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Wireless Sensor Network for Flood Level Notification

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Abstract.

Most of the area around Bangkok are surrounded by rivers and canals. Currently, some people living in such areas are exposed to water hazard. The ground level is somehow lower than sea level, causing severe flood in the city and along the canals in the inner area of the city during rainy season. We suggest Wireless Sensor Network technology as a warning tool during the flood. Our world is a world of communication and various technologies, such as mobile phones. Researchers realized the benefits of using wide range of network which can prevent and use as caution when there is flood in the cities, also to provide security check and give warning signs when flood or drought occurs. Prototype of flood warning model and forecast have already been analyzed.

1. Introduction

This research has benefited from the use of Arduino's predominantly wireless network system with water level measurement devices to provide protection and warning while flooding in Khlong Saen Saep community, Ports and communities, Bangkapi, Khlong Tan and Pratunam, and made security inspections [6]. Monitoring disaster and being vigilant when an emergency occurs. Flood or lack of water for people living in the area near the location of such situations. In prevention and mitigation of floods, there are several methods, each of which is suitable for certain local conditions, ability of defensive or alleviate floods. Also the impact on the environment of Saen Saeb Canal and area we used as a path for walking in our every day’s life as well as the cost of travelling quickly and the benefits are different, so before deciding to proceed with either method, all relevant conditions need to be considered and studied in details. Therefore, it will be a guideline to solve the problem of the tendency of the amount of water in the Khlong Saen Saep Canal [1]. In Bangkok the results of the study were used to develop a model and plan for measuring the water level in Khlong Saen Saep and then analyzing suitable statistical forecasting models for decision making [4]. We are using the technology available today as in the recent years, we are in the world of communication. There are various technologies such as mobile phone which have become more essential for business and daily life as well as demand for information and services which are necessary for business people. There are many technologies that meet those needs, such as mobile phones, notebook, computer Palm, which have been used so much and the benefits of using wireless networking are aware. Bangkok Drainage Department used to protect and warn during flooding in the inner city and make inspections and surveillance when there is flood or no water in the Saen Saep canal which will cause an impact on people. There are people living in an area near the remarked locations in Khlong Tan and Pratunam communities, where the wireless network will be useful for them and it will be small computer network [8] that consists of not many devices.

2. Collection of water level data in Khlong Saen Saep

The method for collecting water level data in Khlong Saen Saep was based on two groups of population, namely those in Klong Tan and Pratunam communities and Saen Saep Canal [1] considered under their daily occupation, which will begin with the following steps.

2.1 Preliminary Interview and Collect data of water level in each period

Conducting an opinion poll by interviewing; This is to ask for cooperation in all communities of the target group of the research [3]. The researcher asked opinions from people living in Khlong Tan and Pratunam areas to see the trend of demand and the need for the installation of equipment used to measure the water level in the canal and communities near the canal. The data will be used as a guideline for conducting research in collecting water-related data in the community area and the port of Khlong Saen Saep. After that start data collection of water level measurements for each period which must be used in accordance with the details of the data used in the study of the Bangkok Drainage Department. The timeline spent in collecting data on the water level in Khlong Saen Saep are divided into three periods to suit the needs of Bangkok's regular boat transportation. Data correlation process in a database used in a rising and falling of water level measurement system. By creating a gray model system as a predictor of the device for measuring the water level in the Khlong Saen Saep, it will work as a type of data that displays immediately after converting the signal sent to the notebook to display the results over time. Numbers and graphs of water intake makes it possible to remotely operate via a mobile phone when using this module for displaying the water level measurement data collection.

2.2 Building Water level measurement tool

Step 1: Component of measurement tool

1. Ultrasonic sensor
2. Arduino board
3. Wi-Fi Arduino
4. Computer
5. Mobile phone
6. Battery

Fig.1 Component of measurement tool

Step 2: Inspection of water level tool

1. Preparation of all equipment and assemble to create a water level meter and then test the system via a wireless notebook and install it with a contract that is simulated from a personal mobile phone as a prototype [6].

2. After completing the inspection of the water level tool, the researcher will evaluate the accuracy of the program on a wireless laptop to measure the water level and send it as data using the method of measuring the height from the canal's edge to the water surface [7] as in Figure 1.

Step 3: Data transmission process

Measure the water level and send it as data which uses the method of measuring the height from the canal's edge to the water surface. Normal values will be displayed on the application page. There is an example of the distribution of some data over time as a graph to calculate and forecast [4]. For example, time spent by most people by boat on the water, the changing situation of the water level in Khlong Saen Saep that causes flooding around Khlong Tan and Pratunam communities, and the height of water level that is not safe for people to travel. The process will show the water level data with basic methods of data mining, for example decision Tree [9,10]. The resulting classification model resembles an upside-down real tree with nodes.

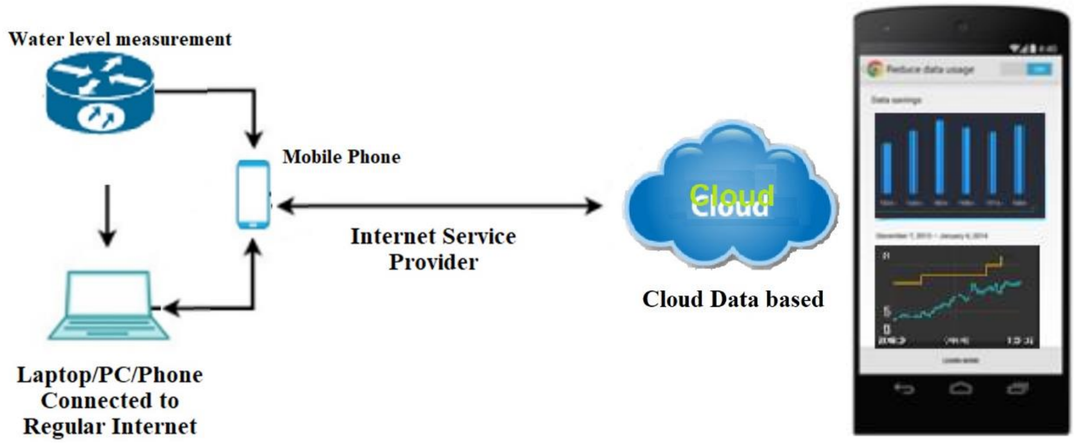

Fig. 2. Data transmission process base on laptop and Phone

3 Methodology

Building a water level measuring instrument can be divided into 2 steps: program to make tracking application and connect a water level measuring device (Arduino Wi-Fi) which shows the operation of the water level measuring device application program after getting a prototype developed and write programs on the simulation website of the application installation system. From http://localhost/... The system of XAPP 1.83 already uses IP address 192.168.1, 192.168.2 and 192.168.3 for easy way. We are installing Apache, PHP and MySQL for laptop workings [12].
Determine the water level data of the Bangkok drainage Department to arrange according to the variables of $X = (x(1), x(2), \dots, x(k), x(k+1), \dots, x(n))$ After that contain the value of $x(k)$ then the starting value $x(k+1)$ to accumulation generating of $x^{(1)}(n)$ under $k \leq (n-1)x^{(1)}(k)$ take $x^{(1)}(k)$ to manage sequence of $X^{(1)}$ under number k of $[x(k-1), x(k+1)]$ the water level data of the Bangkok drainage Department of grey model $X = (x(1), x(2), \dots, x(k), x(k+1), \dots, x(n))$ and Preliminary information consists of $X^{(0)} = (x^{(0)}(1), x^{(0)}(2), \dots, x^{(0)}(n))$ To use collation to accumulate generation data. accumulation and then $X^{(1)} = (x^{(1)}(1), x^{(2)}(2), \dots, x^{(1)}(n))$ and available formatting

$$x^{(1)}(k) + ax^{(1)}(k) = b \quad (1)$$

From equation 1 we call the initial model of the simulation GM(1,1) where the symbol used is GM(1,1) at the beginning. $Z^{(1)} = (x^{(1)}(1), x^{(2)}(2), \dots, x^{(1)}(n))$ then $Z^{(1)}$ is the computed sequence formed by $X^{(1)}$ Choose to calculate the average data as $z^{(1)}(k) = \frac{1}{2}(x^{(2)} + x^{(1)}(k-1))$, $k = 2,3,\dots,n.$ We have respectively to k under $z^{(1)}(k)$ Substitute the value of Equation 2.

$$x^{(1)}(k) + az^{(1)} = b \quad (2)$$

All components are called basic forms of the model of GM(1,1) [2]. Calculate water content predictions to be used to select future data to optimize and accurately process data from the starting point of the Yn group and the B matrix. Determine $X^{(0)}$, $X^{(1)}$, and $Z^{(1)}$ be the similar to above except

that $X^{(0)}$ is non-negative. If $\hat{a} = (a, b)^{(T)}$ is a sequence of parameters, and $$Y = \begin{bmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ \vdots \\ x^{(0)}(2) \end{bmatrix}, B = \begin{bmatrix} -z^{(1)}(2) & 1 \\ -z^{(1)}(3) & 1 \\ \vdots & \vdots \\ -z^{(1)}(n) & 1 \end{bmatrix} \quad (3)$$

then the least squares estimate sequence of the GM(1,1) model equation (2) satisfies

$$\hat{a} = (a, b)^{(T)} = (B^{(T)}B)^{(-1)}B^{(T)}Y. \quad (4)$$

(Liu and Lin, 2006, p. 199 – 202)

a) The solution, also known as time response function, of the whitenization equation $\frac{dx^{(1)}}{dt} + ax = b$ is given by

$$x^{(1)}(t) = \left(x^{(1)}(1) - \frac{b}{a}\right) e^{-at} + \frac{b}{a} \quad (5)$$

b) The time response sequence of the GM(1,1) model in equation(2) is given below:

$$\hat{x}^{(1)}(k+1) = \left(x^{(1)}(1) - \frac{b}{a}\right) e^{-ak} + \frac{b}{a}, k = 1,2,3, \dots n \quad (6)$$

The pointed multiple best graphics have been collected as database, the location to move to is shown for interval forecasting times from among these spaces. This hierarchical structure places the emphasis of the decision on the amount of water level at the Saen Saep canal [11], where distance is only considered after it has been determined that the water levels is shown to the high and low level at the previous warning network on mobile. This real-time scale showing water level with “rational maximizers” in any certain period of time will enable people to know and decide with the best available situation if they want to travel by boat.

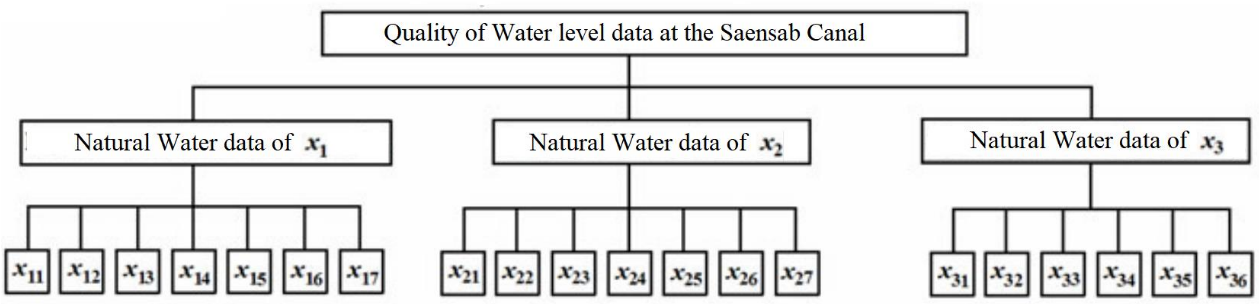

Fig. 3 The criteria system for evaluating the quality of water level data

Evaluation criteria to determine the water level. Based on the hierarchical structure [2] of the evaluation criteria system, we conducted a survey with relevant experts in order to construct the matrix of judgments, on which we obtained the water level as the criteria of different levels, see Figures. 3 for details.

Table 1. Warning Network from Arduino Index

Access to Access to water database transmission structure affect warning index from Arduino water level database mobile and laptop. affect warning index from Arduino transportation database to past mobile and laptop.	Water travel traffic benefits	Moderate scale	-Adaptability of water level and warning transportation network.
		Reasonable structure	-The index of coincidence precisely of correlation flooding in total forecasting -Mode share paying ratio, proportion coordination and work timing.
		Economic adaptation	-Coordination index of transportation investment and fixed assets investment - Network from Arduino Index with regional tools development
	Reduce travel adaptation Direct benefits	Direct benefits	-Time saving data between the farthest cities in the region -Contribution rate of transportation system to national travelers
		Potential benefits	-The impact on Regional flooding improve the ability of emergency response and disaster prevention and mitigation

This isolation is hierarchical in nature. The first identify mobile signal motion control transmitted signal internet-based mobile that includes all possibility of any component water data indicated in interval timing as shown in (x_1, x_2, x_3). The test then continues and, due to isolation limitations, a determination can be indicated by graph possibility consisting of water level and caution [3]. The Pointed multiple best Graphics have been collected as database, the location to move to is shown for interval forecasting times from among these spaces. This hierarchical structure places the emphasis of the decision on the amount of water level at the Saen Saep canal, where distance is only considered after it has been determined that the water level is shown to the high and low level at the previous warning network on mobile. This real-time scale showing water level with "rational maximizers" in any certain period of time will enable people to know and decide with the best available situation if they want to travel by boat.

4. Literature References

Huang CY, Lu CY, Chen CI [13] presented the grey forecasting model was based on the formulation of differential equation. The solution of differential equation as the form of exponential function which could fit observed data with more flexibility. Unlike linear regression, the GM(1,1) and NGBM could provide better forecasting precision. The Corresponding particular solution of $\mathrm{x}^{(0)}(\mathrm{k}) + \mathrm{az}^{(1)}(\mathrm{k}) = \mathrm{b}\left(\mathrm{z}^{(1)}(\mathrm{k})\right)^{\mathrm{n}}, \mathrm{k} = 2,3,4 \ldots$ together with initial condition

$$\hat{x}^{(1)}(1) = x^{(0)}(1) \rightarrow \hat{X}^{(1)}(K+1) = \left[\left(x^{(0)}(1)^{(1-n)} - \frac{b}{a}\right)e^{-a(1-n)k} + \frac{b}{a}\right]^{1/(1-n)}$$

Result of error analysis is needed for examining the precision of forecasted results and shown to Relative Percentage Error (RPE) compares the real and forecast values to evaluate the precision at specific time k. RPE is defined as

$$RPE = \varepsilon(k) = \frac{x^{(0)}(k) - \hat{x}^{(0)}(k)}{x^{(0)}(k)} \times 100\%$$

Examining the raw data, it shows linear characteristics as the increment is small sample size. The Modelling the data from year 2009 to 2012, the point errors are all greatly less than 1%. The average relative percentage error is only 0.074%. Precision is more than 99.9%. The data of year 2013 is served as the criteria for checking the forecasting precision. (Huang CY, Lu CY, Chen CI (2014) Application of Grey Theory to the Field of Economic Forecasting. J Glob Econ 3: 131. doi:10.4172/2375-4389.1000131)

Shuli Song [14] presented Grey system model values have use to study macroeconomic states and predict economic trends through quantitative economics measures and models. However, the massive amount of data in the macroeconomic model makes it extremely difficult to take full account of all the economic relations. This brings the demand for more effective utilization of existing human, material and financial resources in economic development and enterprise management with the aim of achieving more goals, which happens to be the main purpose of linear programming. As a result, general linear programming has been widely applied in various areas of the society. The limitations in the general linear programming can be resolved to a certain extent by the linear programming based on grey prediction. There was an original data column with the variable $x^{(0)}$ and generate first-order accumulated generation model $x^{(1)}$ Establish a differential equation based on the first-order grey model, Putting the $x^{(1)}$into the equation of $\frac{dx^{(1)}}{dt} + ax^{(1)} = b$

Thus, we computing: $\hat{x}^{(1)}(k+1) = \left(x^{(0)}(1) - \frac{b}{a}\right)e^{-ak} + \frac{b}{a}$ and then

$$\hat{a} = (a,b)^{(T)} = (B^{(T)}B)^{(-1)}B^{(T)}Y$$

The predicted value obtained by the prediction model is $\hat{x}^{(1)}(k+1)$. To determine the accuracy of the prediction, it is necessary to carry out a statistical testing. There are mainly two posterior differential test criteria: The first one is the difference ratio C, which is the ratio of residual variance to data variance, i.e.:

$$C = \frac{S_e}{S_x}$$

Where $S_e^2 = \frac{1}{n}\sum_j^n [e^0(j) - \bar{e}]^2$and $S_x^2 = \frac{1}{n}\sum_j^n \left[x^{(1)}(j) - \bar{x}\right]^2$

The secondary data is the small error probability $P, P = \{|e^0(j) - \bar{e}| < 0.6744S_x\}$

According to the above result of test methods, we can divide the level prediction results into four levels of Table 2.

Table 2. Division of prediction levels

Level of prediction accuracy	**C**	**P**
A. good	<0.35	>0.95
B. qualified	<0.5	>0.8
C. reluctantly	<0.45	>0.7
D. unqualified	$\geq$0.65	$\leq$0.7

The relationship between input and output of production is usually expressed by production functions, of which the Cobb Douglas function is the most widely used one [15-16]. It is expressed as: $Y = AL_{\alpha}K_{\beta}$ Because the technical level of production is changing over time, the production function can be expressed as: $\mathrm{Y = F(K, L, t)}$

Where K and L can be regarded as function of t. By taking the derivative of time, we can obtain: $\frac{dY}{dt} = \frac{\partial F}{\partial K}\frac{dK}{dt} + \frac{\partial F}{\partial L}\frac{dL}{dt} + \frac{\partial F}{\partial t}$ with the application of the GM (1,1) model, we can obtain that

$$\hat{a} = (a, b)^T = (-0.0277555, 4.392743)^T$$

Thus, the prediction model is: A(1)(k+1)=194.5364e0.023548643k-192.4325. Based on this model, we make a prediction of the technical level of the enterprise in 2007-2019. The target benefit (investment recovery): f = RMB 231,900 yuan (2015); The average investment recovery rate =23.19÷72.3=0.468; The calculated results show that: the investment benefit is higher in 2015 than in 2014 and the average investment return rate has increased by 3.23%. The grey prediction, which may be using by more scientific, advanced and practical than general linear programming. Mainly, the constraint value is time-variant; secondly, the model's coefficient changes in a certain range; thirdly, the objective function can be prototyping a relative optimization value; finally, the model provides a lot of useful business data, leaving a high standard of freedom for decision-makers.

Luan et al. [15] analyzed the impact of comprehensive transportation formation under the comprehensive transportation level, obtains transformation data to four comprehensive transportation modes, establishes a data set, and analyzes and discusses the coupling and coordination of multiple transportation modes. Interesting out the small comings in the coordinated development of the waterway and highway subsystems. According to the shortcomings, the multi-level evaluation method is used to construct the comprehensive transportation policy effect multi-level evaluation method is used to construct the comprehensive transportation formation effect evaluation model under the comprehensive transportation level, so as to complete the comprehensive transportation policy effect analysis, which is a multimodal transportation. Acquire an increasing number or quantity of. operational policy formulation, management planning, etc. to provide useful reference and guidance.

Ma et al. [16] proposed data of study method for analyzing the effect of comprehensive transportation policy based on analytic hierarchy process. First, analyze the current situation of transportation development, and collect comprehensive transportation policy effect evaluation indicators based on the analysis results. Based on the evaluation indicators, calculate by analytic hierarchy process the comprehensive transportation information effect evaluation weight is used to construct the comprehensive transportation policy effect evaluation model based on the calculation results, so as to complete the comprehensive transportation policy effect analysis based on the analytic hierarchy process.

5. Conclusion

Bangkok is facing an important point of frequent flash floods during the rainy season. The reason was that the drainage of Bangkok is incomplete. The initial amount of water will flood roads and block transportation near Khlong Tan and PratuNam communities. The officials used to inform the residents and pedestrians on the road to be careful when travelling. During the rainy season, there are floods along the Saen Saeb canal in the inner area of Bangkok. Consequently, people in the community and ~~for~~ people who more or less choose to travel by boat of Bangkok along Ramkhamhaeng Road and New Petchaburi Road have to inevitably face the heavy traffic jam. But during the rainy season, there are always problems with water levels that go up and down according to the amount of rainfall, this causes the researchers to study and see the necessity to create the water level measurement tools to be used in public and enable easily accessible from applications located on the website which can be downloaded. For people, there were travel warning application, water level even if it's raining heavy. the installation of this tool and the need to use various technologies such as mobile phones. A variety of brands of tablets that are essential to both business and daily use. Demand for information and services has been used a lot and see the benefits of using it. Extensive wireless networks are used for flood prevention and warning and monitoring in the inner city. and surveillance when there is a flood or there is no water in the Saen Saep Canal. Therefore, creating a wireless network for people in Khlong Tan, Ramkhamhaeng and Pratunam communities will be a way of solution, which will be a small computer network that consists of not much equipment and are often confined to a single building or building in the same neighborhood. The most interesting point of a wireless network is the mobility of use that does not have to be stuck in place. Users can easily move around while still communicate in the network.

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