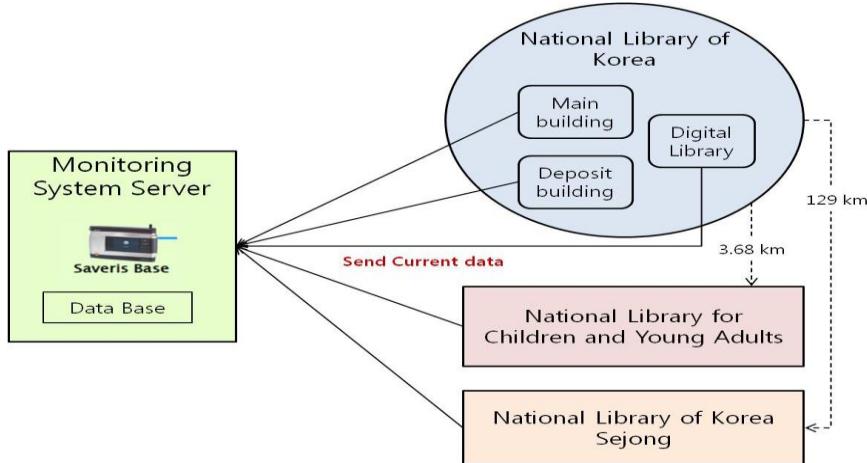
As a depository library, the National Library of Korea (NLK) holds about 10 million books and has a mandate to scientifically and systematically manage these materials and pass them down to the future generation. As such, in order to preserve the materials in an optimal preservation environment, the NLK has been regularly managing the environment of all stacks in the library so as to maintain adequate temperature and humidity levels and check for harmful gases. However, as more branch libraries were built and the number of materials continued to increase, it became necessary to improve the stack environment management system. Under such recognition, the NLK developed a more efficient stack management system.

The NLK consists of a main library and two branch libraries, namely, the National Library for Children and Young Adults (NLCYA) and the National Library of Korea, Sejong. The distance between the main library and each of the two branches is 3.68km and 129km respectively. The main library itself consists of three buildings: the Main Building, the Deposit Building and the Digital Library. Each of the three buildings has its own stacks and an independent stack environment management system, and thus staff members working in the Main Building in charge of the overall preservation environment had difficulty in managing and maintaining an adequate environment for all the stacks in the main library. Therefore, an integrated stack environment monitoring system was developed from a data log system that was previously introduced to maintain the preservation environments of the three buildings in the main library. The new system removes the limitations imposed due to the different physical locations of the buildings by enabling the real-time monitoring of the temperature and humidity levels of the stacks which are regionally distributed. Furthermore, the results of harmful gas inspections, which are conducted twice each year, can be directly input into the system.

The detailed structure and functions of the stack environment monitoring system are discussed below.

■ Establishment of the system

In terms of the number of stacks in the NLK, there are 12 in the Main Building, six in the Deposit Building, 12 in the Digital Library, five in the NLCYA and nine in Sejong. A data log system (TESTO) is installed on the stacks in each of the three buildings of the main library and on the stacks in the two branch libraries which are in different locations from the main library. Temperature and humidity levels are measured and transmitted to the main stack environment monitoring system in the main library, and real-time temperature and humidity levels by building and stack are indicated on the monitoring system screen. Furthermore, the data is stored in a database so that it could be used for various statistical analyses. Additionally, the system is designed so that the results of the biannual harmful gas inspection for each stack can be directly input to be used as statistic data for establishing a long-term preservation plan. The NLK is also planning to develop a system that has an added collections management unit through which the current state of the collections of each stack can be monitored in real-time.



[Figure 1] Block diagram of the system

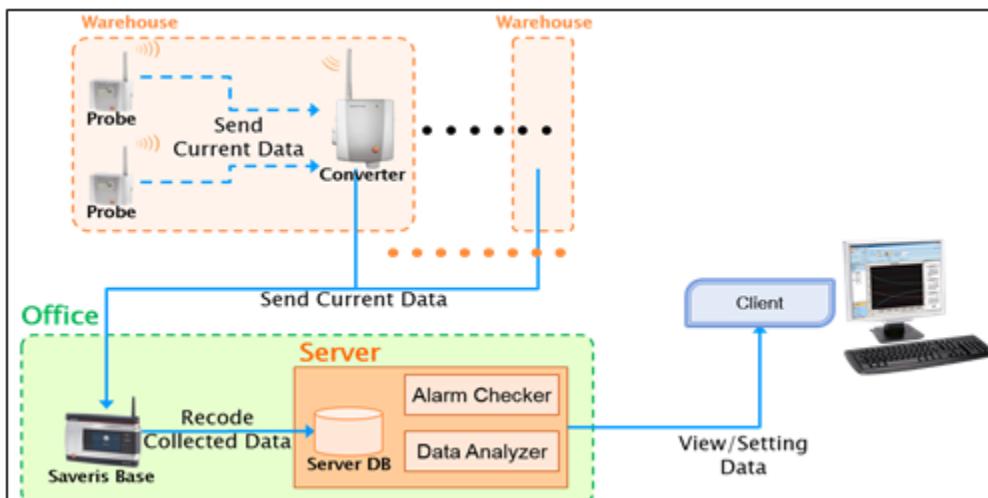
■ Major functions of the system

The stack environment monitoring system has four major functions as follows.

- Monitoring
 - Displaying, on a map image, each building, location and stack at which data is being measured
 - Changing environment management display data
 - Displaying a warning or alarm and enabling inquiries
 - Providing a separate screen and detailed graphs for each stack
- Data collection and input
 - Collecting, processing and storing data measured by the TESTO measurement device
 - Enabling a user to directly input a certain measurement value
- Statistics
 - Enabling the viewing of measurement and statistical data of a single or multiple stacks
 - Enabling the viewing of measurement values by time period
 - Saving graphs, histogram images, and saving data on Excel sheets
- Basic management tools
 - Managing information on the library, buildings, locations and stacks
 - Managing the range of warnings and alarms of each measurement device, and managing staff members who are in charge
 - Managing users and the processing of requests
 - Managing system environment variables such as differentiating the colors of warnings and alarms

■ Detailed functions and block diagram of the system

The stack environment monitoring system largely comprises a server function and a client function, and the detailed functions of each are as follows.



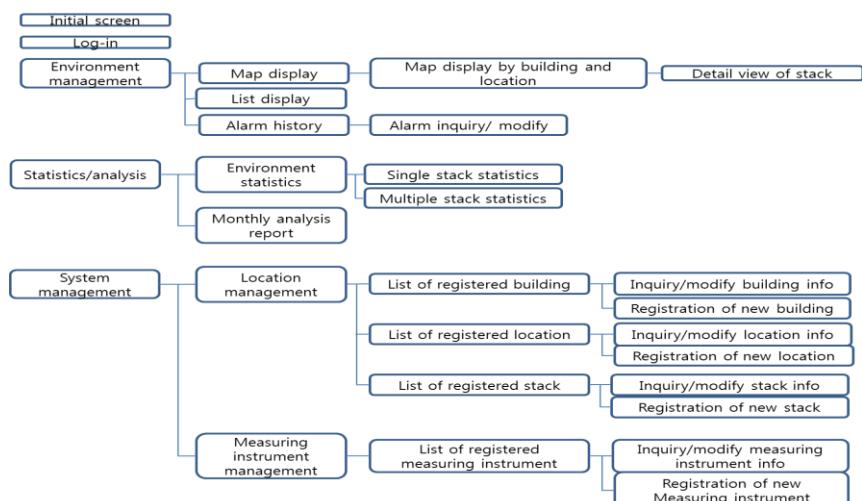
[Figure 2] Block diagram of system development

(1) Server function

The server function comprises a DB unit and a data collector unit. The DB unit saves and stores measurement data, input data and system management information, and the data collector unit collects values measured by a registered measurement device and transmits the values to the DB unit. A background software was also developed to store, in the DB unit, information on reports on the analysis or processing of the collected or input data.

(2) Client function

The client function can be divided into three sub-functions: a monitoring function, a statistics function and a system management function.



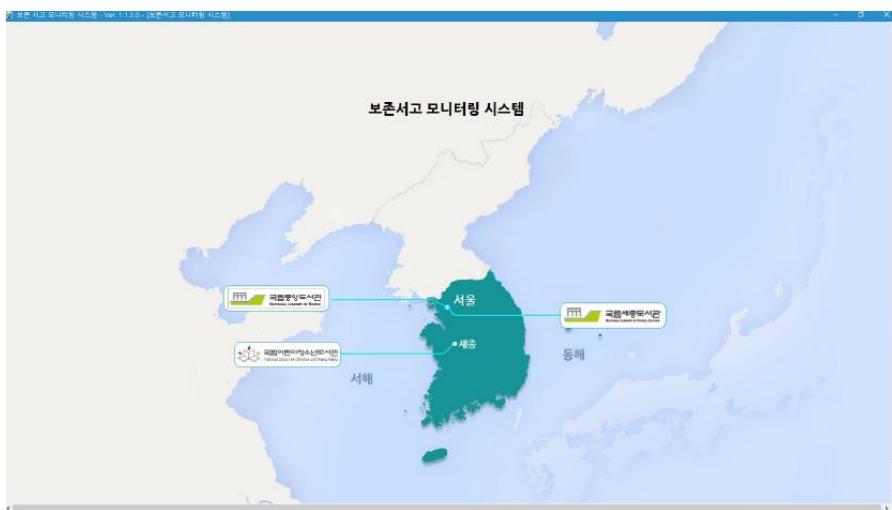
[Figure 3] Diagram for composition of menu

- Monitoring function

Functions included in the monitoring function are: a real-time monitoring function by which all registered stacks are managed in real-time and measurement data are displayed on one screen, and moreover, each library, building and stack is managed separately in real-time and measurement data are displayed by location on a MAP image; an event occurrence (alarm) managing function by which an alarm that has gone off can be viewed and an action to take care of the issue can be input; and a view-by-stack function by which a selected stack can be managed in real-time and its measurement data can be viewed, and input data for a selected stack can be registered, modified and added.

[Table 1] Monitoring function definition

Menu	Submenu	Section	Construction	Function
	Main screen		- Displaying total map - Displaying selectable library	Selecting library and logging in
	Log-in		ID/Password	Using ID/Password to log-in
Management of environment	View of the map	Library	- Displaying library Map - Location of library - Total list of stacks	- When alarm occurs it is indicated by color. - Building menu shows image of the building. - List menu shows image of list. - Data renewed every hour
		Building	- Tab-button for floors of building and stack location - Displaying selected location - Displaying basic stack information - Displaying basic location information	- Displaying tab-button of registered locations - Displaying selected stack menu - Basic information of location and stacks - Data renewed every hour
		Stack	- Displaying stack image - List of recent measurements - Stack information	- Displaying location of measuring instrument - Displaying recent measurement/average etc. - Data renewed every hour
	View the list		- List of stack locations and measurements - Search bar	- Displaying stack list by search - Inquiry possibility on search result and selected stack - Data renewed every hour
	Displaying alarm history		- Displaying list of registered alarms - Searching bar of period and stack - Stack list Tree	- Displaying list of registered alarms - Managing alarms - Inquiry possibility of selected list
	Detail view of stack		- Basic measurement information - Measurement graph of fluctuation - List of measurement and alarm history - Search bar of period and stack	- Displaying selected period of measurement - Displaying measurement graph - History of alarm - Period and stack can be selected in the search bar

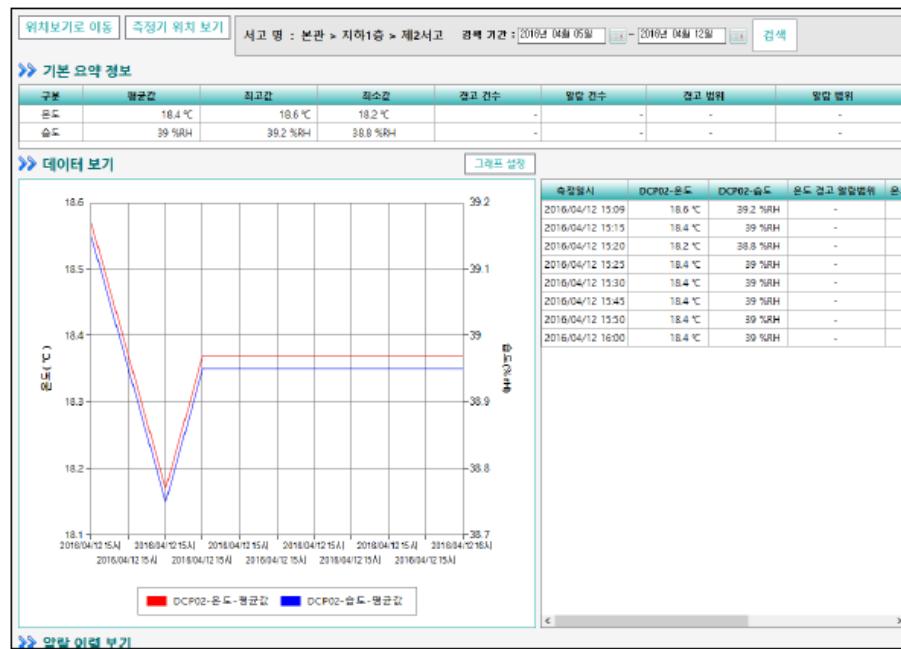


[Figure 4] Example of “Main screen”

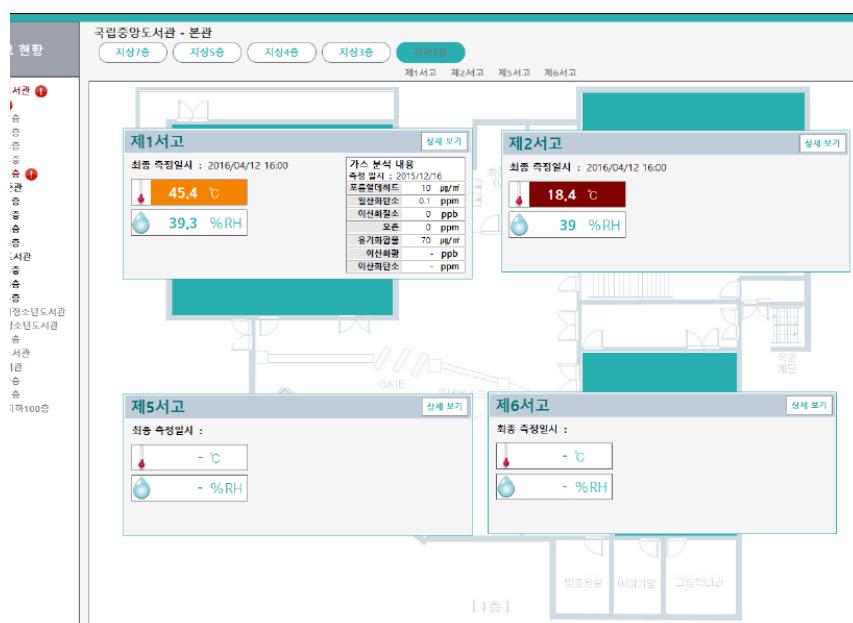


[Figure 5] Example of “Basic screen construction”

- 1) Upper menu
- 2) Stacks
- 3) Principle screen
- 4) Information bar



[Figure 6] Example of “Detail view of stack” Showing temperature and relative humidity data and its graph



[Figure 7] Example of “MAP view” Registered stacks are displayed in the map by its location.

[Figure 8] Example of “List view” Building, location, stack, recent measurements of temperature and relative humidity, and date are displayed as a list.

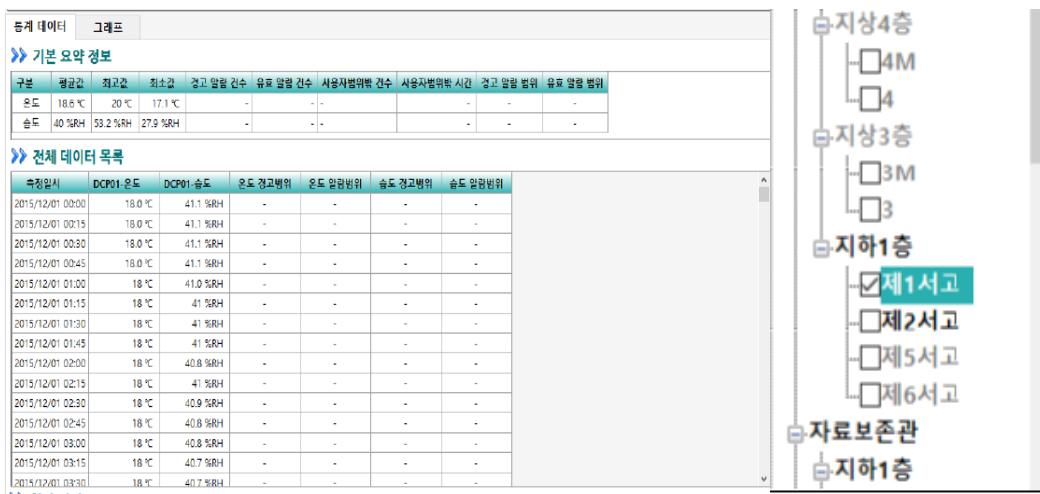
[Figure 9] Example of “Alarm history view” Alarm history can be inquired by stack, period and etc.

- Statistics function

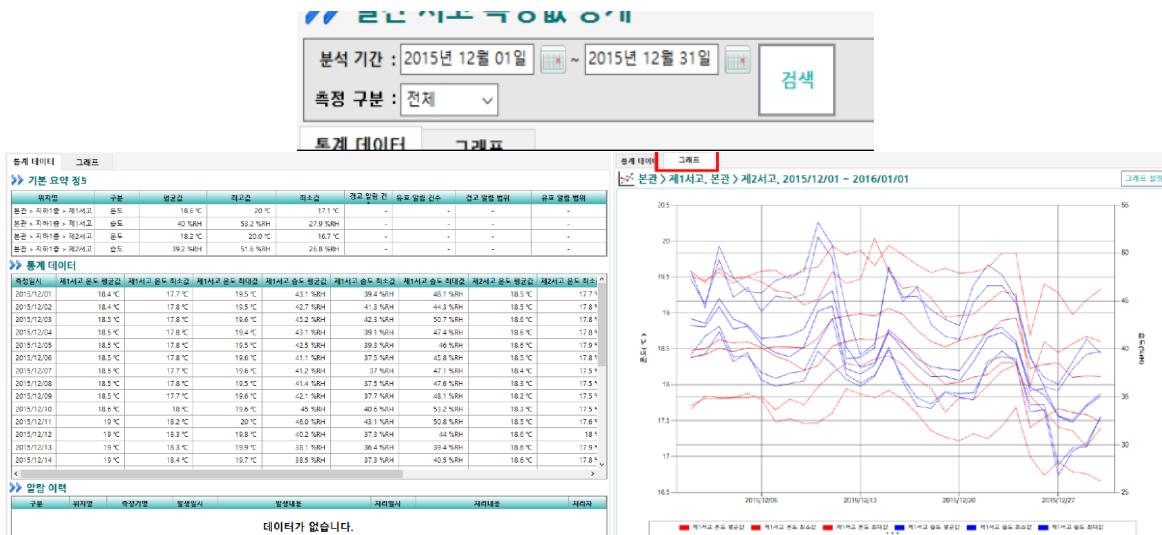
Several kinds of statistical functions were developed in order to enhance the utilization of data in the future. A single stack statistics function shows the current state of measurement data of a single stack during a selected time period. Similarly, a multiple stack statistics function shows the current state of measurement data of all selected stacks during a selected time period. The current state of not only measurement data but also input data of all selected stacks during a selected time period can be calculated, and the current state of all the events that occurred during a selected time period can be known through the statistics of the occurred events. The statistics calculated by means of the above functions can be analyzed through an analysis report on the measurement and input data of all the stacks during a selected time period.

[Table 2] Statistics functions definition

Menu	Submenu	Section	Construction	Function
Environment statistics	Single stack measure statistics	-	<ul style="list-style-type: none"> - Searching bar of period and section - Selectable stack Tree - Tab button for graph/list/daily statistics - Measurement graph and list - Daily statistics graph and list - Save button for graph 	<ul style="list-style-type: none"> -Displaying measurement graph and list for selected single stack -Displaying measurement information list - Displaying recent measurements/average etc - Saving graph image
	Multiple stack measure statistics	-	<ul style="list-style-type: none"> - Search bar of period and section - Selectable stack Tree - Tab button for graph/list/daily statistics - Measurement graph and list - Daily statistics graph and list - Save button for graph 	<ul style="list-style-type: none"> - Displaying measurement graph and list for selected multiple stacks -Displaying measurement information list - Displaying recent measurements /average etc - Saving graph image



[Figure 10] Example of “A single stack statistics function” Selecting stack from the stack Tree then it displays data list and basic information



[Figure 11] Example of “Statistical analysis” Selecting period then it displays total data list and its graph

• System management function

The system management function includes: system user management; management of environment variables used in the system; environment management by which programs can be updated to the latest versions; input data management by which input targets by stack are defined; stack management by which information on target stacks is managed; measurement device management by which target measurement devices are managed; event occurrence (alarm) management by which the range of measurement device alarms is defined; and map location management by which locations to be indicated on a map and relevant configurations are managed.

[Table 3] System management function definition

Menu	Submenu	Section	Construction	Function
Location management	Building management	Displaying of list	<ul style="list-style-type: none"> - Selecting bar for building - Information of registered building - View image by the list and inquiry/modify button - Add and delete buttons 	<ul style="list-style-type: none"> - Displaying list of total registered building - Displaying view image of building -Selecting inquiry/modify button to display inquiry/modify screen
		Displaying of Registration/inquiry/modify	<ul style="list-style-type: none"> - Registration form of building information - Save and delete buttons 	<ul style="list-style-type: none"> - Displaying new registration and inquiry/modify screen - Registering building image - Setting up locations
	Location management	Displaying of list	<ul style="list-style-type: none"> - Selecting bar for building selection and location - Information of registered location - Viewing map image and inquiry/modify button - Add and delete buttons 	<ul style="list-style-type: none"> - Displaying list of registered location information -Selecting map image and registering map
		Displaying of	- Registration form of	- Displaying

		Registration/inquiry/ modify	location information - Save and delete buttons	register/inquiry/modify - Map inquiry and modify are possible
Stack management		Displaying of list	<ul style="list-style-type: none"> - Selecting building/location and search bar by name of stack - List of registered stack information - Viewing map image and inquiry/modify button - View button for alarm - Add and delete buttons 	<ul style="list-style-type: none"> - Total information of registered stacks - Registering and modifying stack map - Inquiry/modify are possible
		Displaying of Registration/inquiry/ modify	<ul style="list-style-type: none"> - Registration form of stack information - Set-up button for alarm and responsible person - Set-up button for map image - Save and delete buttons 	<ul style="list-style-type: none"> - Displaying new registration form - Registering image of stack map - Making range of warnings and alarms
Management of Measuring instrument		Displaying of list	<ul style="list-style-type: none"> - Search bar for measuring instrument - Information list of registered measuring instrument - Add and delete buttons 	<ul style="list-style-type: none"> - Displaying total registered measuring instrument - Inquiring/setting up location of measuring instrument - Searching measuring instrument by its name
		Displaying of Registration/inquiry/ modify	<ul style="list-style-type: none"> - Registration form of measuring instrument - Save and delete buttons 	<ul style="list-style-type: none"> - Displaying registration form of measuring instrument - Displaying location of measuring instrument on the map

건물명	도서관명	설명
본관	국립중앙도서관	국립중앙도서관 본관 건물
자료보존관	국립중앙도서관	국립중앙도서관이나 자료보존실
디지털도서관	국립중앙도서관	국립중앙도서관 디지털도서관
어린이청소년도서관	국립어린이청소년도서관	국립중앙도서관 관리
세종도서관	국립세종도서관	세종시에 위치한 국립 중앙도서관 ...

[Figure 12] Example of “Building management” Displaying name of building, library, account, and number of registered locations

» 위치 관리						
검색 조건 : 품목명		검색		신규 위치 삭제하기		
위치명	도서관명	건물명	설명	등록 서고 개수	램 이미지	조회/수정
지상7층	국립중앙도서관	본관	국립중앙도서관 본관 > 지상 7층 쪽	2 (7)	보기/설정	조회/수정
지상5층	국립중앙도서관	본관		2 (7)	보기/설정	조회/수정
지상4층	국립중앙도서관	본관		2 (7)	보기/설정	조회/수정
지상3층	국립중앙도서관	본관		2 (7)	보기/설정	조회/수정
지하1층	국립중앙도서관	본관		4 (7)	보기/설정	조회/수정
지하2층	국립중앙도서관	자료보존관		2 (7)	보기/설정	조회/수정
지하3층	국립중앙도서관	자료보존관		1 (7)	보기/설정	조회/수정
지하4층	국립중앙도서관	자료보존관		1 (7)	보기/설정	조회/수정
지하5층	국립중앙도서관	자료보존관		2 (7)	보기/설정	조회/수정
지하6층	국립중앙도서관	디지털도서관		3 (7)	보기/설정	조회/수정
지하7층	국립중앙도서관	디지털도서관		5 (7)	보기/설정	조회/수정
지하8층	국립중앙도서관	디지털도서관		4 (7)	보기/설정	조회/수정
세종시하100층	국립중앙도서관	일시인물	지하 100층 전연말반수적 보관	0 (7)	보기/설정	조회/수정
지상1층	국립어린이청소년도서관	어린이청소년도서관		5 (7)	보기/설정	조회/수정
지하2층	국립어린이청소년도서관	세종도서관		5 (7)	보기/설정	조회/수정
지하3층	국립어린이청소년도서관	세종도서관		3 (7)	보기/설정	조회/수정

[Figure 13] Example of “Location management” Displaying name of building, library, account, and number of registered stacks in the location

» 측정기 관리						
검색 조건 : 측정기명		검색		신규 측정기 삭제하기		
측정기명	설치 위치	シリ얼번호	구분	측정방식	연결사용	지도위치
DCP01	본관 > 지하1층 > 제14하고	2022990	testo 온습도기	시스템수집	사용됨	X 100, Y: 100
DCP02	본관 > 지하1층 > 제24하고	2051618	testo 온습도기	시스템수집	사용됨	X 100, Y: 100
DCP03	자료보존관 > 지하1층 > 도서1	2022837	testo 온습도기	시스템수집	사용됨	X 100, Y: 100
DCP07	자료보존관 > 지하1층 > 도서1-1	1904664	testo 온습도기	시스템수집	사용됨	X 100, Y: 100
DCP04	자료보존관 > 지하2층 > 도서1	1975508	testo 온습도기	시스템수집	사용됨	X 100, Y: 100
DCP05	자료보존관 > 지하2층 > 도서3	2022845	testo 온습도기	시스템수집	사용됨	X 100, Y: 100
DCP06	자료보존관 > 지하4층 > 도서4	1975491	testo 온습도기	시스템수집	사용됨	X 100, Y: 100
DCP08	디지털도서관 > 지하3층 > 3-1	2073166	testo 온습도기	시스템수집	사용됨	X 100, Y: 100
DCP09	디지털도서관 > 지하3층 > 3-2	2073175	testo 온습도기	시스템수집	사용됨	X 100, Y: 100
DCP10	디지털도서관 > 지하3층 > 3-3	1904656	testo 온습도기	시스템수집	사용됨	X 100, Y: 100
DCP11	디지털도서관 > 지하4층 > 4-1	2073168	testo 온습도기	시스템수집	사용됨	X 100, Y: 100
DCP12	디지털도서관 > 지하4층 > 4-2	2073174	testo 온습도기	시스템수집	사용됨	X 100, Y: 100
DCP13	디지털도서관 > 지하4층 > 4-3	1975497	testo 온습도기	시스템수집	사용됨	X 100, Y: 100
DCP14	디지털도서관 > 지하4층 > 4-4	2022856	testo 온습도기	시스템수집	사용됨	X 100, Y: 100
DCP15	디지털도서관 > 지하4층 > 4-5	2073169	testo 온습도기	시스템수집	사용됨	X 100, Y: 100
DCP16	디지털도서관 > 지하5층 > 5-1	1904658	testo 온습도기	시스템수집	사용됨	X 100, Y: 100
DCP17	디지털도서관 > 지하5층 > 5-2	2022843	testo 온습도기	시스템수집	사용됨	X 100, Y: 100
DCP18	디지털도서관 > 지하5층 > 5-3	1975492	testo 온습도기	시스템수집	사용됨	X 100, Y: 100
DCP19	디지털도서관 > 지하5층 > 5-4	2022853	testo 온습도기	시스템수집	사용됨	X 100, Y: 100

[Figure 14] Example of “Management of measuring instrument” Displaying location, name of the instrument and serial number

■ Future plans

It is the first step of stack monitoring system. A scientific stack monitoring system will be established through which, in addition to the management of the stack environment, the current state of the collections in all the stacks of the NLK will be computerized and mapped.

Through the new system, it will become possible to share information in real-time for managing the preservation environments and stacks of all the preservation stacks in the NLK. Also, work efficiency will increase by unifying the current states of the stacks. Monitoring by stack will bring the effect of reducing time and human effort needed in moving materials, and analyses of stack space will be done in a systematic and scientific way. Furthermore, monitoring by stack and material in real-time and analyzing accumulated data will be useful in predicting preservation space to prepare for the increase in materials, and can be used as a basic resource to refer to for procuring space for more preservation stacks in the future.

■ Conclusion

A stack environment monitoring system enables the establishment of a centralized control-type remote management structure by which each stack environment, which is geographically separated from another, can be monitored in real-time. The system also makes it possible to take prompt action when a problem occurs.

Furthermore, accumulated data will be statistically analyzed and used for managing materials in a more scientific way by analyzing problems in the stack environments, establishing mid-to long-term preservation plans and establishing basic material necessary for operating preservation environments according to the characteristics of various media.

The NLK has persistently pursued the development of a stack monitoring system, and as a result, was able to extend the lifespan of materials, maintain an optimal preservation environment, and moreover, save energy through the system. The NLK plans to further develop an integrated stack management system that has an added collection management system.

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