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[1]K. S. Krasnikova,
[2]V. A. Kopaniev,
[3]M. P. Vasylenko

SMART LEAKAGE MONITORING SYSTEM WITH BLYNK IoT INTEGRATION USING ARDUINO

[1,2,3]Aviation Computer-Integrated Complexes Department, National Aviation University, Kyiv, Ukraine
E-mails: [1]katkras@email.ua, [2]tennobi@yandex.ru, [3]m.p.vasylenko@nau.edu.ua ORCID 0000-0003-4937-8082

Abstract*—The article is devoted to the solution of the current problem of leaks in pipelines and minimizing their consequences. A practical experiment of wireless monitoring and control of an intelligent microgrid prototype was carried out, which was implemented using various communication protocols based on technical requirements, such as security, data rate, coverage area and program type. The prototype can be implemented using different communication protocols based on technical requirements such as security, data rates, coverage area and type of application. This article presents a methodology for the application of the Smart Water technology to detect water leakage. Analysis of real-time data has allowed the verification of water balance and the estimation of water losses level in the network. This data analysis methodology provides the capability to detect the pipe bursts quickly, thereby reducing the runtime of leakage.*

Index Terms—Ultrasonic sensor; humidity sensor; water presence sensor; Blynk; pipeline; leakage detection; Arduino.

I. INTRODUCTION

The flow of modern life is too fast and there is usually no time to solve the little things. The solution to this problem is the so-called "smart home". The "Smart home" system is a robotic engineering system capable of controlling the functionality of the system with the help of sensors. In the simplest version, the management of engineering communications is implemented: heating, ventilation and air conditioning system to provide the required parameters of the microclimate, electrical supply, lighting control, security system. In this article the system of automatic protection against leaks is considered directly.

Unfortunately, no one is immune from sudden pipeline ruptures. Reasons for leakage can be many. For example, this could be a human factor, in the case when a person forgot to shut off the water supply, could be a wear and tear of engineering networks of water supply systems and sanitary equipment. This may be due to insufficient quality of plumbing equipment and / or installation work, as well as leaks may be due to clogged pipes. As mentioned above, there can be many reasons for leakage, but the result is always the same, and it is always completely unwanted.

Therefore, effective detection of leaks, knowledge of the position of the leak, and subsequent rehabilitation of the pipe could potentially save a large amount of water. In addition, it will save the person a lot of money.

But the water leakage is not just an economical issue as it is often perceived and presented but it is also an environmental, sustainability and potentially a health and safety issue. For example, water entering electrical appliances or outlets can cause a short circuit and, in the worst case, a fire. Flood and fire at the same time is too much, isn't it? And if it also happened while you sleep, the consequences of all this and does seem terrible.

There are many different ready-made systems. Among the ready-made systems can be identified Neptune, Aqua Control, AquaStop, Gidroblock and others. Some are wired, some are wireless. Some more expensive, some cheaper. Advantages and disadvantages of each of the presented system. As for the proposed system in this article, it has a number of advantages. First, different choice of sensors (ultrasonic, water presence and humidity sensors). Second, price. In contrast to the above systems, the cost of the presented is not so great. Third, reliability, because if one sensor does not work, then there are two others, which means the leak will be able to detect and react in time.

II. PROBLEM STATEMENT

The main task of this work is to create, based on the Arduino electronic platform, a instrument for notification of unforeseen situations, such as a leakage or a flood, important data acquisition, then storing and processing information. Also

1) Determine the structure and parameters of the future system.
2) Choose a optimal set of technical means.
3) Definition significant caution levels.
4) Determine the reliability of the system.

It is necessary to create this system rely upon reliability, and the cost level of this system must be not significant.

III. PROBLEM SOLUTION

The development of a smart leakage monitoring system can be divided into two parts which are software and hardware. The methodology involved is discussed as follows:

A. Block Diagram

Figure 1 shows the overall block diagram of the system. Initially, first microcontroller attached with ultrasonic, water presence and humidity sensor will detect the leakage level. The data will be send to Blynk application via wireless connection. The data also will be display in the Blynk application. At the same time, the stored data in a CSV database be converted into excel form, as well as being transmitted to the microcontroller via Blynk Bridge. This data will alert the local authority for further action once the level reaches warning and critical level which triggers LED.

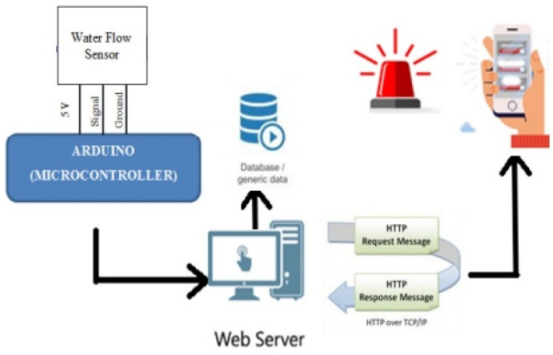

Fig. 1. Block diagram of the system

Using AHM (Analytic hierarchy method) we obtain the weighs of each sensor in our system (Table I).

Using the gain values we can prioritize the importance of our sensors and build the caution levels of system (Table II).

TABLE I. THE ANALYTIC HIERARCHY METHOD VALUES

	Water presence	Humid.	Ultrason.	Vector weight	Weight
Water presence	1	9	6	3.78	0.76
Humid.	1\9	1	1\4	0.30	0.06
Ultrason	1\6	4	1	0.87	0.18
sum				4.95	1

TABLE II. THE CAUTION LEVELS OF SYSTEM

	Safety level 0–10 pts	Warning level 11-18 pts	Critical level 19–25 pts
Water presence	-	+ (in case of activation 15 pts)	++ (in case of activation 15 pts)
Humid.	0–5	6–10	11–25
Ultrason.	0–7	8–15	16–25

B. Blynk Application, Blynk bridge and Database and Hardware Schematic Design

In Figure 2, the water level detection process uses an additional component of an application via a mobile device. Previously the user must login with an account that has been created by the server. So it can login to the application and receive information provided by the server periodically and quickly. If the water level reaches the safe threshold point, a warning will appear immediately to the point of location. There are details that are accompanied by tips in certain conditions related to the condition when reaching a certain status. In this mobile application added with notification, so without opening the application the user can know the condition of the height and speed of water through the notification received.

In the Figure 3 the measurement device and web server monitoring are interconnected with wireless connection using Wi-Fi shield module. In the process of data transmission or communication between sensors with the web using HTTP protocol and this communication occurs in the form of request and response. To send commands to turn on leakage warning alarms that exist in residential areas, the sensor will send a Get-Request command to the web server, while the web when receiving the Get-Request command will respond by sending http-response command. When the water condition is in a normal state between the sensor and the web is still connected.

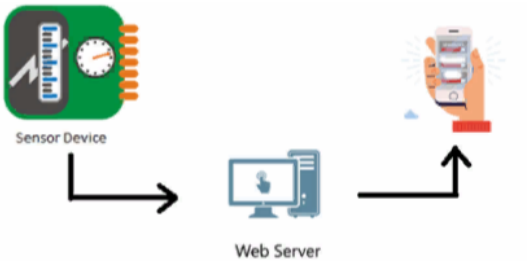

Fig. 2. The system design

Blynk is a platform with IOS and Android application to control Arduino, Raspberry Pi with access of Internet. It's a digital dashboard where it can build a graphic interface for the user by simply drag and drop the widgets. Blynk bridge is another way to communicate between two ESP8266 modules or it is ESP8266 to ESP8266 Communication. It can interconnect all its projects using the cloud Blynk server as a live central transaction manager. At the same time, the database also was created in this Blynk application for the purpose of recording the leakage level sensed by the ultrasonic and humidity sensor (Fig. 4).

Fig. 3. Communication process between the Sensor and Web Server

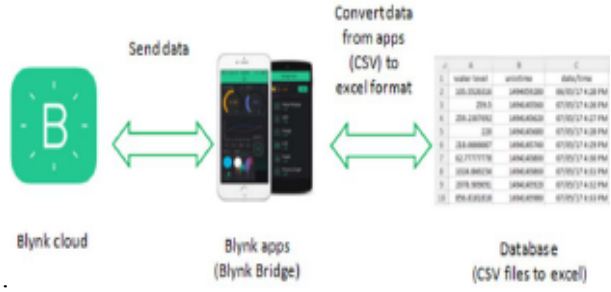

Fig. 4. The flow of database via Blynk application

Figure 5 shows a schematic diagram for microcontroller.

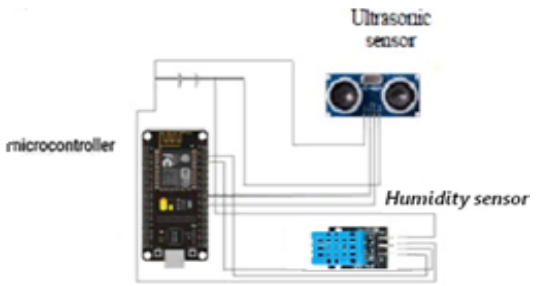

Fig. 5. Schematic diagram for microcontroller

C. *Flowchart*

From the flowchart in Fig. 6, at microcontroller, ultrasonic sensor will detect the amount of water; there will be three states which are level 1, level 2 and level 3. At microcontroller, the data sensed by the sensor will be display at the Blynk application reflecting the level indicator as well as the distance. Once the data being received by the microcontroller, when level 1 detected there were nothing happen, level 2 LED will blink, lastly, at level 3 LED turn ON – comes the notification on the phone that there was a leak. If the ball valves equipped with an electric drive are added to the system, the water will automatically overlap when the signal is given.

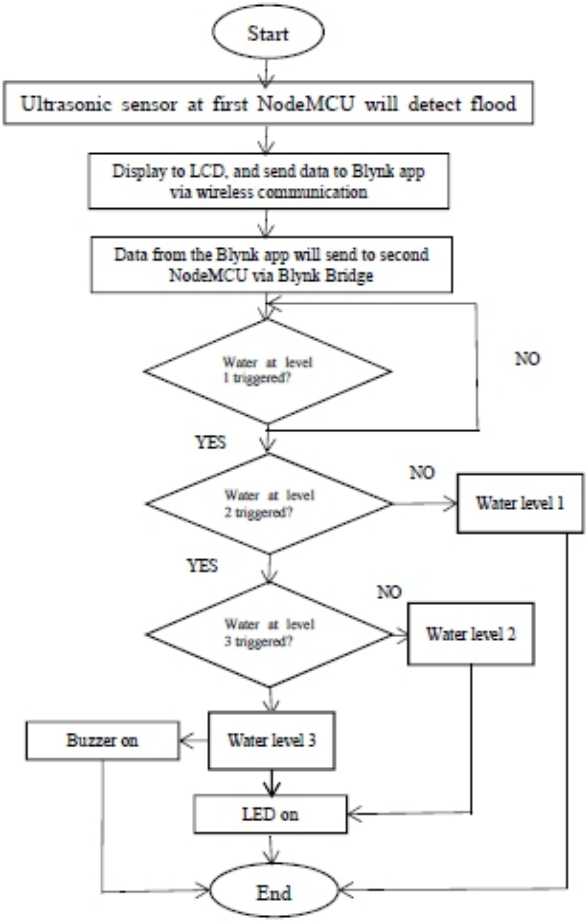

Fig. 6. Flowchart of the system

IV. RESULT AND DISCUSSION

After setting up the project has been completed, it was ready to be tested. The measured data were displays through the Blynk application and it can be possible to record in database developed in this Blynk application. This prototype was tested and the results obtained from the experiment are discussed below.

A. *Blynk Application*

Figure 7 shows the measured data from the ultrasonic sensor from the microcontroller in Blynk application platform. There are three mode displays reflects on the screen of the smart phone using Blynk application. On the screen, it displayed level of water either in safety, warning or critical level to alert the person-in-charge. The congestion of the water is also displays on the widgets which used LED as the indicator (green for safety, orange for

warning and red for critical). The history graph can be used to track the flood level over the time.

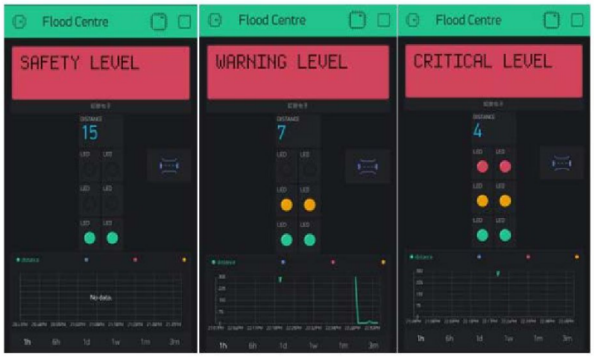

Fig. 7. Blynk application

B. Database

The database is used to store the data tracked by the history graph. The data which in a form of CSV will be converted in excel format as shown in Fig. 8. All the information is required in order to monitor the leakage level and for future improvement of the system.

Congestion	Unixtime	Data/Time
4.00	1494427680	02/16/19 10:48
4.5	1494427740	02/16/19 10:49
5	1494427860	02/16/19 10:51
6	1494427980	02/16/19 10:53
6.6	1494428100	02/16/19 10:55
7	1494428160	02/16/19 10:56
7.5	1494428220	02/16/19 10:57
8	1494428340	02/16/19 10:59
8.6	1494428460	02/16/19 11:01
9	1494428520	02/16/19 11:02
9.8	1494428760	02/16/19 11:06
10	1494428820	02/16/19 11:07
10.8	1494429000	02/16/19 11:10
11	1494429060	02/16/19 11:11
11.7	1494429300	02/16/19 11:15
12	1494429360	02/16/19 11:16
12.7	1494429600	02/16/19 11:20
13	1494429660	02/16/19 11:21
14	1494429900	02/16/19 11:25
14.7	1494430140	02/16/19 11:29
15	1494430200	02/16/19 11:30
15.9	1494430440	02/16/19 11:34
16	1494430500	02/16/19 11:35
16.6	1494430600	02/16/19 11:30

Fig. 8. The example of history graph of water level in Blynk application

C. Web-server of Leakage Monitoring System

Figure 9 illustrates the web-server of leakage monitoring system.

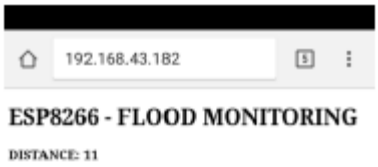

Fig. 9. Web-server of the system

D. Test Rig

To test the effectiveness and the accuracy of this prototype, were it has been conducted. This experiment was conducted in a private house (Fig.10 and Fig.11).

Fig. 10. The response of water level

Congestion	Unixtime	Data/Time
25.2	1496474040	02/16/19 15.14
23	1496474160	02/16/19 15.16
20.1	1496474220	02/16/19 15.17
17.7	1496474400	02/16/19 15.20
17.7	1496474580	02/16/19 15.23
17.7	1496474880	02/16/19 15.28
23.8	1496474940	02/16/19 15.29
20.1	1496475060	02/16/19 15.31
16.64	1496475180	02/16/19 15.33
20.4	1496475240	02/16/19 15.34
20.5	1496475300	02/16/19 15.35
23.8	1496475360	02/16/19 15.36
16.1	1496475420	02/16/19 15.37
20.6	1496475480	02/16/19 15.38
25.6	1496475660	02/16/19 15.41
20.4	1496475900	02/16/19 15.45
17.9	1496476020	02/16/19 15.47
22.7	1496476140	02/16/19 15.49
22.8	1496476200	02/16/19 15.50

Fig. 11. Datalog of notifications about significant levels

V. CONCLUSION

Currently, leakage monitoring technologies are expensive, limited in their application, and for the most part proprietary. Thus, the reality of expensive and proprietary remote monitoring technologies holds hostage the viability of corresponding systems in developing countries. It is arguable that such

systems can be developed using non-customized hardware and open source software that can be obtained and run anywhere in the world.

This project based on the development of a smart leakage monitoring system using ultrasonic sensor with microcontroller and Blynk application which also including humidity sensor.

Refer to above data show that application can be used as a solution for real time water level monitoring process along with leakage alert status. The system also easy to use and the information of system is very useful for people to prepare any condition from disaster effect.

By using the Blynk application, the information can easily be accessed by the person-in-charge. Transmission of information dataflow realized by wireless connection to Blynk IoT application and then it stored in own database. Each significant level of water leakage can by notificated by application. The database of this system is based on the history graph in Blynk and also in excel format form.

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Krasnikova Katerina. Student.
Aviation Computer-Integrated Complexes Department, National Aviation University, Kyiv, (2019).
Research interests: control systems, Applied Mathematics, Robotics, Complex Data Acquisition.
Publications: 2
E-mail: katkras@email.ua

Kopaniev Vladyslav. Post-graduate student. Master.
Aviation Computer-Integrated Complexes Department, National Aviation University, Kyiv, Ukraine.
Education: National Aviation University, Kyiv, Ukraine, (2019).
Research interests: Automatic control systems, Applied Mathematics, Wind/Solar power plant, Data Acquisition.
Publications: 9.
E-mail: tennobi@yandex.ru

Vasylenko Mykola. orcid.org/0000-0003-4937-8082
Candidate of Science (Engineering). Associate Professor.
Aviation Computer-Integrated Complexes Department, National Aviation University, Kyiv, Ukraine.
Education: Kyiv National University of Technologies and Design, Kyiv, Ukraine, (2012).
Research interests: renewable energy sources, thermal noise based estimation of materials properties.
Publications: more than 20 papers.
E-mail: m.p.vasylenko@nau.edu.ua

К. С. Краснікова, В. О. Копанєв, М. П. Василенко. Використання Arduino в системі моніторингу протікань водопроводу з інтеграцією в середовищі IoT Blynk

Статтю присвячено вирішенню актуальної проблеми протікання в трубопроводах та мінімізації наслідків. Запропоновано систему автоматичного захисту від протікання, виконану на базі Arduino і з використанням платформи Blynk, як середовища обробки даних. Проведено практичний експеримент бездротового моніторингу та керування прототипом інтелектуальної мікромережі, який реалізовано з використанням різних протоколів зв'язку на основі технічних вимог, таких як безпека, швидкість передачі даних, зона покриття та тип програми. Аналіз даних у режимі реального часу дозволяє перевірити водний баланс і оцінити рівень втрат води у мережі. Ця методологія аналізу даних забезпечує можливість швидкого виявлення розривів труби, а отже зменшує час витоку.

Ключові слова: ультразвуковий датчик; датчик вологості; датчик наявності води; Blynk; труби; виявлення протікання; Arduino.

Краснікова Катерина Сергіївна. Студентка.
Кафедра авіаційних комп'ютерно-інтегрованих комплексів, Національний авіаційний університет, Київ, Україна.
Освіта: Нацональний авіаційний університет, Київ, Україна, (2019).

Напрям наукової діяльності: автоматичні системи управління, прикладна математика, вітроенергетичні установки.
Кількість публікацій: 1.
E-mail: katkras@email.ua

Копанєв Владислав Олександрович. Аспірант. Магістр.
Кафедра авіаційних комп'ютерно-інтегрованих комплексів, Національний авіаційний університет, Київ, Україна.
Освіта: Нацональний авіаційний університет, Київ, Україна (2019).
Напрям наукової діяльності: автоматичні системи управління, прикладна математика, вітроенергетичні установки.
Кількість публікацій: 9.
E-mail: tennobi@yandex.ru

Василенко Микола Павлович. orcid.org/0000-0003-4937-8082
Кандидат технічних наук. Доцент.
Кафедра авіаційних комп'ютерно-інтегрованих комплексів, Національний авіаційний університет, Київ, Україна.
Освіта: Київський національний університет технологій та дизайну, Київ, Україна (2012).
Напрям наукової діяльності: відновлювальні джерела енергії, оцінка властивостей речовин та матеріалів за власними електромагнітними випромінюваннями.
Кількість публікацій: більше 20 наукових робіт.
E-mail: m.p.vasylenko@nau.edu.ua

К. С. Красникова, В. А. Копанев, Н. П. Василенко. Использование Arduino в системе мониторинга протечкек водопровода с интеграцией в среде IoT Blynk

Статья посвящена решению актуальной проблемы протекания в трубопроводах и минимизации их последствий. Предложенная система автоматической защиты от протечек, выполнена на базе Arduino и с использованием платформы Blynk как среды обработки данных. Проведен практический эксперимент беспроводного мониторинга и управления прототипом интеллектуальной микросети, который реализован с использованием различных протоколов связи на основе технических требований, таких как безопасность, скорость передачи данных, зона покрытия и тип программы. Анализ данных в режиме реального времени позволяет проверить водный баланс и оценить уровень потерь воды в сети. Эта методология анализа данных обеспечивает возможность быстрого выявления разрыва трубы, таким образом, уменьшает время выполнения утечки.
Ключевые слова: ультразвуковой датчик; датчик влажности; датчик наличия воды; Blynk, трубы; обнаружение протечек; Arduino.

Красникова Катерина Сергеевна. Студентка.
Кафедра авиационных компьютерно-интегрированных комплексов, Национальный авиационный университет, Киев, Украина.
Образование: Национальный авиационный университет, Киев, Украина, (2019).
Направление научной деятельности: автоматические системы управления, прикладная математика, робототехника, комплексный сбор данных.
Количество публикаций:2.
E-mail: katkras@email.ua

Копанев Владислав Александрович. Аспирант. Магистр.
Кафедра авиационных компьютерно-интегрированных комплексов, Национальный авиационный университет, Киев, Украина.
Образование: Национальный авиационный университет, Киев, Украина, (2019).
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Количество публикаций: 9.
E-mail: tennobi@yandex.ru

Василенко Николай Павлович. orcid.org/0000-0003-4937-8082
Кандидат технических наук. Доцент.
Кафедра авиационных компьютерно-интегрированных комплексов, Национальный авиационный университет, Киев, Украина.
Образование: Киевский национальный университет технологий и дизайна, Киев, Украина, (2012).
Направления научной деятельности: возобновляемые источники энергии, оценка свойств веществ и материалов по их собственным электромагнитным излучениям.
Количество публикаций: больше 20 научных робот.
E-mail: m.p.vasylenko@nau.edu.ua