

Indoor Monitoring System Employing Facebook Platform for WSN

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Abstract— Currently, developers of sensor network monitoring systems have to use various web languages including HTML, JavaScript and Ajax, and have to set up web servers using Apache, PHP, and MySQL. In addition, the implementation of security and authorization may need to be considered in many cases. Thus, the implementation and management of sensor network system are quite a burden to the developers. In this paper, we propose a new approach that uses Facebook as a platform for sensor network monitoring systems. In order to use Facebook as a platform for our sensor network monitoring system, a PC side application that connects Facebook and WSN is needed. The PC side application, which is built with Facebook C# SDK, is capable of automatically posting the sensory data of WSN on Facebook. By applying our proposed method, the difficulties in using web languages or setting up servers can be reduced. As a case study, an indoor monitoring system based on our proposal has been developed. From our experiment, we found out that our approach provides easiness, cost-effectiveness and flexibility when constructing WSN rapidly

Keywords— Wireless Sensor Network, Web of Things, Social Network Service, Facebook.

I. INTRODUCTION

With the advancement of Web of Things (WoT), Wireless Sensor Network (WSN), Social Network Service (SNS) and Internet, ubiquitous computing has been extensively researched for quite a long time. Also, existing devices such as home appliances and industrial machines are becoming more smart with the progress in computing technology development[1].

The advance of the Internet made it possible for people to communicate and share information easily through SNS. The SNS such as Facebook, Twitter, Yozm and Me2Day is an online service, platform, or site that concentrates on facilitating the building of social networks or social relations among people who would like to share interests, activities, backgrounds or real-life connections[2].

One of the important applications of WSN is area monitoring, where nodes are deployed over a region to monitor the environment[3]. Connecting WSN to Internet provides us with a convenient way to show physical world to end-users and control WSN located in remote places for administrators[4]. Typically, developers have lots of work to do and it is hard for administrators to manage WSN when

implementing systems that show sensory data only in web format to interested users. For example, they have not only to develop their webpage with web languages such as HTML, JavaScript, Ajax, etc. but also to set up a web server which normally consists of Apache, PHP and Mysql in order to show the status and data of WSN. Moreover, the implementation of security and authorization may need to be considered in some cases. A database server also may be needed in order to save sensory data from WSNs. As mentioned, the development and management of WSN have become an issue.

In this paper, we propose a new approach that uses Facebook as a platform for sensor network monitoring systems. By making full use of our proposal, we are able to overcome the implementation issues that we mentioned above without much effort. Specifically, web or database servers will not be needed. The burden of handling web languages can also be alleviated. Our proposed system enables people to monitor and manage WSN with Open Authorization[5], an authorization framework for an HTTP service, by using Facebook C# SDK which is an ongoing open source project. Therefore, developers do not need to pay much attention to account and permission management. Additionally, people share their own opinions and activities through SNS. It is expected that some information will be shared between people and devices such as computers, embedded systems, machines, robots and more by using another SNS consisting of additional functions and another format in the future.

The remainder of the paper is organized as follows. Section II contains an overview on related works. In Section III, a typical WSN system without using SNS is mentioned. In Section IV, we explain the implementation of an indoor monitoring system employing Facebook Platform for WSN and some experimental results are shown. Finally, we conclude this work and suggest the future work in Section V.

II. RELATED WORKS

There are some approaches that use SNS as a platform for sensor network systems. However, all of them use Twitter in their researches. For example, S-Sensors (Social-Sensors)[6] is a sensor-to-web model framework based on Twitter. SoMoS (An Interactive Social Network Service Enable Middleware for Wireless Sensor Networks)[4] is a middleware capable of managing WSNs through Twitter. Crown-sourced and collaboration system[7], the research of integrating sensor or

smartphone to SNS, is also using Twitter.

In Twitter, users are unable to post more than 140 characters per update. If there are lots of informations from WSNs, all the informations cannot be posted at once. It means that lots of texts limited to 140 characters are uploaded many times to show interested users all the data. Moreover, the way to view images is not that intuitive. Compared to Twitter, the users of Facebook are able to post as many characters as they want and the feature for viewing images is very intuitive. When it comes to the number of people who use Facebook and Twitter which are being used worldwide, Facebook has even more users than Twitter[8, 9]. Our approach with Facebook is better than the previous research with Twitter by the above reasons. This is why we selected Facebook to take advantage of user-friendly functions.

Facebook C# SDK, an ongoing open source project[9], helps .(Dot)Net developers build web, desktop, phone and windows 8 applications that integrate with Facebook. In this paper, we built an application capable of integrating WSN or embedded systems with Facebook by using the SDK.

III. THE DESCRIPTION OF PREVIOUS SYSTEM

We mention a typical WSN system, referred to as, Indoor Monitoring System through Web, designed before this work.

A. Typical WSN System without SNS.

Before working on integrating WSN with Facebook, Indoor Monitoring System had been built as shown in Figure 1. The purpose of this application is to show temperature and light values from WSN through webpages. As for the hardware, this system consists of a webcam, sensor nodes and a computer. From experience on implementing the system, we realized that developers have a lot of work to do and it is not that easy for administrators to manage WSNs. Additionally, the webpage is displayed in a different style from web browser to web browser (e.g. Chrome, Firefox and Explorer).

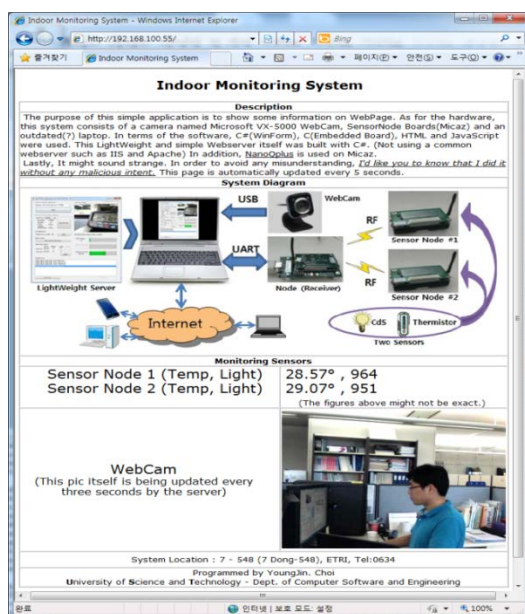


Figure 1. Indoor Monitoring System through Web (without SNS)

It takes a lot of time to adjust the webpages in all web browsers for the same style

B. Wireless Sensor Network (WSN)

MICA2 Mote and MDA100CB are used. This sensor node is composed of ATmega128, a thermistor and a light sensor. Also, NanoQplus[11] which is an operating system for WSN is used. In order to communicate between sensor nodes and a base station, a simple method is used in our proposed system. We designed the data format for transferring the sensory data as Table 1 shows.

TABLE 1. DATA FORMAT OF SENSOR NODE FOR COMMUNICATION

Field Sequence	Type	Description
1	UINT8 (1byte)	ID of data packet
2	UINT16 (2byte)	Value of Thermistor
3	UINT16 (2byte)	Value of Light Sensor

Field 1 is ID (IDentification) of data packet. Field 2 and Field 3 are the digital values of thermistor and light sensor respectively, as shown in Table 1. Sensor nodes send the data of two sensors to the base station periodically in compliance with the above data format. Lastly, the base station transfers all the sensory data from sensor nodes to PC through serial communication.

IV. THE DESCRIPTION OF PROPOSED SYSTEM

In this section, we explain our indoor monitoring system that uses Facebook as a platform for WSN.

A. Proposed System with SNS Diagram

The diagram of our proposed indoor monitoring system employing Facebook is shown in Figure 2. The sensory data from each sensor node, consisting of thermistor and light sensor, are transferred to a windows application through a base station. And then, this application posts the sensory data periodically on Facebook.

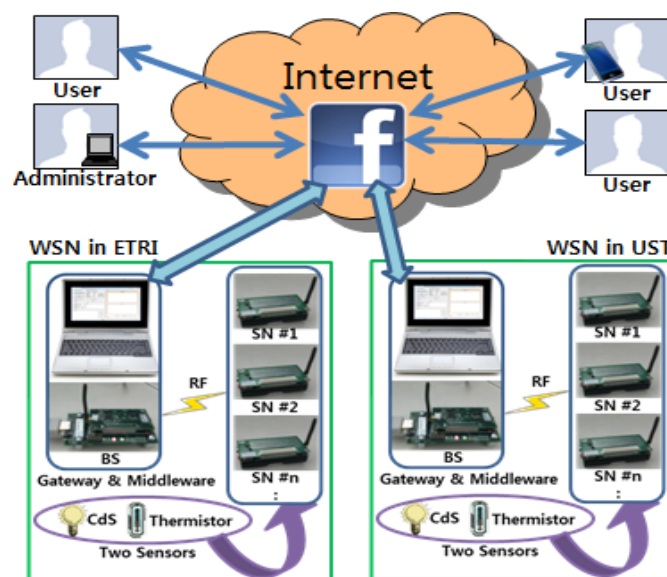


Figure 2. Diagram of System with WSN and SNS

Authorized users on Facebook can have access to the sensory data such as temperature and light by computers and smart phones and the like. In our system, thermistors and light sensors are used for the implementation.

B. Application for Connecting WSN to SNS

In order for all the information including the sensory data and the status of WSN to be automatically posted on Facebook, a PC side application for connecting WSN to Facebook is needed. So, Figure 3 shows the relationship among components.

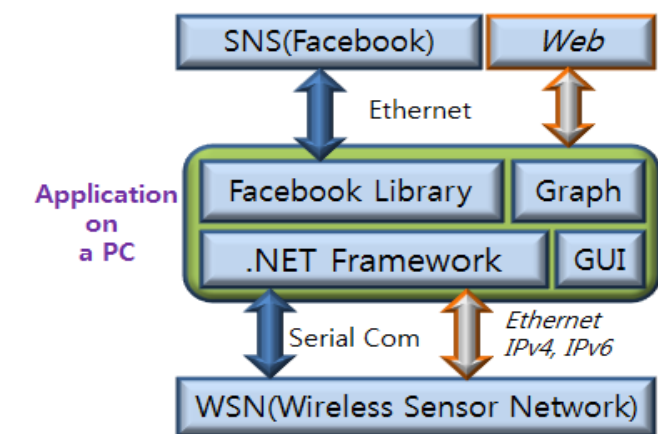


Figure 3. Block Diagram of our System

As mentioned above, the base station transfers all the data from sensor nodes to this application through serial communication. A certain amount of the data from WSN is displayed, saved and processed in order to make text and graph images in this application which is developed with Facebook C# SDK (Version 6.0.10.0), as shown in Figure 4. And then, the application periodically uploads the processed text and graph images. Users of the application can control the period of sampling time.

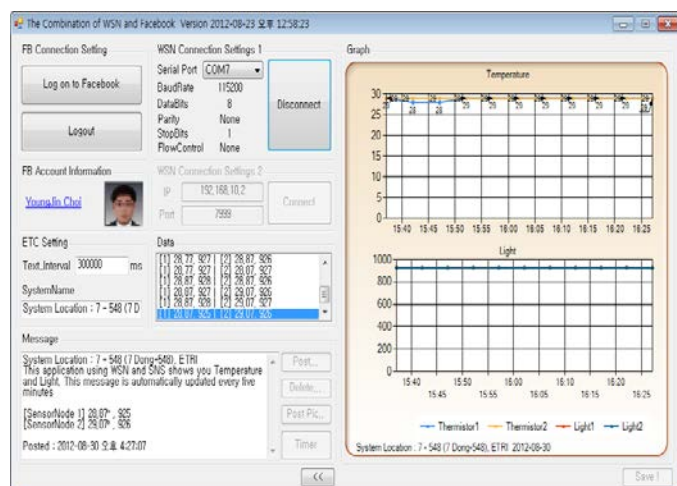


Figure 4. GUI of the Application

The application shown in Figure 4 consists of four features which is supported by Facebook C# SDK as follows:

- Log on / out
- Take and Renew an access token
- Post and Delete text
- Upload Images

In order to use Facebook C# SDK, developers need to log on to Facebook with user ID and password and then take AppID/API Key from Facebook developers webpage. The AppID is a unique identifier that ensures your application has the right level of security[12].

Logging on to Facebook, the application is allowed to get an access token by using AppID. When posting and deleting data, the application has to hold the valid access token. Due to the expiration deadline of the access token, this application renews the access token every five minutes. The SDK supports posting and deleting text and image on Facebook as well.

Figure 5 shows the flow chart of the application. Sensor nodes sample the data of their thermistors and light sensors every five minutes. After receiving all the sensory data from WSN, the application shown in Figure 4 posts the sensory data every five minutes and uploads graph images every two hours in order to show all the collected data for two hours. In the case of the text, whenever the application posts new text on Facebook, it deletes old one. Old text is not needed any more since we can analyse changes of sensory data through graph images.

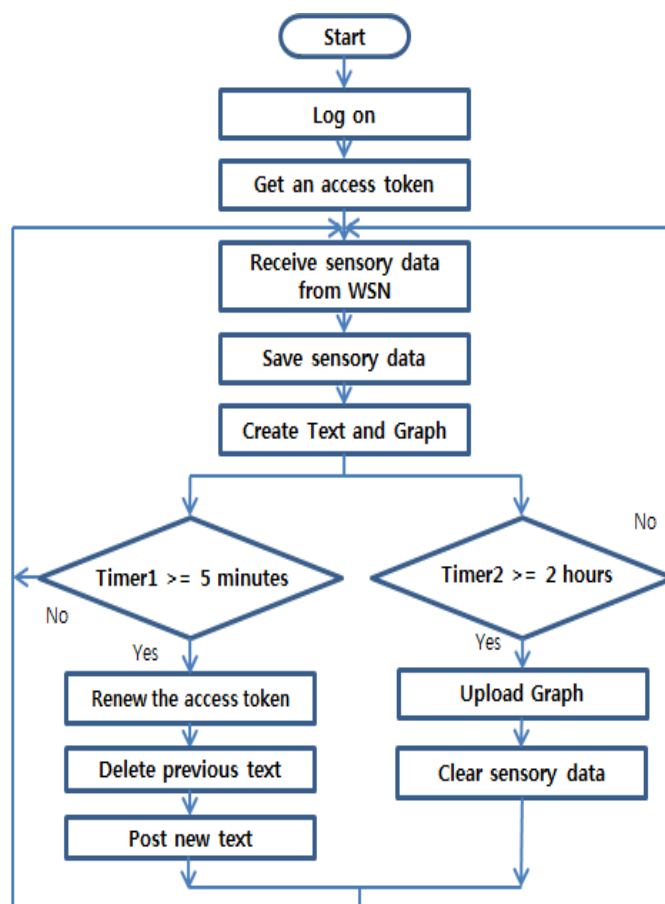


Figure 5. Flow Chart of the Application

C. Results of the Case Study

The experiments were conducted at a laboratory of ETRI (Electronics and Telecommunications Research Institute) and at Science Hall of UST (University of Science and Technology). Each WSN has an account on Facebook. Thus, as you can see and expect from Figure 6, three Facebook accounts were used: Ust, Etri and end user ID.

Figure 6 shows periodically posted text including system location, temperature and brightness from ETRI and UST.

If users who are interested in information from WSNs add an account of our proposed system as a friend on Facebook, they are able to manage or access to everything of WSN by smart devices such as smart phones, tablet PC and laptops.

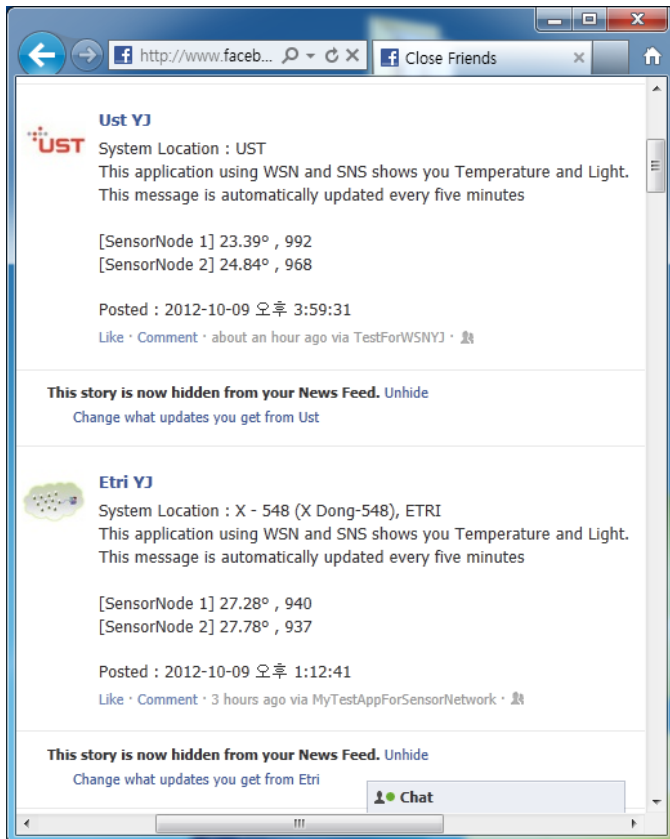


Figure 6. Text information on Facebook

Figure 7 shows a graph image. As you can see from graphs, indoor temperature and brightness of two sensor nodes are displayed. Since two sensor nodes are placed indoors when we conduct the experiments, most values from two sensor nodes are the same. In order to test whether our proposed system works properly, we powered off one of sensor nodes on purpose. As a result, the values of 'Thermistor2' and 'Light2' around 14:25 in the red rectangle on the graph dropped to zero. After seeing these values, we powered it on again. And then, we confirmed that it worked properly as Figure 7 shows. Compared with posted text shown in Figure 6, uploaded graph images are on display for everyone who added an account of this system unless an administrator deletes corresponding graph images on Facebook.

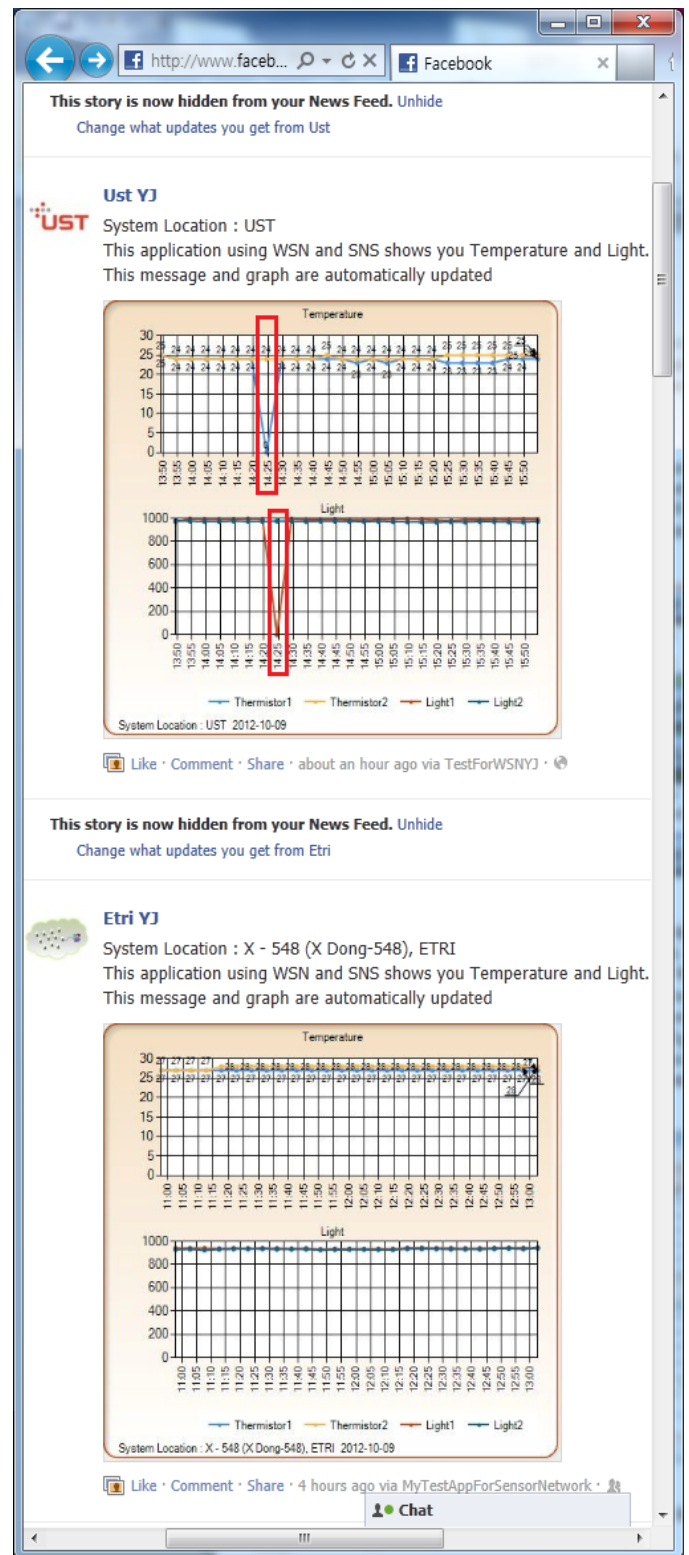


Figure 7. Graph on Facebook

D. Comparison of Differences

As we mentioned before, there is some work to do in order for developers to build up the system without SNS able to manage a single-WSN or multi-WSNs through only web. Table 2 is inserted for comparison of two different systems.

TABLE 2. COMPARISON OF TWO DIFFERENT SYSTEMS

	Without SNS	With SNS
Languages	HTML, XML, CSS, JavaScript, Ajax, etc.	C# (Language for SDK)
Need of Web Server	Yes	No
Need of Database Server	Yes	No
Implementation of security and authorization	Yes	No need (Included in SNS Platform already)

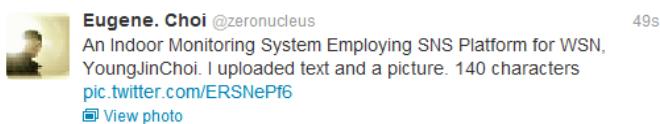
If our proposed method is used, some implementation work mentioned in Table 2 will be considerably reduced. It means that developers do not need to set up additional servers or learn more than two languages related to web technology, as shown in Table 2. In addition, developers desiring to build the system with Facebook will not have to take into account security and authorization problems on the Internet because most of the SNSs use OAuth (Open Authorization) which is an authorization framework for an HTTP service[5].

TABLE 3. COMPARISON BETWEEN OTHER APPROCHES AND OUR SYSTEM

	SoMoS & S-Sensors with Twitter	Our system with Facebook
Text limitation	Yes (Limited to 140 characters)	No
Images	No	Yes (for graphs)

In terms of functionality, our proposal has some advantages over other approaches such as SoMoS[4] and S-Sensors[6] as shown in Table 3. Text is limited to 140 characters per update in Twitter, which may cause overhead if there are lots of informations to be displayed. For example, if text has 200 characters, posting text twice is needed. It is possible to upload an image in Twitter, but users have to click either an address link or View photo link at least once in order to see an uploaded image as shown in Figure 8. However, as mentioned earlier, our proposed system is capable of posting more than 140 characters per update and uploading graph images in order to analyse changes of sensory data as shown in Figure 6.

Tweets

**Figure 8.** Posted text and picture on Twitter

V. CONCLUSIONS

In this paper, by using Facebook, we presented a method to monitor the sensory data and manage WSN effectively. For our research, a windows application for connecting WSN to SNS was developed. In addition, we implemented Indoor

Monitoring System by using our proposed method and application as a case study.

In the process of our research and experiment, we found out that developers do not need to take web languages or web/database servers into consideration and it is possible to connect other embedded systems to SNS as well. For these reasons, our proposed system has advantages over previous approaches. All things considered, the proposed method can be a good solution for delay-insensitive systems.

The ultimate purpose of our proposal is to save money and time. However, there is a trade-off relationship between these advantages and the increment of delay. Although we conducted small-scale experiments because of some experimental constraints such as the short distance of less than 1km between ETRI and UST and the small-scale testbed composed of two or three Sensor Nodes and laptops, the experiment was successful.

In the future, we will conduct the large-scale experiments and integrate WSN into both Twitter and Facebook at the same time for the sake of more flexibility.

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