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Local wisdom-based flood early warning system: a case study on Glintung Water Street (GWS) Malang City

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Abstract. A flood early warning system as part of flood risk management must be applied in a flood-prone area. This study aims to develop and examine a flood early warning system using an information and communication technology (ICT) appropriate to the local wisdom values of the Glintung Water Street (GWS) community, Malang City. This study used a descriptive qualitative research method. Data collection techniques include interviews, observation, and documentation/literature studies. The flood early warning system was developed using the SMS system. The warning information sent by the system consists of alert-1 for a water level of 0 cm - 20 cm, alert-2 for a water level of 20 cm - 30 cm, and alert-3 for a water level of 30 cm - 50 cm and probe sensors for electronic devices that play an important role in this system consisting of probe sensors as water level detectors, the GSM/GPRS SIM900 module, as the sending medium to the cellphone and Arduino which functions as the control system. Based on the research results, the design of a flood early warning system using the Probe Sensor combined with Arduino and the SMS Program is appropriate for the study area concerning the local wisdom values already embedded in the community.

Keywords: arduino, flood early warning system, local wisdom, short message service

1. Introduction

Glintung Water Street (GWS) is a village in the Purwantoro area, Blimbing District, Malang City which is often flooded in the rainy season. Kampong Glintung is traversed by the Lahar River which flows directly beside residential areas, making it prone to flooding and river overflow. Another factor that causes flooding is the narrowing of the river banks due to inappropriate land use. The inability of the river to accommodate water discharge, exacerbated by the narrowing of the river banks due to inappropriate land use on the river banks, results in an increased risk of flooding. Flood risk management is an urgent need considering the potential and patterns of disaster cycles in Indonesia that repeat themselves at certain time intervals. Flood risk handling technology, both from the aspect of risk management, technology, and post-flood handling, is important for almost all regions in Indonesia [1].

To minimize the risk of disasters, this can be undertaken by using a disaster early warning system. The system consists of several elements, namely hazard monitoring, disaster risk assessment, communication and disaster preparedness. This system allows stakeholders at every level, from the individual level, community level, and government level to take proper actions to reduce the risk and impact of disasters. An early warning system should be effective and people-centered [2], [3], and built

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to provide information about pre-disaster signs so that security measures can be taken as soon as possible.

The steps and efforts to overcome social welfare problems due to natural disasters are a series of prevention activities. There three activities in the natural disaster management activities that is:

1. pre-disaster activities include flood prevention, mitigation, preparedness, and early warning activities;
2. activities during a disaster include emergency response activities to relieve temporary suffering, such as Search and Rescue (SAR) activities, emergency assistance, and evacuation; and
3. post-disaster activities include recovery, rehabilitation, and reconstruction activities.

The problem of disaster management requires the role of all parties. Several disaster management actors exist: the government and local government, the community, and the business world. The roles of the three actors are regulated in Law No. 24 of 2007 concerning Disaster Management. The role of the government and local government is regulated in Article 5, Article 6, and Article 7; the role of the community is regulated in Article 26 and Article 27; and the role of business institutions is regulated in Article 28 and Article 29.

The government's lack of attention to disasters in Glintung Village, Blimbing District, has encouraged local communities to start disaster management based on local wisdom. With a combination of local wisdom and a web-based flood early warning system, it is hoped that it will help synthesize natural disaster management policies that are effective enough to minimize losses due to flooding [4], [5].

With a web system that quickly provides information regarding flood early warning to the community, the potential risk of flooding can be reduced, and the community is better prepared to face future floods. With the current era of globalization, it is possible that technological advances can be developed further, such as IoT (Internet of Thing) based flood early warning sensors [6], [7].

An information technology concept that is currently widely used by humans, which can connect all physical objects that have computing capabilities globally via the internet so that they can connect with each other and share information to make it easier for humans as users. The internet of things has also been applied in various areas, such as in the development of Smart Cities, Smart Home Systems, agricultural and livestock monitoring, as well as for work safety management.

Several studies on web-based disaster early warning systems, specifically flood disasters, include [8], [9] developed an online water level monitoring system with an IoT technology approach. The MCU ESP2866 microprocessor reads the water level sensor data and sends the data wirelessly to an Android smartphone. Sulistyowati, et.al. [10] developed a flood detection system using a microcontroller and ultrasonic sensor to detect the water level. Information on water level readings can then be accessed via the SMS Gateway.

Based on the descriptions that have been discussed, this design can be developed as flood early warning using Short Message Service (SMS) technology. Sensor Probe combines with Arduino to detect water levels and can maximize the system in reading water levels. So that monitoring of water levels can be done anywhere and anytime, the system is added with a GSM/GPRS SIM 900A module so that the values of water levels and early flood warnings can be monitored via short messages. Besides, the system can automatically send flood warning messages and water levels if there is a discharge. Water increases and enters at certain levels, such as SIAGA I, SIAGA II, and Beware of Floods. The system as a whole is quite good at monitoring water levels and can then be applied to the actual environment combined with the community's local wisdom [7], [11]. This study aims to develop and examine a flood early warning system using an information and communication technology (ICT) appropriate to the community's local wisdom values.

2. Materials and Methods

This study used a qualitative approach to research social phenomena. This research approach is used to explore facts in depth related to the local wisdom of the community in the flood early warning system and explore things that researchers do not yet know with a qualitative descriptive method [12]. Data was

collected from interviews, observations, and documentation studies to gather information about flood events and the implementation of flood early warning systems in the community previously carried out [13]. The interview involved community leaders and the people of Glintung Water Street (GWS) Malang City as informants. The interview process used structured interviews and was conducted face-to-face with informants. Interviews were undertaken to determine the most appropriate technology that is suitable to the local wisdom value of the community, that is, cooperation ("*gotong royong*") and living in harmony ("*guyub rukun*"). The observation method is carried out by directly observing the object under study and systematically recording all data obtained in the field. The documentation method complements related data or information obtained in the field or from other reference sources.

With the condition of Kampung Glintung, which is always flooded when the rainy season arrives, the local community conveys many complaints, maybe with the condition of Kampung Glintung, which is always flooded. The recommended step is implementing a web-based flood early warning system. This system was developed using a Probe sensor combined with the Arduino Uno system.

The warning information sent by the system consists of:

1. alert-1 for a water level of 0 cm - 20 cm
2. alert-2 for a water level of 20 cm - 30 cm
3. alert-3 for a water level of 30 cm - 50 cm

Electronic devices that play an important role in this system consist of:

1. probe sensors as water level detectors
2. the GSM/GPRS SIM900 module, as the sending medium to the cell phone and
3. Arduino as the control system.

2.1. Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328P that contains everything needed to support the microcontroller. It has 13 digital input/output pins, six of which can be used as PWM outputs, and six analog inputs. Additionally, it has a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. The board can be connected to a computer using a USB cable or supplied with an AC to DC adapter, and it can also be powered by a battery.

Figure 1 illustrates the Arduino Uno, which serves as a microcontroller board utilizing the ATmega328P. The Arduino UNO is equipped with 13 digital input/output pins (with 6 available for use as outputs), six analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. The Arduino Uno encompasses all the essential components required to facilitate the microcontroller, making it simple to establish a connection to a computer via a USB cable, power it with an AC to DC adapter, or initiate it using a battery.

2.2. Sensor Probe

The probe sensor is a sensor that functions as a water level detector. Its working principle is that if the positive and negative probes touch the water, the probe will be short-circuited, and the probe sensor uses copper wire as a probe. There are four copper wires, three to detect the water level and one as ground. If one of the copper wires has not touched the water, the copper wire has logic 1. At the same time, if one of the copper wires has been in contact with water, the copper wire has logic 0. Both copper wires are connected to the output ports on the Arduino.

2.3. Short Message Service (SMS) Gateway

SMS gateway is a software that uses the help of a computer and utilizes integrated cellular technology to distribute integrated messages via information systems via SMS media handled by the cellular network SMS Gateway usually supports messages in the form of text, unicode characters, and also smart messaging (ringtones, picture messages, operator logos, and others), the SMS Gateway working mechanism can be seen as shown in Figure 2.

Figure 2 shows the working mechanism of sending SMS through the Base Transceiver Station (BTS), which is divided into two parts, namely: (a) Intra-operator SMS: sending SMS within one operator; (b) Inter-operator SMS: sending SMS between different operators, and the recipients.

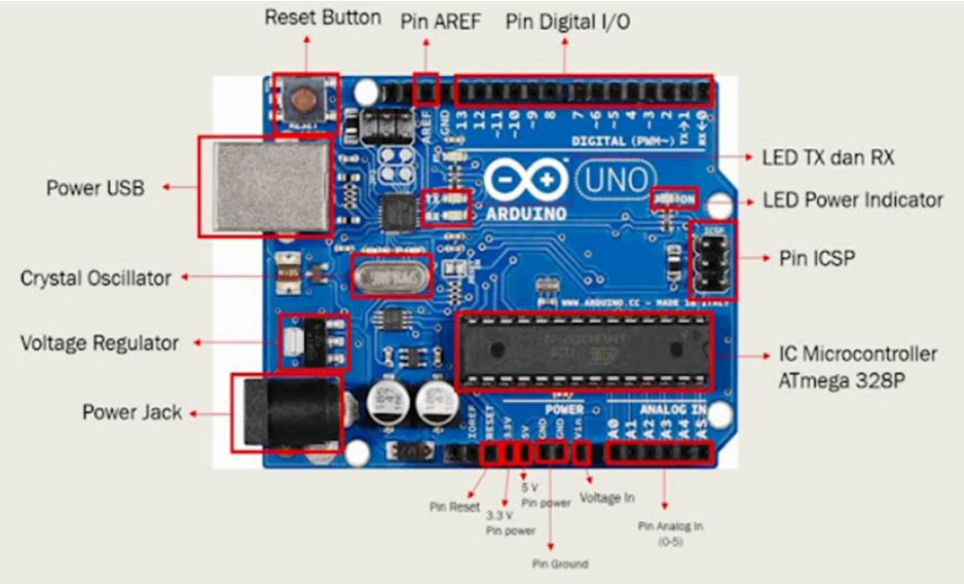

Figure 1. Board Arduino UNO [14]

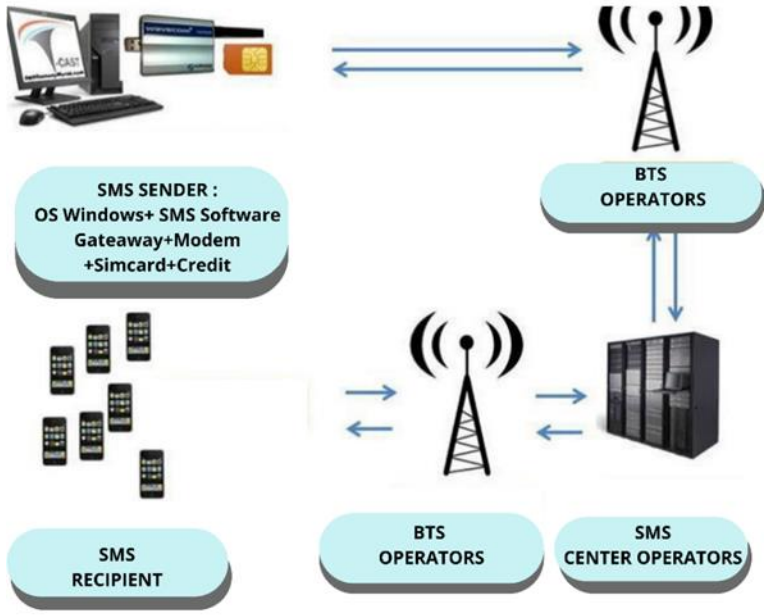

Figure 2. SMS Work Steps [15]

2.4. GSM/GPRS SIM 900A

The SIM900 GSM/GPRS module is the part that functions to communicate between the main monitor and the mobile phone. This module can communicate with the microcontroller via serial communication. Communication can be through the SMS, enabled to send water level conditions [16]. Figure 3 is the GSM Shield Sim 900 board.

Figure 3 shows the GSM/GPRS SIM 900A board, which sends an SMS to the operator to determine the river's height and low tide of water.

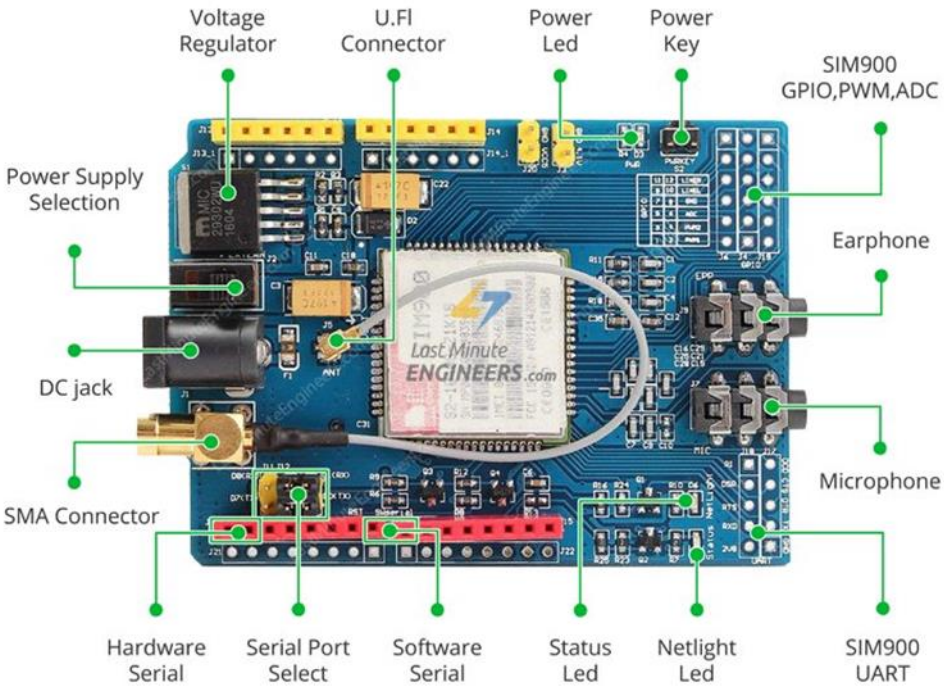

Figure 3. GSM Shield SIM 900 [17]

3. Results and Discussion

3.1. Interview Results

There were seven informants involved that is the head of the village ("*lurah*"), the head of kampong ("*Ketua RW*"), the head of the local women's organization ("*Ketua PKK*"), the head of the local youth organization ("*Ketua Karang Taruna*"), three religion leaders. Almost of the informants said that although the kampong has already successfully transformed from a slum condition to a neat and clean village, it still floods and is inundated during heavy rain, so there is still a need for an early flood warning system with simple technology and easy to operate by the community in which harmony and cooperation values have firmly embedded. These values will be the basis for disseminating flood-related information throughout society, especially residents affected. The recommended technology uses SMS, which most communities can operate, and only needs cell phone credit. Residents who receive flood information via SMS can forward the information to residents who do not have cellular telephones and are sometimes unavailable. Still, wherever possible, the information is delivered as quickly as possible.

3.2. Arduino UNO testing

Table 1 shows that the sensor has two different conditions, high and low. The high sensor (target level reached) is detected if a short circuit occurs between the common and high sensors and then sends an input signal to the Arduino. The Arduino will order the GSM to message the cell phone through water level and low tide.

Table 1. Testing the Arduino Uno port

No. Pin	Voltage	Serial Data (BIN)	Condition Description
0	4.5	1	*High*
1	4.4	1	*High*
2	4.6	1	*High*
3	0	0	*Low*
4	4.6	1	*High*
5	4.6	1	*High*
6	0	1	*High*
7	0	1	*High*
8	4.6	0	*High*
9	4.6	1	*High*
10	4.6	1	*High*
11	4.6	1	*High*
12	0	0	*Low*
13	0	0	*Low*

3.3. Testing buzzer to Arduino

The buzzer is an indicator for the initial warning simulation that the system is ready to run, and the buzzer is also used at the second and third levels. As a warning indicator, the pin used on Arduino is PIN 12.

Table 2. Testing the buzzer voltage

Electronic Components	Voltage	Information
Buzzer	0	*off*
	4.2	*on*

Table 2 shows the results of the buzzer test as an initial simulation indicator warning that the system is ready to run, and the buzzer is also used at the second and third levels as a warning indicator.

3.4. Sensor Probe Testing

This sensor probe has two different conditions: high and low. Sensor high is detected when a short circuit occurs between common and sensor high (target level is reached). The input signal is sent to the Arduino, instructing GSM to send a message to the cell phone with information on the water level and low tide.

Table 3. Sensor test data at standby 1

Sensor	Stand by 1	
	Voltage	Information
Sensor 1	0	*On*
Sensor 2	2.61	*Off*
Sensor 3	2.80	*Off*

Table 4. Sensor test data at standby 2

Sensor	Stand by 2	
	Voltage	Information
Sensor 1	0	*On*
Sensor 2	0	*On*
Sensor 3	2.80	*Off*

Table 5. Sensor test data at standby 3

Sensor	Stand by 3	
	Voltage	Information
Sensor 1	0	*On*
Sensor 2	0	*On*
Sensor 3	0	*On*

Table 3-5 shows that during standby one, the signal that is only on is sensor 1; during standby 2 the sensors are on are sensors 1 and 2; when standby 3 all sensors are on.

3.5. GSM/GPRS SIM 900A

Tests carried out on the GSM module are expected to be able to send an SMS to the operator to find out the height of the water level and low tide. The SIM900 GSM/GPRS module is the part that functions to communicate between the main monitor and the cellphone. This module can communicate with the microcontroller via serial communication. Communication is done via SMS, which sends water level conditions. All information delivery is accessed in the database, so it is easy to track, if needed at any time in the future.

3.6. Overall system testing

The test system is carried out on each tool, which will produce how each system works, and when the system is suitable, the overall test will be carried out to see whether the system has been achieved perfectly.

Table 6. Overall water level data during standby 1

Sensor	Stand by 1		
	Voltage	Buzzer	SMS Status
Sensor 1	0	*Off*	*Send* SMS
Sensor 2	2.60	*Off*	*No Send*
Sensor 3	2.80	*Off*	*No Send*

Table 7. Overall water level data during standby 2

Sensor	Stand by 2		
	Voltage	Buzzer	SMS Status
Sensor 1	0	*Off*	*No Send*
Sensor 2	0	*On*	*Send* SMS
Sensor 3	2. 80	*Off*	*No Send*

Table 8. Overall water level data during standby 3

Sensor	Stand by 3		
	Voltage	Buzzer	SMS Status
Sensor 1	0	*Off*	*No Send*
Sensor 2	0	*Off*	*No Send*
Sensor 3	0	*On*	*Send* SMS

Table 9. Overall data at low tide to alert 2

Sensor	Low tide to Alert 2		
	Voltage	Information	SMS Status
Sensor 1	0	*Off*	*No Send*
Sensor 2	0	*Off*	*No Send*
Sensor 3	2.80	*On*	*Send SMS*

Table 10. Overall data at low tide to alert 1

Sensor	Low tide to Alert 2		
	Voltage	Information	SMS Status
Sensor 1	2,80	*Off*	*No Send*
Sensor 2	2,60	*On*	*Send* SMS
Sensor 3	0	*Off*	*No Send*

Table 11. Overall data at normal water times

Sensor	Sensor normal water		
	Voltage	Information	SMS Status
Sensor 1	2,80	*Off*	*No Send*
Sensor 2	2,60	*Off*	*No Send*
Sensor 3	1,42	*Off*	*No Send*

Tables 6-11 show that each system can work well and appropriately so that the system as a whole can be tested, and the results obtained are that the system has worked perfectly when a short circuit occurs between common and sensor high, sensor high is detected (target level is reached). The input signal is sent to the Arduino, which will instruct GSM to send a message to the cellphone with information on the water level and low tide.

4. Conclusions

This study tries to develop and examine a flood early warning system using an Information and Communication Technology (ICT) appropriate to the community's local wisdom values. Based on the research results, the design of a flood early warning system using the Probe Sensor combined with Arduino and the SMS Program is appropriate to be applied at the study area concerning the local wisdom values already embedded in the community. The system can work properly so that the information that will be conveyed becomes more real-time so the residents can evacuate their properties as soon as possible to minimize the losses. With the SMS Program, all information delivery is accessed in the database, making it easy to track if needed. This tool still requires a further testing phase so that the GWS community can operate the system themselves.

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References
[1] M. A. Y. Al Bustomi and Asmunin, "Rancang Bangun Sistem Monitoring Peringatan Dini Bencana Banjir Berbasis Iot Menggunakan Protokol MQTT Dengan Notifikasi Bot Telegram," *J. Manaj. Inform.*, vol. Vol 12, no. 1, pp. 1–13, 2021.
[2] E. P. Tenda, A. V. Lengkong, and K. F. Pinontoan, "Sistem Peringatan Dini Banjir Berbasis IoT dan Twitter," *CogITo Smart J.*, vol. 7, no. 1, pp. 26–39, 2021, doi:10.31154/cogito.v7i1.284.26-39
[3] I. Khan, A. Razzaq, A. Jan, S. Riaz, and N. Shehzad, "An analysis of Community Based Flood Early Warning System in the State of Azad Jammu & Kashmir," *Procedia Eng.*, vol. 212, pp. 792–800, 2018.
[4] R. Y. Fadhila, P. S. Rudati, and F. Feriyonika, "Sistem Monitoring Level Air Menggunakan Sensor Level Berbasis Differential Pressure Transducer," *Pros. Ind. Res. Work. Natl. Semin.*, vol. 10, no. 1, pp. 220–225, 2019, DOI: https://doi.org/10.35313/irwns.v10i1.1392
[5] D. D. Chinguwo and D. Deus, "Assessment of community-based flood early warning system in Malawi," *Jamba J. Disaster Risk Stud.*, vol. 14, no. 1, pp. 1–10, 2022.
[6] Y. Herdiana and A. Triatna, "Prototype Monitoring Ketinggian Air Berbasis Internet of Things Menggunakan Blynk Dan Nodemcu Esp8266 Pada Tangki," *J. Inform.*, vol. 07, pp. 1–11, 2020.
[7] R. More, "Community based flood early warning system Connecting communities," p. 2022, 2022.
[8] D. Shakya, V. R. Khadgi, N. Bajracharya, S. R. Bajracharya, S. K. Rai, and N. S. Pradhan, "Community Based Flood Early Warning System Resource Manual Revised Edition for Telemetry Based Instrumentation," 2019.
[9] A. Muzakky, A. Nurhadi, A. Nurdiansyah, and G. Wicaksana, "Perancangan Sistem Deteksi Banjir Berbasis Iot," *Conf. Innov. Appl. Sci. Technol. (CIASTECH 2018)*, vol. 7, no. 2, pp. 43–51, 2018.
[10] Sulistyowati. R., H. A. Sujono, and A. K. Musthofa, "Sistem Pendeteksi Banjir Berbasis Sensor Ultrasonik dan Mikrokontroler dengan Media Komunikasi SMS Gate Way," pp. 49–58, 2015.
[11] R. Sufia, S. Sumarmi, and A. Amirudin, "Kearifan Lokal Dalam Melestarikan Lingkungan Hidup (Studi Kasus Masyarakat Adat Desa Kemiren Kecamatan Glagah Kabupaten Banyuwangi)," *J. Pendidik. Teor. Penelitian, dan Pengemb.*, vol. 1, no. 4, pp. 726–731, 2016, doi: 10.17977/jp.v1i4.6234
[12] R. R. Daniel Bicknell, Colleen Narlock, "Community Based Flood Early Warning Systems ;Improving Climate Change Adaptation in the Hindu Kush Himalayan Region," *Harvard Kennedy Sch.*, no. August, 2020.
[13] L. Sedyowati, G. Chandrarin, and G. I. K. Nugraha, "Towards sustainable community: Effort to reduce flood risk and increase well-being in a densely populated flood-prone area," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 930, no. 1, p. 12096, 2021.
[14] "Sekilas Tentang Arduino Uno (Overview of Arduino Uno)." [Online]. Available: https://www.katatatas.com/2021/06/sekilas-tentang-arduino-uno-board.html#google_vignette. [Accessed: 06-Sep-2023].
[15] M. Afrina and A. Ibrahim, "Pengembangan Sistem Informasi SMS Gateway Dalam Meningkatkan Layanan Komunikasi Sekitar Akademika Fakultas Ilmu Komputer Unsri," *J. Sist. Inf.*, vol. 7, no.

2, pp. 852–864, 2015, DOI: https://doi.org/10.36706/jsi.v7i2.2265
[16] F. R. Usman, W. Ridwan, I. Z. Nasibu, P. T. Elektro, F. Teknik, and U. N. Gorontalo, "Sistem peringatan dini bencana banjir berbasis mikrokontroler arduino," *JAMBURA - J. Electr. Electron. Eng.*, vol. 1, no. 1, 2019, DOI: https://doi.org/10.37905/jjeee.v1i1.2721
[17] "Send Receive SMS & Call with SIM900 GSM Shield & Arduino." [Online]. Available: https://lastminuteengineers.com/sim900-gsm-shield-arduino-tutorial/#google_vignette. [Accessed: 06-Sep-2023].

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