An Improved Design and Implementation of IoT Based Road Accident Avoidance System for Motorcycles

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ABSTRACT

In this project, designed and implemented effective and technological way of smart monitoring to avoid acciden1s using IoT. Arduino microcontrollers are used to control the entire system. Sharp IR sensor detects the head of the motorcyclist within the range of 10-80 cm. In order to enhance more safety on motorcycle especially during night times, detecting and implementing a couple of parameters like tire pressure malfunction, fuel exact status like its availability in quantity informa1ion and high speed notifications on display, in order to send above safely information, Wi-Fi Module is used for sending text message notification to family members of Bike rider when in ride.

Keywords: Helme1 Detection, Speed Detection, Fuel Detection, Pressure Detection, Buzzer, Notifica1ion, LCD display, Wi-Fi ESP 8266, Arduino.

1. Introduction

The worldwide status report on road safety in 2018, distributed by WHO in December 2018, features that the quantity of yearly road traffic deaths has come to 1.35 million with the most victims are motorcyclist. Head injuries are the leading cause of death and major trauma. Liu et al. in [1] conveying that the correct use of helmets can lead to a 42% reduction in the risk of fatal injury and a 69% reduction in the risk of head injury. The utilize of a standard helmet is critical implies to anticipate the deaths occurs in traffic accidents.

The Indonesian government has made a law concerning road traffic and transport [2] in Article 57 Paragraph 2 states that the Indonesian National Standard helmet (SNI) is standard equipment for the motorcyclist. Article 106 Paragraph 8 of the Law, also states that every motorcyclist must use a SNI helmet. Then it is followed up on article 283 that any person who rides a motorcycle on the road improperly and does other activities or is affected by a condition that causes concentration disturbances in riding will be subject to sanctions.

Five main innovations that support the improvement of the Industry 4.0 framework in Indonesia are the Internet of Things (IoT), Artificial Intelligence, Human-Machine Interface, robotics and sensor technology, and 3D printing technology [3]. IoT carries the concept of connectivity of objects using the internet. Coetzee and Eksteen in [4] connectivity is improved from "anytime, anywhere" for "anyone" to "anytime, anywhere" for "anything". IoT by Patel and Patel [5] is connectivity to the internet among objects: people with people, people with machines, and machines with machines, which are pervasive, with wired or wireless connections and addressing schemes that is unique for creating applications or services with specific goals.

There are a few past articles or previous related works that have discussed smart systems using helmets as safety equipment with the following intelligence:

1) Forcing the rider to wear a helmet, otherwise the motorcycle engine cannot be started [6, 7, 8, 9, 10, 11, 12, 13, 14]

2) Give the rider a warning when drowsy [15] ed on making smart helmets with features to detect accidents and provide notification to other entities. They used a 3-axial BMA222 accelerometer to check the three orthogonal spatial components of the x, y, z directors of the helmet. Accidents occured when there are shocks/collisions that cause changes in the value of the threshold that has been determined from the x, y, z helmet. The GPS module and the CC3200 microcontroller wireless were used to process the condition of the change in value as an accident along with its latitude and longitudinal location sent to the cloud-based web service. Notification of an accident via email / SMS to other entities along with its location using the Pager Duty REST API.
References [17] Shabbeer and Meleet used the MPU6050 6-axis accelerometer and gyroscope sensor to determine the accident by looking at the slope of the motor and in determining the accident's location using the NEO6M V2 GPS Module and tracking the accident location using the Google Maps API. They used the Arduino Uno microcontroller with Sim900 GSM Module for internet connectivity with the web server. Notifications were sent to other entities via email.
References [18] Lekha et al. detected accidents using a vibrator sensor in the presence of shocks to the helmet. NEO6M V2 GPS Module was used to provide latitude and longitude information on the accident's location so that it can be tracked with the help of Google maps. Notification to other entities was sent via SMS.
Public awareness to comply with traffic laws can be helped by the existence of a smart helmet that has several functionalities, including being obliged to wear a helmet and not riding when tired/drowsy or intoxicated. This is in order to prevent or reduce the higher accident rate. When an accident occurs, it should be able to be treated quickly to decrease the death rate. This can also be helped by IoT technology, where entities are connected to one another. The expectation is that if there is an accident, it can be quickly handled by others. In the smart helmet feature of accident detection and notification along with the coordinates of the accident location that can be tracked.
This article discussed a prototype of a smart system that uses IoT technology. It was organized as follows: Section 2 presents the prototype design. Section 3 offers result and discussion, and finally, this research work is concluded in Section 4. This system involved objects such as helmets which are standard equipment, motorcycles and people (via smart phones). They were connected in both wired and or wireless networks in an application or system. This system was designed to support motorcyclist safety. The development of previous work was that this system combined several features from previous works: (1) helm detection, (2) drowsiness detection, (3) accident detection and notification, (4) location tracking. Previous works used a third party: Pager Duty and Email or SMS for notification and share location while the system in the present study used an Android-based application.

2. Prototype Design

The System applied the Internet of Things (IoT) technology using the real time database firebase platform and wireless microcontroller node MCU. The objects (motors, helmets, and riders) were connected in the internet network with the firebase and node MCU platforms. This design was illustrated using a system architecture, component block diagrams, and program pseudo code

2.1. System architecture

The IoT-based system architecture shown in Figure 1 is a network between objects (helmets, motorcycles, riders) on the Firebase and Node MCU platforms.

Figure 1. System architecture.

2.2. Embedded in helmet

Node MCU microcontrollers, sensors and other electronic components were embedded in helmets and motorcycles. They were used to sense/record data using a helmet or not, drowsy or not, rider status: safe or danger (accident) and accident location: latitude and longitude. These data a hotspot network of smart phones.

Figure 2 shows a block diagram of the electronic component that embedded in the helmet.

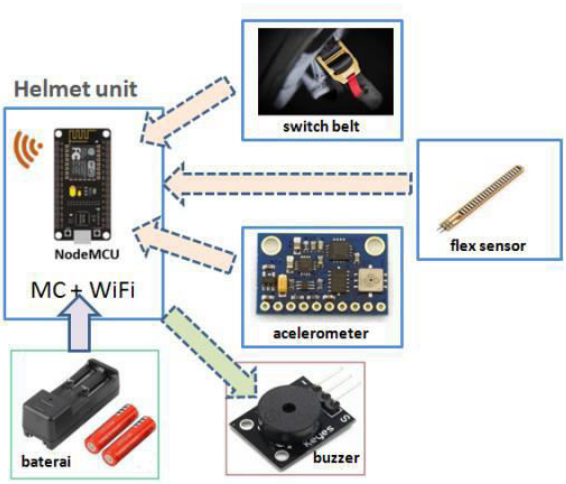

Figure 2. Block diagram of electronic devices at helmet unit.

On the helmet, there was a microcontroller, switch belt, accelerometer gyroscope sensor, flex sensor, buzzer, and power supply. The microcontroller component used Node MCU to process the input data from the accelerometer sensor and switch belt as a trigger to turn on the actuator. The relay on the motorcycle through firebase became actuators from the switch belt and flex sensor. If the riders do not use helmet and switch belt properly, the relay disconnected the motor ignition. Buzzer became an

2.3. Embedded in motorcycle

Accelerometer actuator when it was detected drowsiness with a predetermined slope, is considered to be drowsy. Some DC battery supplied all electronic components.
Figure 3 shows a block diagram of electronic components embedded in the motorcycle.

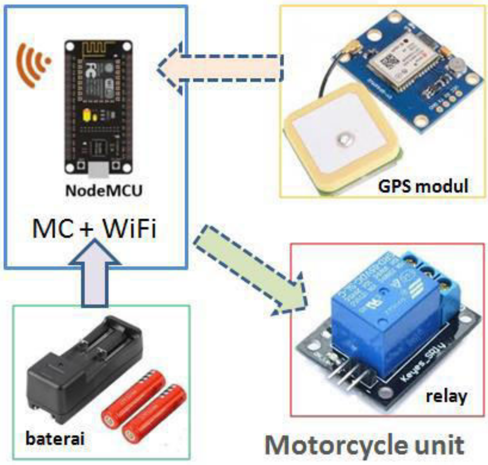

Figure 3. Block diagram of electronic device at motorcycle unit.

On a motorcycle, there were Node MCU microcontroller, GPS module, relay and power supply. The GPS module used UBLOX NEO-6M V2 GY-GPS6MV2, to record the latitude and longitude of the accident location. When the accelerometer GY-521 MPU6050 3-AXIS on a helmet detected a shock or accident, the system sent location data to Firebase and notified other users. Other users through Android application can track the accident's location

3. Result and Discussion

3.1. Result

The functionality of this helmet has been tested. The belt switch was designed by using a copper wire connection through the helmet belt. The connection made conditions on like a switch, meaning the helmet was used properly. And then the flex sensor ensured the helmet was used by the rider. The electronic component was embedded on the helmet, so that it is pervasive, integrated into the helmet

Figure 8. Electronic devices embedded at helmet unit.

The prototype to show the system can run on a motorcycle using a mini replica. The dc motor was used as a substitute for the ignition engine. The DC motor was disconnected by a relay contact ignited from the Node MCU microcontroller. GPS modules were installed on the motorcycle, as shown in Figure 9.

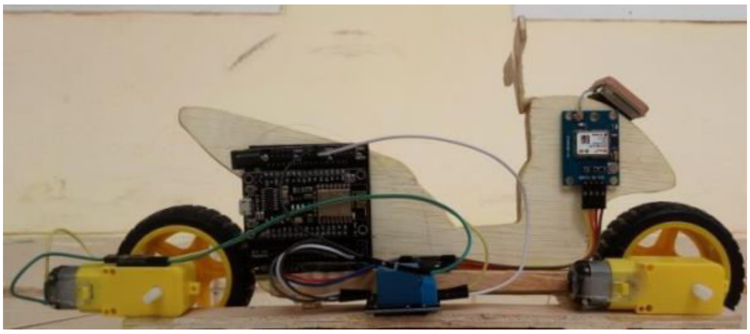

Figure 9. Electronic devices embedded on motorcycle unit.

Helmet switch belt functionality testing aimed to fasten the helmet strap properly so the engine can start. This test was carried out 60 times. When the helmet strap is not fastened, the engine will not start and to ensure the helmet used by the rider, a flex sensor was added. The helmet was worn when the flex sensor value is above or equal to 330 [19]. Table 1 shows the helmet detection test results.

Table 1. The helmet detection test result.

Condition of helmet	Average flex value	Switch belt	Expected as detection	System detection
				True (10 from 10 testing)
Being brought	294	on	False	False (10 from 10 testing)
Being hanged	309	on	False	False (10 from 10 testing)
Being worn	335	off	False	False (10 from 10 testing)
Being brought	292	off	False	False (10 from 10 testing)
Being hanged	307	off	False	False (10 from 10 testing)

The rider status shown in Figure 10 are friends seen in the nearest Google map. If a friend has an accident, there is a notification, and the location of the incident can be traced.

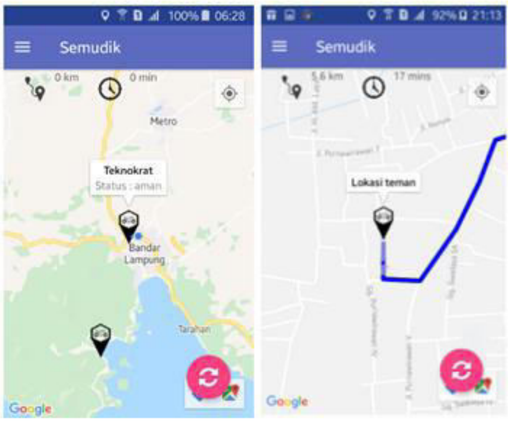

Figure 10. Rider status and tracking rider's location at Android App.

4. Conclusions

The prototype of the smart system has successfully implemented Internet of Things (IoT) technology, which can build connectivity between objects: motorcycle, helmets and riders/others via smart phone for support motorcyclist safety. Four system features have been functionally tested. They are helmet detection, drowsiness detection, accident detection and notification, and tracking location of the accident. The test results are successful and in accordance with how the system works. The accuracy value for helmet detection is 100%, drowsiness detection is 87%, and accident detection is 90%. Rider status and location can be monitored and tracked by others via the android application. This system is helpful for support the safety of the motorcyclist.

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