A Motorcycle Safety System Design based on the Internet of Things

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Abstract

A huge number of motorbike thefts are still happening in Surabaya City. The most way the thief does to steal the motorbike is damaging the ignition lock using a "T key" so that the motorbike can be started and can be taken easily by thief. Besides that, there are still many other ways to thief the motorbike. The number of theft cases indicates that there are some weaknesses in the safety system on motorbikes made by manufacturers, especially on motorbikes that use the conventional ignition lock system. Along with the rapid development of increasingly sophisticated technology, it can be utilized to improve the security system on motorbikes. The conventional ignition lock is very easy to break into and is not effective in preventing theft. Designing a system that can turn on a motorcycle through an e-KTP scanning using RFID can be the respond to the huge number of theft cases in Surabaya City. This system uses NodeMCU ESP8266 as a microcontroller that is connected to modules such as RFID, GPS, and relays. Through this system, the owner can also monitor the position of his motorcycle through an application connected to the GPS and microcontroller placed in the motorcycle. In case of theft, the motorcycle owner can turn off the motorcycle through the application then the motorcycle will die and cannot be restarted.

Keywords: *Motorcycle, RFID, e-KTP, GPS Neo 6M, NodeMCU-ESP8266*

1. Introduction

Along with the rapid development of the sophisticated technology and numerous fields exploiting work development technology to support the better human life quality. The development of this technology can be used to improve the motorbike safety system. It is known that in the old version of motorbike using the traditional key for locking and unlocking the motorbike system. Locking and unlocking system in the traditional key using “T key” that still have some safety issues. The “T key” lock is easily broken by the the thief. To improve the safety issues of the “T key” lock system, we need an innovation to secure the old version of motorbike [1], [2]. One way to improve the safety system on the old version motorbike, it can be examined from the the way to start running the motorbike. The traditional way to start running the machine is that we must inject the “T key” then the motorbike will start running the machine. But there is research that adopts RFID technology to start running the machine of motorbike. In the research, RFID receiver will get the signal from the RFID tags [3], [4]. One of the RFID tags that can be used is E-KTP. E-KTP is a unique identity card that all the citizens must have. E-KTP is used as the alternate of “T-key” to start running the electricity and machine of the motorbike. E-KTP in Indonesia is used as the identity card owned in 17 years old. Along the time, E-KTP is used as the identity card only. As the development of RFID, it can be used in RFID technology as RFID tags[5], [6], [7].

Based on the early research related to motorbike safety improvement, there are some researches relevant to the topic. Research related to the E-KTP used as identity authentication is explained by F. Fauzi. The research explained their ignition system based on RFID technology that uses E-KTP as the user identification rather than traditional ignition. The system uses ATmega328 on Arduino UNO microcontroller that is connected to the RC522 RFID Reader. Then, the system controls the relays and solenoid lock[8].

The other research from P. Sihombing explained that they proposed the prevention of theft by using sensors and microcontroller connected to the smartphone. When the theft happens, the sensor will be activated automatically and send the notification warning and location to the owner through the smartphone via internet. The owner can also turn off the motorcycle through their smartphone [9].

Another research is explained about motorcycle security system using RFID, GSM and GPS using Nodemcu as a microcontroller. RFID reader is used to read E-KTP tags whereas GPS is used to get the location of motorbike through Latitude and Longitude. There is also GSM module to interact with the smartphone through SMS [10].

Based on the related research, the motorcycle safety system design based on the IoT is developed. There are three main processes in this research. The first process is the ignition system using RFID authentication to start running the motorbike. Then, the second process is the system can monitor the location of the motorbike. The third one is the system that can control the motorbike through the smartphone based on Internet of Things.

2. Method

The used research method is experimental research then, it means to analyze the causality between the component included. The system in this research consists of hardware and software designs as shown as Figure 1. Figure 1 explains the scheme of the whole research system. Hardware and software are integrated for running the three main processes. They are key authentication for the motorbike ignition system, position monitoring by detecting moving motorbike with no key authentication and automatic turning off the motorbike based on IoT.

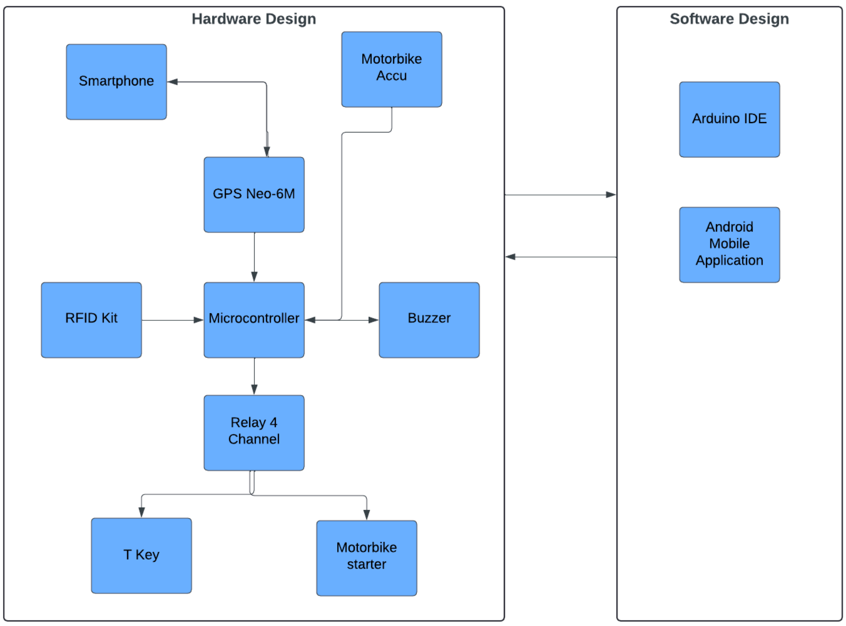

Figure 1. Research diagram

The used hardwares are GPS Neo 6M to obtain Latitutde and Longitude of motorbike location, RFID kit to authenticate ignition system, Relay 4 Channel to connect the RFID kit with the “T Key” and motorbike starter. On the other hand, the system uses the buzzer as a warning system for moving motorbike with no RFID authentication. All the hardware connects to the mobile apps through the internet to monitor the motorbike location. The used hardware in this research topic as shown as Table 1.

Table 1. The hardwares used in the safety system design

Numb.	Name	Description
1	NodeMCU ESP8266	It is used as a microcontroller for connecting all modules. The microcontroller is equipped with Wifi to communicate the microntroller to the mobile application for the motorbike position monitoring
2	RFID-RC522	It is used to read the E-KTP ID or any other RFID tags. The E-KTP card based on RFID technology used in this research
3	Relay	It is used to control (turn on/off) the electricity and machine in the motorbike
4	Step down LM2596	It is used as voltage conversion from the motorbike's accu to control the amount of voltage that streamed to the microcontroller
5	GPS u-blox Neo6M	It is used for motorbike locations monitoring. Location data is obtained from GPS and stored in the database
6	Buzzer	It is used as a warning that electricity and machine has been turned on. Besides that, it is also used as theft warning system
7	Jumper Cable	It is the cable connector between the Arduino and the modules
8	Motorbike's Accu	It is used as the main resource for the hardware kit and the motorbike

3. Results and Discussions

The evaluation schemes are designed to observe the optimal RFID signal range between RFID receiver and RFID tags. Furthermore, the evaluation schemes are also designed to observe GPS accuracy. The evaluation schemes are running on the environment divided into three sub-environments. They are motorbike specifications, hardware and software specification.

(1) Motorbike specifications
Brand : Honda Supra X 125
Production year : 2005
Electricity system : Full-DC (modification)
Accu capacity : 12 V x 5.5 A

(2) Hardware specifications
The hardware specification used in this research as shown as Tabel 2

Table 2. Hardware specifications

Numb.	Specification parameter	Description
1.	Height	4 cm
2.	Length	16 cm
3.	Width	14 cm
4.	Input voltage	6 V
5.	Microcontroller	NodeMCU ESP8266
6.	Transmission	WiFi
7.	Navigation system	GPS Neo-6M

(3) Software specifications

The software specification used in this research as shown as

Table 3. Software specifications

No.	Specification parameter	Description
1.	Application name	SmartMotorStart
2.	Memory size	13 MB
3.	Mode	Online
4.	Android version	8.0 Or newer

(4) RFID range evaluation

RFID range evaluation scheme is designed to observe and find the optimal range between RFID sender and receiver. Based on the early hypothesis, the range between RFID sender and receiver predisposes the rate of RFID receiver to receive signal from RFID sender. Optimum level is determined by the rate level of RFID receiver ro receive signal from RFID sender. The lower the rate of RFID receiver, the more optimal RFID receiver in receiving signal.

Evaluation scheme is designed to three types of RFID tags, they are E-KTP (Citizens Identity Card), KTM (College student Identity Card) and RFID tags from RFID kit. It is examined in case of range variety between 0.1 cm ~ 3 cm. Data samples taken as many as 30 datas in each range variety. Based on the results, it is shown that the most optimal range of the card to be read are 0.1 ~ 2 cm. success rate for each RFID tags type is, E-KTP 94.4%, KTM 98.9% and RFID tags kit 100%. The average time for RFID kit to read the RFID tags is in the range 29 ~33 ms

(5) GPS accuracy evaluation

GPS accuracy evaluation scheme is designed to observe and find the error rate of GPS Neo-6M to determine the motorbike location. The Error rate is determined by calculating the deviation between latitude-longitude GPS Neo-6M and the GPS android smartphone as the golden standard. Latitude and longitude from the golden standard and GPS Neo-6M taken as many as 30 data each. Error rate is determined using *Euclidean Distance.* The result of the GPS accuracy evaluation is shown as Table 4.

The results of GPS accuracy evaluation can be seen from the error rate that in the range of 2.01 m until 38.58 m. As the evaluation schemes, some factors provide the impact to GPS error rate. One of the factors is the indoor positioning to GPS can reduce the signal received from satellites accurately.

(6) The user interface of the system

The user interface of the system is used to view the motorbike location and control the engine when the motorbike is moving around without authentication. The user interface is shown as Figure 2.

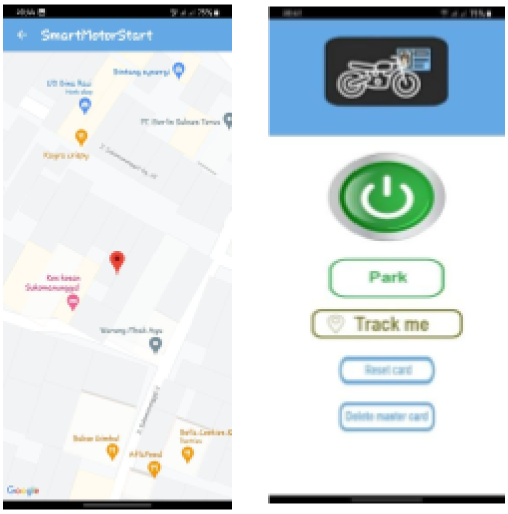

Figure 2. The User interface of the system

Table 4. GPS accuracy evaluation results

Menit ke-	Koordinat Lokasi (GPS Android)		Koordinat Lokasi (GPS Neo-6M)		Error (m)
	Latitude	Longitude	Latitude	Longitude	
0	-7.265302	112.696669	-7.265099	112.696505	19.34
1	-7.265292	112.696610	-7.265142	112.696447	24.66
2	-7.265278	112.696577	-7.264968	112.696422	38.58
3	-7.265265	112.696532	-7.265014	112.696460	29.07
4	-7.265252	112.696585	-7.265153	112.696508	13.96
5	-7.265232	112.696527	-7.265170	112.696549	7.32
6	-7.265237	112.696579	-7.265177	112.696557	7.11
7	-7.265282	112.696523	-7.265187	112.696542	10.78
8	-7.265238	112.696579	-7.265242	112.696515	7.14
9	-7.265245	112.696524	-7.265202	112.696513	4.94
10	-7.265237	112.696575	-7.265191	112.696520	7.98
11	-7.265242	112.696525	-7.265178	112.696537	7.25
12	-7.265239	112.696556	-7.265213	112.696533	3.86
13	-7.265238	112.696520	-7.265138	112.696556	11.83
14	-7.265244	112.696554	-7.265144	112.696528	11.50
15	-7.265215	112.696545	-7.265177	112.696507	5.98
16	-7.265261	112.696609	-7.265207	112.696494	14.14
17	-7.265258	112.696621	-7.265197	112.696502	14.89
18	-7.265240	112.696554	-7.265197	112.696502	7.51
19	-7.265240	112.696552	-7.265205	112.696532	4.49
20	-7.265232	112.696545	-7.265222	112.696530	2.01
21	-7.265224	112.696541	-7.265230	112.696578	4.17
22	-7.265227	112.696555	-7.265318	112.696552	10.14
23	-7.265258	112.696592	-7.265361	112.696529	13.44
24	-7.265248	112.696562	-7.265212	112.696567	4.05
25	-7.265228	112.696542	-7.265363	112.696495	15.91
26	-7.265245	112.696578	-7.265336	112.696540	10.98
27	-7.265252	112.696574	-7.265252	112.696617	4.79
28	-7.265257	112.696560	-7.265284	112.696589	4.41
29	-7.265231	112.696597	-7.265278	112.696559	6.73
30	-7.265225	112.696597	-7.265284	112.696557	7.93

4. Conclusion

As the research explanations, it can be concluded that:

1. The most optimum distance that E-KTP tags can be read by RFID receiver is in the range 0.1 – 2 cm with the success rate of 94.4%
2. The location coordinates received by GPS Neo-6M have high differences because it is predisposed by the evaluation positions. The highest difference is in **38.58 m** and the lowest difference is in **2.01 m**

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