

## Prototype of landslide detection alarm based on IoT (Internet of Things) as a physics learning medium

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**Abstract:** This research aims to create a prototype device in the form of an alarm capable of detecting landslide disasters in Donggala Regency. It is expected to be utilized in the environmental physics subject at the secondary school level. The study utilizes long-range communication (LoRa) and Telegram application as an early warning notification system for landslide disasters. The research method adopts the Research and Development (R&D) design adapted from Sugiyono's development research, consisting of potential and problems, data collection, product design, design validation, product testing, analysis, and reporting. The survey was employed as a data collection instrument. The quality or feasibility of the developed prototype, based on expert validation, indicates a "Very Good" category, and students' responses to the tool testing also show a "Very Good" category. Thus, the IoT-based landslide detection alarm prototype has been well-developed and is suitable for use in physics education at the secondary school level.

**Keywords:** landslide; telegram; LoRa

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### Introduction

Disaster is a series of events that threaten and disrupt community life, caused by natural or non-natural factors with impacts such as loss of life, environmental damage, material losses, and psychological effects (Caldera & Wirasinghe, 2022). In Indonesia, in 2021, there were a total of 5,402 disasters, an increase compared to the previous year, 2020, with 4,650 incidents, and 2019, with 3,814 incidents. The disasters in 2021 included 1,321 landslides, 1,794 floods, 15 droughts, 1 volcanic eruption, 24 earthquakes, 579 forest and land fires, 1,577 extreme weather events, and 91 tidal waves and abrasions (Diskominfo Kabupaten Bogor, 2021). Landslides caused more significant losses compared to other disasters, claiming the lives of 397 people who died, went missing, or were injured. Landslide incidents tend to increase every year, especially during the rainy season, focusing on steep hill locations in various areas that are more vulnerable to landslides (Putra & Wardika, 2021).

The movement of a portion of soil on a large or small scale with gradual or spontaneous movement is referred to as a landslide disaster. Factors such as erosion, vibrations, increased water retention in the soil, slope inclination, high rainfall, and reckless deforestation without replanting contribute to soil shifts (Reynaldi et al., 2019).

In the physical concept, a natural landslide disaster can be explained by the material on a sloping surface in Newton's Law. Palu City has a hilly topography with slope levels categorized as very low with an inclination  $\leq 15^\circ$ , low with an inclination  $>15^\circ-24^\circ$ , moderate with an inclination  $>24^\circ-44^\circ$ , and high with an inclination  $\geq 45^\circ$  (Pratiwi et al., 2021).

Mitigation efforts can be carried out through the use of available technology, such as social media. The utilization of Twitter, done by the National Disaster Management Agency (BNPB), serves as a means of disseminating information, especially about natural disasters, educating the public on what to do before, during, and after a disaster, mapping disaster-prone areas, and raising awareness during emergencies, from declaring a disaster status to conducting evacuations, and post-disaster trauma healing and reconstruction (Fariz et al., 2021).

Telegram is one of the instant messaging applications that operate cross-platform and is based on cloud technology, providing free and nonprofit services. Users can send photos, videos, voice messages, and files (up to 2 GB per file) individually or in groups of up to 200,000 members (Jamil et al., 2019).

LoRa (Long Range) is a wireless communication system for the Internet of Things (IoT). This system excels in long-distance communication up to 15 km with Line of Sight (LOS) conditions and low power consumption. LoRa Alliance promotes this system with the goal of being used in long-lasting battery-powered devices. LoRa technology also exhibits good resistance to interference in transmission systems. Another advantage of this system is its efficiency in saving communication channels, as it requires only one channel for the gateway compared to one channel for each IoT device (Islam et al., 2022).

The design of a landslide detection alarm, especially in Donggala Regency, has not been conducted yet. However, in other areas, landslide detection alarm designs have been implemented, focusing on soil moisture levels connected to notifications on smartphones via applications such as Telegram and SMS, providing information on soil moisture values, slope steepness, and disaster status, along with additional alerts (Diana & Wildian, 2019).

Previous research has utilized IoT systems, but the communication system used was the Antares platform, developed by PT. Telkom Indonesia for IoT-based devices. However, this platform proved to be less effective among the public. In 2021, research was conducted using rain and vibration sensors based on web and SMS services (Raharja et al., 2022).

Therefore, the author conducts research on a prototype landslide disaster mitigation alarm based on IoT (Internet of Things), using LoRa communication system and the Telegram social media application, focusing on soil moisture levels, slope inclination, and disaster status. The results of this research are expected to be utilized in physics education in secondary schools.

## Method

In this study, the type of research conducted involved MTs Alkhairaat Maleni. The research was carried out during the odd semester of the academic year 2022/2023, with the subjects being students of class VII A at MTs Alkhairaat Maleni. The data collection technique utilized a questionnaire or survey, which served as a data collection tool containing a set of statements or questions to be answered by the study subjects. In this survey, a closed-ended questionnaire using a Likert scale was employed. The instrument used in this research was a questionnaire or survey technique, which was validated by experts in the field and seventh-grade students, aiming to measure the feasibility of the prototype media.

The data analysis technique was determined based on the opinion of Arilkunto 2013 (Arikunto, 2014). It stated that to determine the final score on each item of the survey questionnaire, the total score obtained was divided by the number of respondents who answered the survey questionnaire. It can be formulated as follows:

$$\underline{X} = \frac{\sum x}{N} \quad (1)$$

The average score obtained is used to find the table of assessment criteria according to categories, following the provisions in Table 1 for the analysis of student response data, similar to the analysis of product quality data.

**Table 1. Analysis of Student Response Data and Analysis of Product Quality Data**

	Average Score	Qualitative Criteria
$\bar{X}$	3,25 < ≤ 4,00	VG (Very Good)
$\bar{X}$	2,50 < ≤ 3,25	G (Good)
$\bar{X}$	1,75 < ≤ 2,50	L (Less Good)
$\bar{X}$	1,00 < ≤ 1,75	SK (Very Less)

The ESP32 is a microcontroller that is an advancement from the ESP8266 microcontroller. The ESP32 comes with a built-in WiFi module, making it highly suitable for implementing IoT applications (Arrahma & Mukhaiyar, 2023).



**Figure 1. Microcontroller ESP32**

The GY-9250 Sensor Module is a breakout board for the InvenSense MPU-9250 9-Axis IMU (Inertial Measurement Unit). The MPU-9250 combines a 3-axis accelerometer, a 3-axis gyroscope, and a 3-axis magnetometer in a single chip, providing 16-bit resolution for each of the 9 axes, low power consumption, and additional I2C pins for reading data from external sensors (El fatimi et al., 2023).



**Figure 2. GY-9250 Sensor Module**

The HD-38 soil moisture sensor is capable of reading the amount of moisture present in the surrounding soil. Specifically, the HD-38 sensor uses two probes to pass a current through the soil and then reads the resistance to obtain the moisture level (Zhao et al., 2023).



**Figure 3. Soil Moisture HD-38**

Wireless communication technology widely used in wireless sensor network applications includes the SX1278 Transceiver module. As one of the LPWAN (Low Power Wireless Access Network) technologies, the SX1278 Transceiver module is designed for end devices, gateways, network servers, and application servers, featuring Long Range capabilities that are resistant to interference and have minimal power consumption (Guevara et al., 2022).



**Figure 4. SX1278 Module**

## Results and Discussion

Based on the evaluation by students through product testing, the obtained scores are 3.51 for the physical appearance of the device categorized as "Very Good", 3.65 for the suitability of the device to the needs categorized as "Very Good", 3.64 for the operation and performance of the device categorized as "Very Good", 3.48 for the quality and effectiveness of the device categorized as "Very Good", and 3.61 for the accuracy of the device readings categorized as "Very Good". Students provided feedback, suggesting that the prototype's physical appearance lacks color, and there is a need for more soil in its usage.

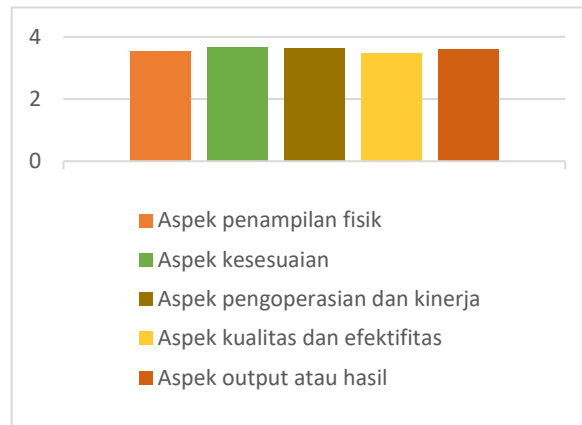


Figure 5. Student Assessment Diagram

The prototype's readings at a slope of  $\pm 45^\circ$  indicate that if the moisture is 0%-24%, the disaster status is "NORMAL"; if it is 25%-49%, the status is "ALERT"; if it is 50%-74%, the status is "WATCH"; and if it is 75%-100%, the status is "DANGER/LANDSLIDE". When the disaster status is "LANDSLIDE," the alarm will sound, accompanied by a flashing red light indicator. Based on the results obtained, the prototype can detect natural disasters such as landslides.

This research is relevant to that conducted by (Fachrizal et al., 2020); however, in their study, data or signals were sent using SMS, and the alarm notification was still simple, like a typical alarm (Fachrizal et al., 2020). In the device created by the researcher, data or signals can be sent using the internet, and alarm notifications can be accessed through the Telegram application.

## Conclusion

Based on the research results, it can be concluded that the goal of this study, which is to develop a device in the form of a prototype alarm capable of detecting landslide disasters in Donggala Regency, has been achieved. The quality or feasibility of the developed prototype, based on expert validation, falls into the "Very Good" category, and student responses to the device testing also fall into the "Very Good" category. Thus, the IoT-based landslide disaster detection alarm prototype has been successfully developed. Considering the research findings, the following recommendations can be made: 1) Improve the quality of the prototype's physical appearance to make it more appealing, and 2) Enhance the prototype to measure not only moisture but also motion to detect landslides.

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