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Arduino-based Disaster Management Alarm System with SMS

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***Abstract*—The Philippines suffered from an inexhaustible number of deadly typhoons, earthquakes, volcano eruptions making it a country prone to natural disasters. Natural causes are inevitable but having a warning device to alert people and prepare them from what's about to come is essential today. In this paper, the Arduino-based disaster management system is proposed. The device created is a disaster management device that consists of temperature, soil drift, accelerometer, tilt, and rain sensor. A hardware prototype model was developed. It is operated through microcontroller Arduino and implemented using the C language. The effectiveness of the proposed method is verified by experimental studies. If a sensor is activated, it will send data to the selected receiver, which is a mobile phone. Acquired data were provided in this article. Results reveal the effectiveness and efficacy of the proposed system. An expressive future directive has been incorporated at the end of this paper.**

***Keywords*—Arduino, C, disaster management, SMS, sensors**

I. INTRODUCTION

Over the years, new technologies have been introduced to improve first responders' efficiency and effectiveness, further expanding the role that technology plays in aiding disaster relief. Knowledge and the dissemination of information are crucial in what seems like a constant string of natural disasters. Rapid technological developments in several fields [1]-[7] ensure that both emergency response teams and survivors are better equipped to address the immediate challenges a natural disaster poses.

The Philippines is one of the world's most natural hazard-prone nations [8]. Due to population growth, shifts in land-use patterns, migration, unplanned urbanization, environmental degradation, and global climate change, the country's social and economic costs of natural disasters are increasing. Reducing the risk of disasters will be key to achieving the development goals in the Philippines. There is a need for a device that monitors and sends early warning systems that are usually unable to autonomously detect and interpret disaster signals in either non-real time or real-time [9]-[16].

In the previous study [17], the proposed system detection portion consists of a microcontroller and capacitive sensor to detect the occurrence of the tsunami. The theory is that there is an unprecedented rise in pressure in the seafloor on the arrival of Tsunami or any other natural calamity of this sort. A proximity capacitive sensor is used here, which provides performance depending on the capability variations, and a microcontroller was used to announce the oncoming Tsunami event to a person concerned through mobile computing. The simulations of the Earthquakes and Tsunami through GSM Network by G. Saradha [18], a seismic alert system based on GSM which could warn against if an earthquake occurs, without warning Earthquakes to strike. The potential damage can be reduced and lives can be saved if people in the area vulnerable to earthquake are already prepared to withstand the impact. It includes a warning from the earthquake's arrival before strong ground motion. Such a warning system is feasible because it moves slower than light due to the energy wave emitted at the earthquake epicenter. The earthquake epicenter warning signal can be transmitted via the satellite communication network, fiber optics network, pager service, cellphone networks, or the combination of these to different locations. In another study, the wireless sensor network for landslide assessment conducted by Ramesh, *et al.*, [19] and [20]-[22] in which natural disasters are rising worldwide due to the climate change and global warming. It was focused on catastrophe and landslides. This disaster, however, is mostly unpredictable and happens within a short time [23]. The software needs to be re-established in capturing appropriate signals with a small delay in monitoring [24]-[27]. The core of this project lies in using a GSM, Zigbee, and sensor. Each sensor have mounted a Zigbee transmitter with it. When landslide occurs, the sensor senses the signal and transmits data to the coordinator via a router. GSM and Zigbee receivers were coordinating. In some other studies, microcontroller was involved in disaster management, monitoring, and even firefighting. In [28], the AT89S52 was used as a controller for the robot for firefighting utilizing the ultrasonic and ultraviolet sensors. In paper [29], the general concept of robotics has been applied for human seeking as part of the disaster management system. Several sensors were used such as PIR, ultrasonic, and gas sensors to check poisonous gases during operations. In another paper [30], the house monitoring was proposed to ensure security order, environmental hygiene, among others. Arduino along with some security sensors were used for partial automation and monitoring of a residential house.

In this research, a disaster management alarm system to detect and notify the user using a cellphone was developed using Arduino Uno. A design prototype uses various sensors: temperature sensor, earthquake sensor, rain sensor, and tilt sensor. Once the sensors have been activated, SMS will be sent to the users and notified through the message.

The system is useful to monitor disaster and prevent the risks in line with it. Landslide management is an important issue relevant to hill slides [31]. Examples are in mountain regions of the Cordillera, Philippines. This work is beneficial to the region, especially during rainfalls. If sloping areas are completely saturated by heavy rainfall, landslides will occur several times over. The use of this system will serve as a warning device before rock falls due to the landslides. Also, this system is useful for earthquake-prone areas such as in Davao and Batangas. It also provides a tsunami warning system that can be used in advance to prevent loss of lives and damages.

This paper is structured as follows. Section II presents a discussion of the project. Experimental results are shown and discussed in Section III. A conclusion is finally given in Section IV.

II. METHODOLOGY

A. *General Block Diagram*

The prototype design has five sensors. The temperature sensor (LM35) for temperature collection. Sensor angle or tilt which gives the slope angle readings if there is any movement in the landslide and is also used for tsunami purposes. A rain gauge sensor is used in order to collect the depths of water. Earthquake sensors are used for earthquake purposes. Soil drift sensor is used for the landslide. The circuit should test the resistance to the soil. If there is any drift or change, the data will be sent to the microcontroller module for further data processing. For data collection, these sensor nodes are connected to the Arduino. The LCD display is installed in the prototype at the receiver side, which serves to alert people. This includes GSM wireless communication technology and able to inform quickly the user, or to the responsible authority if the sensor is activated. Fig. 1 shows the block diagram.

Fig. 1. General block diagram of the system.

B. *Schematic, PCB Layout, and Experimental Set-Up*

Figure 2 shows the schematic diagram of the disaster management project. It shows the connection of the sensors to the Arduino that was used. Figure 3 presents the layout of the connections when placed in a PCB. This was the layout that was printed in the PCB and it was used in the project. Figure 4 illustrates the layout connections in breadboard and in Figure 5, it shows the setup or connections of the sensors and the Arduino during the testing process. Figure 6 shows the text messages received during the testing period. This shows that the tilt sensor has been activated during the testing of the project. During this case, the project as well as the Arduino was connected to the power supply for turning on.

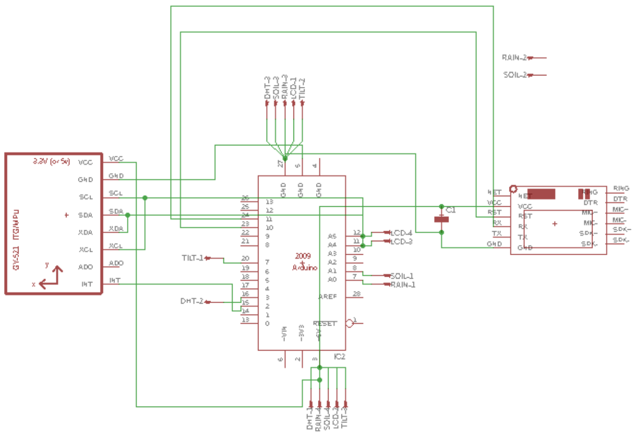

Fig. 2. Schematic diagram.

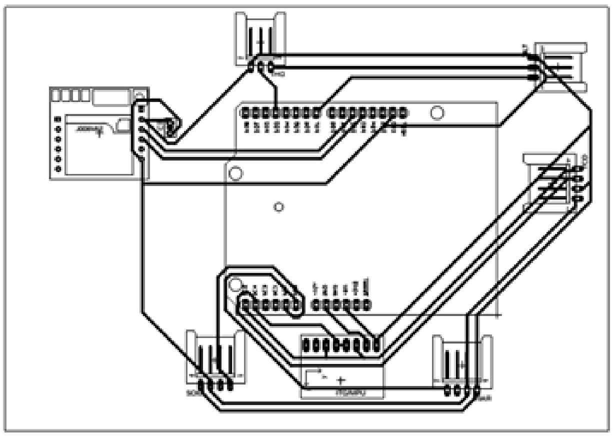

Fig. 3. PCB circuit layout.

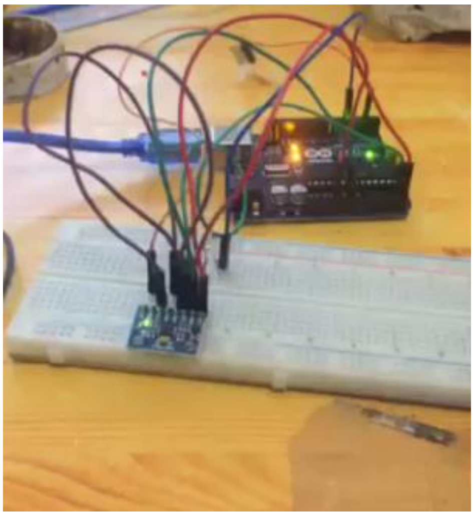

Fig. 4. Breadboard layout.

III. Results and Discussion

The graphical data provided representation of the output results of each sensor. The data proved reliable due to the consistency of the results. With the binary nature of the output of the sensors, excluding the soil humidity and temperature, the outputs can be considered reliable to provide an accurate analysis of the surrounding area. Figure 7 shows some data result of testing when the sensors and Arduino are connected to the power supply. The readings show

Fig. 5. Experimental Set-up.

Fig. 6. SMS received data.

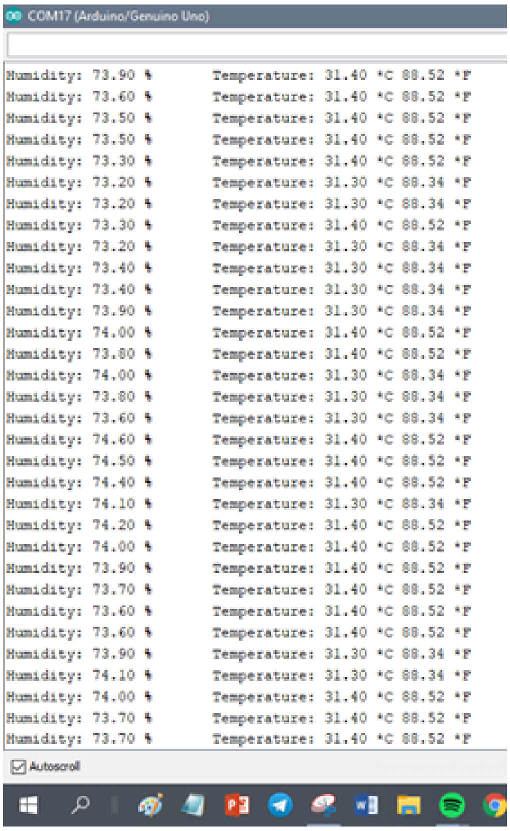

Fig. 7. Serial output data.

TABLE I. Results of Evaluation.

Trial	Temp (°C)	Soil Humidity	Tilt	Accelerometer	Rain Steam
1	17	25%	On	Off	On
2	18	22%	Off	On	Off
3	17.5	36%	On	Off	On
4	20	65%	On	On	On
5	21	45%	Off	On	Off
6	21	9%	On	Off	On
7	21	12%	Off	On	Off
8	25	4%	Off	On	On
9	25	7%	On	On	Off
10	25	99%	Off	Off	On
11	25	76%	On	Off	On
12	27	14%	Off	On	On
13	27	87%	On	On	Off
14	17	30%	Off	Off	On
15	17	45%	On	On	Off
16	17.5	42%	Off	On	On
17	17.5	97%	On	Off	Off
18	18	88%	On	On	On
19	18	82%	Off	Off	Off
20	17	80%	On	Off	Off
21	25	95%	Off	On	On
22	25	57%	On	On	On
23	26	37%	Off	Off	On
24	26	75%	On	On	On
25	27	47%	Off	Off	On

26	28	13%	On	On	Off
27	26	2%	Off	On	On
28	24	1%	On	Off	Off
29	24	78%	Off	On	Off
30	24	69%	On	Off	On
31	17	25%	On	Off	On
32	18	22%	Off	On	Off
33	25	99%	Off	Off	On
34	25	76%	On	Off	On
35	27	87%	On	On	Off
36	17	30%	Off	Off	On
37	17	45%	On	On	Off
38	17.5	42%	Off	On	On
39	26	37%	Off	Off	On
40	26	75%	On	On	On
41	27	47%	Off	Off	On
42	28	13%	On	On	Off
43	25	99%	Off	Off	On
44	25	76%	On	Off	On
45	27	87%	On	On	Off
46	28	13%	On	On	Off
47	25	99%	Off	Off	On
48	25	76%	On	Off	On
49	27	87%	On	On	Off
50	17.5	97%	On	Off	Off

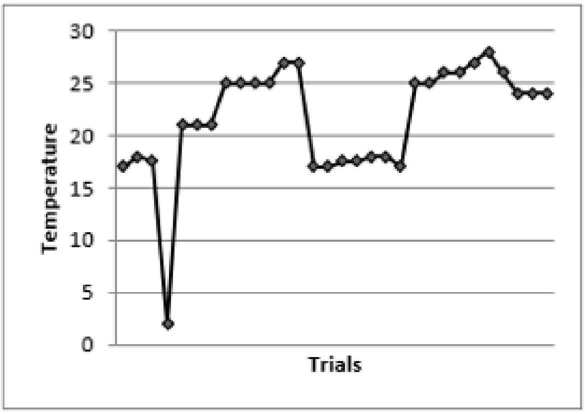

Fig. 8. Obtained temperature data.

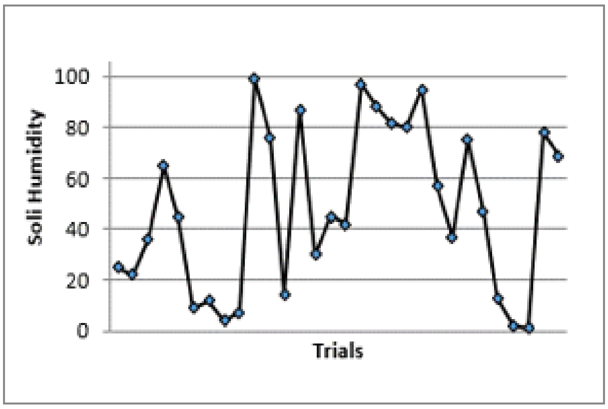

Fig. 9. Obtained soil humidity data.

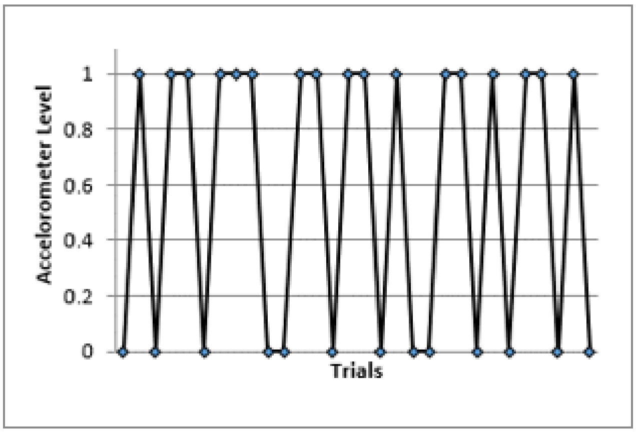

Fig. 10. Obtained accelerometer data.

the humidity and temperature at a given time. The humidity was read in percentage while the temperature was read in both Celsius and Fahrenheit. The system functioned normally in various temperatures as it was tested in 17◦C to 28◦C. The system encounter errors at extreme temperatures only in un-natural cases. All sensors are good and functional.

Table I shows the data obtained during the testing period. The researchers made fifty trials for the system and the data were gathered. It also shows the different states of the sensors during trial tests. Figures 8, 9, and 10 shows the data obtained such as temperature, humidity, and accelerometer during trial testz. The system run in different functions of the sensors. Figures 8–10 shows the graphical results.

IV. Conclusion

In this paper, the Arduino based disaster management alarm system was proposed. The authors tested functionality of the designed system by creating an improvised disaster like scenarios. Experimental studies have been carried out to verify the effectiveness of the proposed scheme. Results have shown that the disaster management alarm system using Arduino was successful. After several trials, we were able to obtain the values as shown in the data, which was transmitted through the mobile phone. The user was notified during a test.

It is envisaged that the developed system can be used to a wider class of real-world problems. Moreover, the integration of internet of things (IoT), artificial intelligence, and smart technology is further recommended for improvement.

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References

[1] A. A. Beltran Jr., Z. Lontoc, B. Conde, R. Serfa Juan, and J. R. Dizon, *World Congress on Engineering and Technology; Innovation and Its Sustainability 2018*, Springer, Switzerland, September 2019. ISBN 978-3-030-20903-2.

[2] A. C. Paglinawan, L. C. Valiente, A. A. Beltran Jr., A. V. Mabalot, J. A. Verdida, and C. L. D. Marte, "Wireless power transfer using near field communication for mobile devices," in *IEEE 3RD International Future Energy Electronics Conference and ECCE Asia 2017*, pp. 1747–1752, Kaohsiung, Taiwan, June 2017.

[3] D. Satria, S. Yana, R. Munadi, and S. Syahreza, "Prototype of Google maps-based flood monitoring system using Arduino and GSM module," *International Research Journal of Engineering and Technology*, vol. 4, no. 10, pp. 1044–1047, October 2017.

[4] S. Murti, P. Megantoro, G. D. B. Silva, and A. Maseleno, "The design and analysis of DC electrical voltage current datalogger device implemented on wind turbine control system," *Journal of Robotics and Control*, vol. 1, no. 3, pp. 75–80, May 2020.

[5] A. A. Beltran Jr., F. I. Alano, V. B. Alvarez, R. J. D. Habab, and P. M. P. Buay, "A simulation research in linear beam forming transmission," *International Journal of Scientific Engineering and Technology*, vol. 3, no. 12, pp. 1431–1435, December 2014.

[6] A. A. Beltran Jr., R. E. Tolentino, N. C. Javier, and H. Zhang, "MCU-based robotic elbow movement control," *International Journal of Scientific Engineering and Technology*, vol. 4, no. 8, pp. 438–442, August 2015.

[7] T. P. Tunggal, L. A. Kirana, A. Z. Arfianto, E. T. Helmy, and F. Waseel, "The design of tachometer contact and non-contact using microcontroller," *Journal of Robotics and Control*, vol. 1, no. 3, pp. 65–69, May 2020.

[8] J. H. E. Doroteo, "Disaster Risk Profile and Disaster Risk Management Framework of the Philippines: Natural Calamities," *Monographic Report, Erasmus Mundus Master in Public Health in Disasters*, University of Oviedo, Spain, December 2015.

[9] K. Smarsly, K. Georgieva, and M. König, "An Internet-Enabled Wireless Multi-Sensor System for Continuous Monitoring of Landslide Processes," *IACSIT International Journal of Engineering and Technology*, vol. 6, no. 6, pp. 520–529, December 2014.

[10] S. M. Hossain, S. H. Rafi, M. Rokonuzzaman, and M. A. Wahed, "An Enhanced Tsunami Detection System," *International Journal of Innovation and Scientific Research*, vol. 21, no. 1, pp. 103–109, March 2016.

[11] M. W. Hariyanto, A. H. Hendrawan, and R. Ritzkal, "Monitoring the environmental temperature of the Arduino assistance engineering faculty using telegram," *Journal of Robotics and Control*, vol. 1, no. 3, pp. 96–101, May 2020.

[12] A. U. Ganggangan, A. A. Beltran Jr., E. C. Barreto, P. F. Hernandez, P. E. P. De Villa, and M. T. A. M. Cabatac, "Chest worn pulse oximeter integrating NI USRP with GPS disciplined clock transmitter," *International Journal of Scientific Engineering and Technology*, vol. 4, no. 1, pp. 10–14, January 2015.

[13] P. Megantoro, A. Widjanarko, R. Rahim, K. Kunal, and A. Z. Arfianto, "The design of digital liquid density meter based on Arduino," *Journal of Robotics and Control*, vol. 1, no. 1, pp. 1–6, January 2020.

[14] N. F. Apsari, P. Megantoro, M. U. Sattar, A. Maseleno, and O. Tanane, "Design of laboratory scale fluid level measurement device based on Arduino," *Journal of Robotics and Control*, vol. 1, no. 5, pp. 145–149, September 2020.

[15] A. A. Beltran Jr., A. C. Clavero, J. M. B. De Vera, P. A. P. Lopez, C. A. Mueca, N. A. Pempena IX, and A. Z. D. Roxas, "Arduino based food and water dispenser for pets with GSM technology control," *International Journal of Scientific Engineering and Technology*, vol. 3, no. 4, pp. 231–234, April 2014.

[16] A. A. Beltran Jr., G. Tan, S. Y. Castriciones, K. Cuerdo, A. Valdez, and J. J. Vega, "Design and implementation of an emergency datacasting system using 2-meter amateur radio band," in *IEEE International Conference on Smart Technology and Applications*, pp. 1–5, Surabaya, Indonesia, February 2020.

[17] V. Ramya and B. Palaniappan, "An automated tsunami alert system," *International Journal of Embedded Systems and Applications*, vol. 1, no. 2, pp. 65–78, December 2011.

[18] G. Saradha, "Simulation of earthquakes and tsunami through GSM network," in *IEEE International Conference on Emerging Trends in Electrical and Computer Technology 2011*, pp. 912–916, Nagercoil, India, March 2011.

[19] M. V. Ramesh, S. Kumar, and P. V. Rangan, "Wireless Sensor Network for Landslide Detection," in *International Conference on Wireless Networks*, vol. 2, pp. 1–7, Las Vegas, Nevada, USA, July 2009.

[20] S. Mehra and Tanmay, "Disaster detection system using Arduino," in *IEEE International Conference on Information Communication and Embedded Systems 2017*, Chennai, India, pp. 1–6, February 2017.

[21] Adawasti, R. Febriani, Sholihin, E. Susanti, and E. Hesti, "Xbee Pro module application to organize and monitoring earthquake disaster location with the robot control system," in *IEEE International Conference on Information and Communications Technology 2018*, pp. 651–655, Yogyakarta, Indonesia, March 2018.

[22] A. Amelia, A. Arief, A. M. P. Lubis, B. V. Sundawa, M. Rusdi, and Roslina, "Design of early landslide warning system caused by rainfall influence," in *IEEE International Conference on Applied Science and Technology 2018*, pp. 477–480, Manado, Indonesia, October 2018.

[23] F. Aji, N. M. Yoeseph, and G. W. Abisatya, "Landslide early warning system based on Arduino with soil movement and humidity sensors," in *9TH International Conference on Physics and Its Applications*, vol. 1153, pp. 1–5, Surakarta, Indonesia, February 2019.

[24] T. M. Velayudhan and M. Yameni, "GSM module for wireless radiation monitoring system via SMS," in *International Nuclear Science, Technology, and Engineering Conference 2017, vol. 298*, pp. 10–12, Selangor, Malaysia, September 2017.

[25] L. Louis, "Working principle of Arduino and using it as a tool for study and research," *International Journal of Control, Automation, Communication and Systems*, vol. 1, no. 2, pp. 21–27, April 2016.

[26] F. Bäfverfeldt, "Building an Arduino based weather station and connecting it as a slave to a control system," *FREIA Report*, Uppsala University, Sweden, September 2016.

[27] I. Prasojo, A. Maseleno, O. Tanane, and N. Shahu, "Design of automatic watering system based on Arduino," *Journal of Robotics and Control*, vol. 1, no. 2, pp. 59–63, March 2020.

[28] I. Prasojo, P. T. Nguyen, O. Tanane, and N. Shahu, "Design of ultrasonic sensor and ultraviolet sensor implemented on a firefighter robot using AT89S52," *Journal of Robotics and Control*, vol. 1, no. 2, pp. 55–58, March 2020.

[29] J. Joseph, N. Berhmans, M. R. Varghese, M. Krishnan, B. S. Arya, and M. Antony, "Arduino based automatic human seeker robot for disaster management," in 2ND *IEEE International Conference on Intelligent Computing, Instrumentation and Control Technologies 2019*, pp. 770–773, Kannur, Kerala, India, July 2019.

[30] F. Nurpandi, A. Musrifalr, and I. Rizaldi, "Prototype residence monitoring and automation system using microcontroller Arduino," in *International Conference on ICT for Smart Society 2018*, pp. 1–5, Semarang, Indonesia, October 2018.

[31] T. Alcayna, V. Bollettino, P. Dy, and P. Vinck, "Resilience and disaster trends in the Philippines: Opportunities for national and local capacity building," *PLoS Current Disasters*, vol. 1, pp. 1–10, September 2016.