Arduino and SMS gateway-based for ships emergency information system

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Abstract. One of the factors hampering aid to ship accidents is the assistance that comes does not match the type of accident on the ship. No navigation device that is able to identify the type and position of the accident is the cause of inappropriateness in providing emergency assistance. The purpose of this study is to develop a device that could provide information on the type of emergency and the latitude and longitude positions during an emergency. This emergency information system uses GPS devices Neo 6MV2 to determine the coordinates of the accident and SIM900A. To send the type of emergency identified through four (4) push buttons. Red push button for fire, yellow for collision, green for leakage and flooding, and blue for ship grounding. The device is equipped with LED indicator according to the color push button to indicate the type of emergency on the ship. The results of reading the push button will be processed using the Arduino Mega. Latitude and longitude coordinates are displayed on the LCD. As an indicator of sending the ship's emergency information message, the buzzer is used and the information delivery time is 5:32 seconds on average.

1. Introduction

Indonesia is a country with the second largest island in the world at 17,504 islands. Indonesia also has the longest coastline in the world, sized some 54,716 km. Indonesia geographic conditions require sea transportation mode to be used intensively. Especially the province of Riau Islands which has 95% of the sea makes every activity of people who want to move within the region should use sea transportation. Sea transportation uses various type of ships, ranging from small to medium sizes.

Sea transportation is the kind of transportation that require proper navigation device. Navigation is used as a direction and a regulator of vessel traffic system. The whole ship requires to have an instrument – a navigation device in order to maintain safety and security in sailing. Navigation device often used in determining the position of the ship, and some are only used in emergencies only, especially to find the help in the event of an accident the safety of the ship. The number of ship accidents occurring during the year 2010-2016 in the province of Riau Islands as reported by the National Committee of Transportation Safety (NCTS) amounted to 54 events [1]. Accidents on the vessel can occur due to negligence or errors that occur during transit operation. These events include, fire, collision, drowning, and ran aground. The death toll from the data of the NCTS amounted to 337 people.

A research on the system information for viewer ship wreck using Arduino-based and SMS Gateway have similarities in methods that do [2] with the tracking device GPS Location-Based Communication Via Mobile. The purpose of a tracking device that is developed is to determine the position of the GPS device placed in the vehicle. The device can be detected continuously by the user to monitor the presence of the tracking device. Devices using EG-T10 GPS module and a microcontroller ATMega8535. The
device will send a message in the form of the location of the tracking device. The results show that the tracking device can be used properly and can be set to send SMS at any given time.

Subsequent research carried out [3], entitled Making History Travel App GPS Tracker WEB Based on Mobile Using J2ME using GPS as input data recorded continuously, and will be displayed on mobile phones with an application that has been designed. Researchers used a GPS tracker device to obtain information in real time. The results of the research can be seen in the user's mobile phone to see clearly when the trip begins to record up to arrive somewhere. Not only that the user can see the history (records of travel) for a predetermined time.

Subsequent research conducted by Pradata [4] on the Security and Monitoring System Settings Location Mobile SMS facility. Usefulness of the device is to know the location and can control life and death machine. This study uses the GPS module Skylab SIM900 and SKM53 as security control. Users can receive messages in the form of location coordinates of the point of the car using the instant messaging has been set. This study was also able to turn on and off the vehicle through a short message sent by the user. Results from this study is that the device serves as a remote control system to turn on the vehicle's engine and determine the position of the vehicle via GPS.

Security System Design of GPS-Based to Know Position Vehicle Lost and Published By Smartphone is described in [5,6] The goal is to facilitate the user to locate the vehicle by using a smartphone. The design created a security system to determine the coordinates of the missing vehicle and then tracked using Google Maps. Users can use the Google Maps app to determine the position of where the vehicle is located. Better efficiency of the device due to a visual form that is easier to be known. The results show that the user is in the access point's coordinates using the Google Maps app on the smartphone.

The next study is Prototype System Design and Implementation of GPS and SMS Gateway in Search of Motor Vehicles based on Arduino Uno as explained in [7,8]. The usefulness of this device is to obtain information coordinate point via a message sent in advance. The device will then receive a text message from the SIM. This device must be used because the Android smartphone using a special application created with C-language made the application is quite easy and the device contains two (2) pieces of command, by touching the "Search" on the application is then automatically send a short message to a GSM SIM, and will receive back reply in the form of the coordinates of where the device is placed. Users simply use a smartphone to monitor the presence of the device at that time.

The latest research is the Design of Information Systems on ships by accident [9,10]. Function device designed to provide information for the harbor master in the form of links received through the media Short Message Service (SMS). Links are instantly directs the recipient to coordinate a point that can be opened in Google Maps. So that users can receive accurate information via Google Maps application in the search for a ship is in danger. The device also can send information automatically when the ship in conditions of oblique (90°), making it easier for the recipient to perform rescue and evacuation.

This paper is presented to explain a research on the development of a device to aid ships during emergency situation. The device is developed by referring to literature and information as described above.

2. Methodology

2.1 Method of Data Collection

The data collection conducted in the current study comprise the following aspects:

1) Literature: The method is to study the references contained in the reference books, journals and e-books that is linked to the study.

2) Observation: This method involves direct review all research sites related to what you want investigated. Direct review of issues related to emergencies on the ship.

3) Design: The design is a design of a GPS device, push button, LED, buzzer, LCD device and SIM device 900A.

4) Design: This experiment is to test the device gradually. Test push button, GPS devices, LED, 900 SIM device, buzzer, LCD devices to test the overall device.
2.2 System Planning
The device consists of three main parts: the input of the push button and the coordinates of the GPS signal, part of the process consists of an Arduino Mega and output section comprised of 900A SIM, LCD and buzzer. Figure 1 is a block diagram of the overall device for emergency information delivery system of the ship emergency. There are devices such as adapters, I2C IC and battery. Figure 2 presents the block diagram of the overall device design.

![Figure 1. Block diagram of the tool design](image1)

![Figure 2. Block diagram of the overall device design](image2)

2.3 How to Work
Emergency information viewer system used in this study is utilizing the GSM signal contained in water areas for sending information. As input coordinates obtained from GPS location NEO6 MV2 when the push button is pressed. In the process Arduino microcontroller processes the data in the form of message information to be transmitted. The output of the device is that information will be sent by SIM900 as a transmitter. The receiving party is having the authority in terms of saving the sea.

The device must be in a position and active, then the auto GPS will always be active as an input location. After that, the next step is pressing one of the push button there. Each push button has different information. Data obtained is processed by Arduino, then the data obtained will be transferred to SIM900A to transmit information in the form of text to a number of destinations. Delivery location data will be successful if SIM900A has gained GSM signal.
In Figure 3 it can be seen when the device starts to work then it will read the GSM signal availability in advance. Push button as the type of emergency and GPS location as input for the coordinates. There are four (4) push button, namely red is for fire, yellow for the collision, green for leakage and flooding lead to sinking, and blue for go aground. LCDs are used as display location and buzzer as a sign of the push button has been pressed. The data were processed by the Arduino mega and sent to the recipient using SIM900A.

![Figure 3. How to work flow chart software systems](image)

3. Testing and Analysis

3.1 Testing Push Button

Testing push button serves as a button to send a signal on the state of the vessel information on each of the push button is:

1. Push button Red : Fire
2. Push button Yellow : Collison
3. Push button Green : Leakage and flooding lead to Sinking
4. Push button Blue : Aground

![Figure 4. Testing on push button leg](image)

In Figure 4 leg for the push button connected to the Arduino Mega tested with positive leg on the multimeter and oscilloscope. Leg for push button which is connected to ground is tested with negative leg on multimeter and oscilloscope.
Table 1. Push button test results

| No | Condition | Push Button | Push Button Condition | Measured Voltage (V) | Description          |
|----|-----------|-------------|-----------------------|----------------------|----------------------|
| 1  | Fire      | Red         | On                    | 0.05                 | Signal Sent          |
|    |           |             | Off                   | 4.89                 | Signal Not Sent      |
| 2  | Collision | Yellow      | On                    | 0.05                 | Signal Sent          |
|    |           |             | Off                   | 4.88                 | Signal Not Sent      |
| 3  | Leakage   | Green       | On                    | 0.05                 | Signal Sent          |
|    |           |             | Off                   | 4.87                 | Signal Not Sent      |
| 4  | Aground   | Blue        | On                    | 0.05                 | Signal Sent          |
|    |           |             | Off                   | 4.89                 | Signal Not Sent      |

Results of the push button testing in Table 1 shows the voltage is obtained when the condition of 4.89V push button off, then when the push button on voltage condition obtained at 0.01V. When the push button is currently turned on, it will enable the Arduino Mega SIM 900A to send messages (SMS) form on the condition of the ship in an emergency.

3.1.1 Red push button
Red push button testing is performed by pressing the red push button for 2 seconds, until the red LED light turns on. Then the LCD display will send the message to the recipient of the information. Results of the testing device can be seen in Figure 5.

![Figure 5](image-url)

Figure 5. Results SMS Gateway (left) when the red push button is pressed (right)

3.1.2 Yellow push button
Testing is carried on yellow push button by pressing the yellow push button for 2 seconds, until the LED light turns yellow. Then the LCD display will send the message to the recipient of the information. Results of the testing device can be seen in Figure 6.
Figure 6. Results SMS Gateway (left) when the push button is pressed yellow (right)

3.1.3 Green push button
Green push button testing is done by pressing the green push button for 2 seconds, until the green LED lights up. LCD display will send a message to recipients of information. Results of testing the device can be seen in Figure 7.

Figure 7. Results SMS Gateway (left) when the green push button is pressed (right)

3.1.4 Blue push button
Blue push button testing is done by pressing the blue push button for 2 seconds, until the blue LED light turns on. Then the LCD display will send the message to the recipient of the information. Results of the testing device can be seen in Figure 8.

Figure 8. Results SMS Gateway (left) when the push button is pressed blue (right)
3.2 LED Testing
LED testing aims to determine whether the LED as an indicator of the state of vessel emergency can function and work optimally. LED is connected to pin 5, 6, 7, 8 and GND on the Arduino Mega and push a button to get a signal from each LED. Testing device used is multimeter and oscilloscope.

![Figure 9. Testing on the LED](image)

Figure 9 shows the results of measurements of voltage on the LED anode leg. Voltage is obtained by 1.81V push button connected limiting resistor due to the incoming voltage on the LED anode leg. For results and the type of test information corresponding push button input device is presented in Table 2.

### Table 2. LED testing results

| No | Condition | LED | Measured Voltage (V) | Type of Information (SMS) |
|----|-----------|-----|----------------------|---------------------------|
| 1  | Fire      | Red | 1.81                 | Ship in dangerous condition, fire take place |
| 2  | Collision | Yellow | 1.80               | Ship in dangerous condition, due to collision |
| 3  | Sinking   | Green | 1.81                | Ship in dangerous condition, due to leakage and flooding |
| 4  | Aground   | Blue | 1.80                 | Ship in dangerous condition, due to aground |
| 5  | –         | No Push Button | 0                   | – |

3.3 Testing of GPS Neo 6MV2
GPS testing aims to determine that the GPS can receive the coordinates properly. GPS functions as a data input device shipboard emergency information system. The device used in the testing of GPS was multimeter and oscilloscope, as depicted in Figure 10. The results of the GPS input is in the form of latitude and longitude coordinates of the location of the incident. Parameters obtained by the GPS is displayed on an oscilloscope. Tests are performed in coastal waters to ensure the accuracy of the coordinates of the GPS module.
GPS testing results are shown in Table 3. Forms of the signal variation can be seen on the oscilloscope screen. This is because the TX pin as the sender has a signal delay (pause) on the delivery of GPS data. Whereas the GPS position is always in the real time and changeable, so that the pin TX suffer from delays in data collection of point coordinates. In the RX pin the results obtained are digital signals for the RX pin that will change as the push button is pressed, so that there is a signal that is disconnected at the time of data collection.

GPS testing was also conducted at various locations to determine the level of error from the GPS, the results of which are presented in Table 4. There are five different locations with the corresponding coordinates are included in this study, as follows:

a. Bridge of Sei Carang
b. Port of Sri Bintan Pura
c. Bridge of Dompak
d. Coastal Senggaran
e. Port of Tanjung Sebauk
Table 4. GPS testing at several locations

| Location                  | GPS Instrument | LCD Display | Push Button |
|---------------------------|----------------|-------------|-------------|
| Bridge of Sei Carang      | 0.930307, 104.492137 |             | Red         |
| Port of Sri Bintan Pura   | 0.931865, 104.437751 |             | Yellow      |
| Bridge of Dompak          | 0.892366, 104.454376 |             | Green       |
| Coastal Senggaran         | 0.942650, 104.434913 |             | Blue        |
| Port of Tanjung Sebauk    | 0.977548, 104.418540 |             | Green       |

3.4 Testing SIM Device 900A

900A driver's license testing is performed to ensure the device can function as a data sender via SMS. Testing is done by using a multimeter to get a working voltage and an oscilloscope to get the form data. Testing is performed by connecting pin VCC, RX and TX on SIM 900A in multimeter and oscilloscope. The test instruments and systems can be seen in Figure 11.

![Testing SIM 900A on the multimeter (left) and SIM 900A TX pin display on the oscilloscope and multimeter (right)](image)

Figure 11. Testing SIM 900A on the multimeter (left) and SIM 900A TX pin display on the oscilloscope and multimeter (right)

Testing of any single SIM pin 900A has a difference with another due to the function of each pin. The shape of the signal and the voltage measured on the SIM pin 900A are pin VCC, TX and RX. Source voltage pin VCC is a SIM pad 900A. Pin is a radio transmitter TX and RX is a receiver. Testing of data transmission in the form of SMS to the recipient was also conducted to evaluate the response of SIM
900A at the time of sending emergency information. Pin used as the sender information is the transmitter pin TX. Table 5 listed the GPS results on any condition of emergency.

Table 5. GPS test results on any condition of emergency

| Condition       | Push Button | Voltage Pin TX (Volt) | Information Content (SMS)                                                                 |
|-----------------|-------------|-----------------------|-------------------------------------------------------------------------------------------|
| Fire            | Red         | 3.897                 | **SHIP ACCIDENT WARNING!!!**  
MV. TEKNIK ELEKTRO  
Fire Take Place  
Ship Position:  
Latitude = 0.934004 and  
Longitude = 104.441095.  
PLEASE HELP IMMEDIATELY! |
| Collision       | Yellow      | 3.366                 | **SHIP ACCIDENT WARNING!!!**  
MV. TEKNIK ELEKTRO  
Collision has happened  
Ship Position:  
Latitude = 0.934004 and  
Longitude = 104.441095.  
PLEASE HELP IMMEDIATELY! |
| Leakage /      | Green       | 3.396                 | **SHIP ACCIDENT WARNING!!!**  
MV. TEKNIK ELEKTRO  
Sinking in process  
Ship Position:  
Latitude = 0.934004 and  
Longitude = 104.441095.  
PLEASE HELP IMMEDIATELY! |
| Flooding /     |             |                       |                                            |
| Sinking        | Blue        | 3.498                 | **SHIP ACCIDENT WARNING!!!**  
MV. TEKNIK ELEKTRO  
Flooded and grounding  
Ship Position:  
Latitude = 0.934004 and  
Longitude = 104.441095.  
PLEASE HELP IMMEDIATELY! |

3.5 20X4 LCD Testing

LCD testing aims to determine whether the device is functioning properly and in accordance with the design that has been created. LCD testing is conducted by measuring the voltage on the I2C foot on the LCD. Voltage measurement is performed to determine the LCD can work with normal voltage. Figure 12 illustrate the LCD testing with multimeter and oscilloscope.

3.5 20X4 LCD Testing

LCD testing aims to determine whether the device is functioning properly and in accordance with the design that has been created. LCD testing is conducted by measuring the voltage on the I2C foot on the LCD. Voltage measurement is performed to determine the LCD can work with normal voltage. Figure 12 illustrate the LCD testing with multimeter and oscilloscope.

The device can work well according to the results that have been obtained.

![LCD testing with multimeter and oscilloscope](image-url)

Figure 12. LCD testing with multimeter and oscilloscope
Based on the data in Table 6 that the voltage measured at each leg of the LCD has a fairly small margin. This test proves that the LCD device can run well.

| Power Supply (V) | Condition          | Measured Voltage (V) | Signal Form                        | LCD Display |
|------------------|--------------------|----------------------|------------------------------------|-------------|
| 4.96             | Fire               | 4.77                 |                                    |             |
|                  | Collision          | 4.73                 |                                    |             |
|                  | Leakage            | 4.73                 |                                    |             |
|                  | Aground            | 4.72                 |                                    |             |
|                  | No Emergency Occurs| 4.72                 |                                    |             |

Table 6. Results of 20X4 LCD testing results

3.6 Analysis

The device has three sequential steps, namely input, process and output. The device has two inputs in the form of push button and location data from the GPS. The process is the reading the data input from the push button, which has different information, namely:

- Red: Fire / Explosion
- Yellow: Collisions
- Green: Leakage and flood lead to sinking
- Blue: Run aground

Input process GPS location data takes about 1 to 2 minutes to wait for a signal from the satellite at the time it is turned on. After getting the signal from the GPS satellite, the GPS can be used in real time. GPS is also capable of recording the data even if taken when driving or sailing. Data generated on the GPS are latitude and longitude and then processed by the Arduino to be displayed on the LCD 20X4. 20X4 LCD has the ability to show more characters, so that the data from the GPS can be viewed in detail and in real time.

LED serves as an indicator in accordance with each color push button. At the time of the position on the push button LED also received input voltage. Arduino will process the data obtained from push button and GPS. Therefore, information such as emergency and coordinate points on the device are displayed. Data were processed and received by SIM 900A as the media sender. SIM 900A requires a signal to send the message. 900A SIM signal obtained from provider (network provider). It takes 10 to 20 seconds at startup to get a signal from the provider.

Indicators signal that has been received can be viewed on the LED located on the SIM 900A. Speed
is an important factor in an emergency rescue system. The faster the delivery accident information is sent, the faster rescuers will perform the rescue actions and minimize casualties. Data retrieval is done 10 times and obtained an average delivery of data to the receiver takes some 5.32 seconds. Successful data delivery occurs when the buzzer is active. Buzzer will be activated simultaneously when the SIM 900A sends information in the form of SMS to the recipient.

4. Conclusions
The device so developed from the current research will be active if it has received the GSM and GPS signal and will not get the coordinates if the SIM 900A does not obtain a signal. The device is easy to use and efficient because it is not difficult to get a GSM signal. The device does not require a large power because it only requires 5V voltage with a current of 1 to 2 amperes. SIM 900A can transmit the information of location’s latitude and longitude obtained from the GPS module with accuracy to facilitate the rescue process. Information obtained in the form of an emergency warning that makes the recipient well informed to aid and relief. The average data transfer speed is 5.32 seconds, so rescuers can quickly perform a rescue. The LCD will return to show the coordinates after sending data.

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