Development of smart and safe-bags for children based on microcontroller

A Baihaqi, W Djamiko and M Yusro*
Faculty of Engineering, Universitas Negeri Jakarta, Jl. Rawamangun Muka, Jakarta Timur, Indonesia

*myusro@unj.ac.id

Abstract. This study aims to develop smart and safe bag that children use to go to school. This bag can provide information about the bag's weight and the location of the user via text messages (SMS). The bag is designed using several main electronic devices, namely the microcontroller (Arduino Mega2560 board), the buck adjustable IC LM2956 module, the 5 Kg load cell sensor, the Neo 6M-V2 GPS module and the 800L-SIM module. From the test results, this bag system can measure the bag weight of up to 5 Kg with measurement accuracy reaching around 0.3 Kg; can read the user's position with the accuracy of the GPS position reading reaching around 25 meters, and can provide bag weight information and user's position through SMS communication. This bag is also capable of working for around 8 hours using a rechargeable Li-Po-3S 1400mAH battery.

1. Introduction
At present, the problems that often occur for children who go to school are complaints about the severity of school bag carried by children. The backpack is the most dominant bag used for school activities. Carrying bag have been known to be associated with complaints in the back area which can occur if the weight of the bag carried exceeds the limit of 10% [1,2].

Besides the problem of bag, another problem that arises is about criminality in children. Children are vulnerable to being the object of criminal acts. Todays, all over the world, crime against children is increasing at higher rates and it is high time to offer safety support system for the children [3]. One of the cases that disturbs the community is the case of missing children. During 2011 to 2016, the Indonesian Child Protection Commission (KPAI) recorded cases of missing children touching 233 cases [4].

Research about smart bag using load cell, GPS, and SMS has been carried out by other studies but it hasn't been created in an integrated application [5-7]. To overcome the above problems, it is necessary to have a system for measuring the weight of the child bag and monitoring the child's position. Child weight gauge that can measure the weight of a child's bag so that it does not exceed the weight of the bag recommended by the expert. Monitor the position of children who can provide information to their parents where the child's position.

This study aims to develop smart and safe bag that children use to go to school. This bag can provide information about the bag's weight and the location of the user via text messages (SMS). The bag is designed using several main electronic devices, namely the microcontroller (Arduino Mega2560 board),
the buck adjustable IC LM2956 module, the 5Kg-TAL220B load cell sensor, the Neo 6M-V2 GPS module and the 800L-SIM module [8,9].

2. Method
The system developed using research & development model by Borg & Gall [10]. The basic principles of this method are 1) the analysis, 2) the design, 3) the development and 4) the testing. A system that informs the bag weight and position of the Arduino Mega2560 based bag with a weight measuring system based on the 5Kg-TAL220B load cell and the HX711-ADC 24 bit which will detect the weight of the bag so that it does not exceed the weight of the bag that is not recommended by the expert with the Neo 6M-V2 GPS module to find out the GPS position, then it will send heavy SMS data to the destination number, and use a monitor system based on LCD Keypad and I2C as an interface with the use of this bag which is named "Smart and Safe Bag". Design of smart and safe bag can be seen in figure 1.

![Figure 1. Smart and safe bag design.](image)

3. Results and discussion
3.1. The 5Kg-TAL220B load cell test result
Results of 5Kg-TAL220B load cell test can be seen in table 1.

| No. | Weight User (Kg) | Bag's Weight Max (Kg) | Measured Wight of Load Cell (Kg) | Bag's Weight (Buz) | Result |
|-----|------------------|-----------------------|----------------------------------|--------------------|--------|
| 1.  | 20               | 2                     | 1                                | Safe (Off)         | Ok     |
| 2.  | 20               | 2                     | 2                                | Safe (Off)         | Ok     |
| 3.  | 20               | 2                     | 2.1                              | Not Safe (On)      | Ok     |
| 4.  | 45               | 4.5                   | 3                                | Safe (Off)         | Ok     |
| 5.  | 45               | 4.5                   | 4.5                              | Safe (Off)         | Ok     |
| 6.  | 45               | 4.5                   | 5                                | Not Safe (On)      | Ok     |
In table 1, weight measuring systems 5Kg-TAL220B load cell and HX711-ADC24 based are tested, produced accurate weight measurements. This proves that weight measuring systems 5Kg-TAL220B load cell and HX711-ADC24 based in good condition.

3.2. Neo 6M-V2 GPS test result
Results of Neo 6M-V2 GPS test can be seen in table 2.

Table 2. Data testing neo 6M-V2 GPS.

| No. | Place                        | GPS Position Data of Smartphone | GPS Position Data of Neo 6M-V2 GPS module | GPS Distance Difference(m) | Result |
|-----|------------------------------|---------------------------------|-------------------------------------------|-----------------------------|--------|
| 1   | IT Center UNJ                | Long -6.19424, Lat 106.87895   | Long -6.19437, Lat 106.87916             | 19.08                       | Ok     |
| 2   | Monument UNJ                 | Long -6.19519, Lat 106.87826   | Long -6.19531, Lat 106.87841             | 21.39                       | Ok     |
| 3   | In front of BAAK UNJ         | Long -6.19585, Lat 106.87819   | Long -6.19603, Lat 106.87807             | 23.55                       | Ok     |
| 4   | Economic Faculty UNJ         | Long -6.19367, Lat 106.87758   | Long -6.19378, Lat 106.87761             | 11.61                       | Ok     |
| 5   | Engineering Faculty UNJ      | Long -6.19361, Lat 106.87844   | Long -6.19374, Lat 106.87851             | 13.85                       | Ok     |

Average difference of position GPS 17.89

In table 2, the testing of the Neo 6M-V2 GPS module produces a fairly accurate GPS position with an average accuracy rate of 17.89 meters from 5 trials from different places. This proves that the Neo 6M-V2 GPS module is in good condition.

3.3. 800L-SIM module test result
Results of 800L-SIM module test can be seen in table 3.

Table 3. Data testing 800L-SIM module.

| No. | SMS come in SIM 800L | Sender | SMS Reply 800L-SIM to Registered User Number | SMS Reply come in Registered User Number | Result |
|-----|----------------------|--------|----------------------------------------------|------------------------------------------|--------|
| 1   | WEIGHT Registered    | Weight 1.0 Kg || SAFE! || 10:23 WIB || 10-12-2018 Lat: -6.19437, Lon: 106.87916 follow this link | Weight 1.0 Kg || SAFE! || 10:23 WIB || 10-12-2018 Lat: -6.19437, Lon: 106.87916 | Ok     |
| 2   | GPS Registered       | www.google.com/maps/place/-6.19437,106.87916 || 19-57 WIB || 10-12-2018 | www.google.com/maps/place/-6.19437,106.87916 || 19-57 WIB || 10-12-2018 | Ok     |
| 3   | weight Registered    | Unknown Commands | Unknown Commands | Unknown Commands | Ok     |
| 4   | GPS Registered       | Unknown Commands | Unknown Commands | Unknown Commands | Ok     |
| 5   |Hallo SIM800L Registered | Unknown Commands | Unknown Commands | Unknown Commands | Ok     |
| 6   | WEIGHT Unregistered  | SMS come in to Smart and Safe-Bag but, number not registered || Message: WEIGHT || Sender: *(No.Sender) | SMS come in to Smart and Safe-Bag but, number not registered || Message: WEIGHT || Sender: +6289635960428 | Ok     |
| 7   | GPS Unregistered     | SMS come in to Smart and Safe-Bag but, number not registered || Message: GPS || Sender: *(No.Sender) | SMS come in to Smart and Safe-Bag but, number not registered || Message: GPS || Sender: +6289635960428 | Ok     |
| 8   | Hallo SIM800L Unregistered | SMS come in to Smart and Safe-Bag but, number not registered || Message: Hallo SIM800L || Sender: *(No.Sender) | SMS come in to Smart and Safe-Bag but, number not registered || Message: Hallo SIM800L || Sender: +6289635960428 | Ok     |
In Table 3, testing on the 800L-SIM module which results when the module receives SMS then sends reply SMS according to the command written in the sketch program. This proves that the 800L-SIM module is in good condition.

3.4. **Smart and Safe-Bag test result**

Results of Smart and Safe Bag test can be seen in table 4.

| No. | Place                  | Condition       | Data Source | Data from SMS Reply come in Registered User Number | Difference |
|-----|------------------------|-----------------|-------------|--------------------------------------------------|------------|
|     |                        |                 | Weight      | Weight                                           |           |
|     |                        |                 | Object      | Bag’s                                            |           |
|     |                        |                 | GPS data of | Lon     | Lat       | Neo 6M-V2 Module Lon     | Lat         |
| 1.  | MTS. Yurja             | Outdoor         | 1 Kg        | -6.16006 | 106.93229 | 1.1 Kg                  | -6.16008    | 106.93226 | 0.1 ± 4.65 |
| 2.  | RPTRA Sukapura         | Outdoor         | 2 Kg        | -6.15507 | 106.92443 | 2.0 Kg                  | -6.15507    | 106.92438 | 0 ± 6.26  |
| 3.  | Jl. Pelajar Sukapura   | In Building 1 Floor In Building | 3 Kg | -6.15836 | 106.93294 | 3.1 Kg                  | -6.15835    | 106.93312 | 0.1 ± 19.18 |
| 4.  | Jl. Salon Sukapura     | In Building 2 Fl., on 1 Fl. | 4 Kg | -6.15570 | 106.93040 | 4.2 Kg                  | -6.15575    | 106.93025 | 0.2 ± 17.95 |
| 5.  | Pulo Gadung Trade Center | In Building 5 Floor, on 4 Floor | 5 Kg | -6.18331 | 106.91598 | 5.1 Kg                  | Cann’t get GPS signal |
| 6.  | Pulo Gadung Trade Center | Basement      | 5 Kg        | -6.18338 | 106.91627 | Cann’t get SMS and GPS signal |

Average difference 0.1 ± 12.01

In Table 4, after the sub-system is assembled into a smart and safe bag system, it can measure the bag weight with the accuracy of reading up to ± 0.3 Kg, GPS fear reaches ± 25 meters, and SMS communication can well when the system is outdoors, in a 1-story building and a 2-story building. When the system is in more than 2-floor buildings, SMS communication can still be done with the system, but the system does not get a GPS signal. Whereas when in the basement the system cannot carry out SMS communication or access GPS data.

The smart and safe bag system testing is carried out by testing one by one sub-system to be used which consists of a weight measuring system based on the 5Kg-TAL220B load cell and HX711-ADC, Neo 6M-V2 GPS module, 800L-SIM Module then tested for the overall system. TAL220B based weight measuring systems were tested and the HX711-ADC produced accurate weight measurements. This proves that the weight measuring system in good condition.

Testing on the Neo 6M-V2 GPS module produces a fairly accurate GPS position with an accuracy rate of 17.89 meters from 5 trails from different places. This proves that the Neo 6M-V2 GPS module is in good condition. Testing on the 800L-SIM module produces when the 800L-SIM module receives an SMS, it sends a reply SMS according to the command written in the sketch program. This proves that the Neo 6M-V2 GPS module is in good condition.

The test was found that after the sub-system was assembled into a smart and safe bag system it can measure bag weight with the accuracy of reading up to ± 0.3 Kg, GPS fear reaches ± 25 meters, and SMS communication can well when the system is outdoors, in a 1-story building and a 2-story building. When the system is in a more than 2-floor building, SMS communication can still be done with the system, but the system does not get a GPS signal. Whereas when in the basement the system cannot carry out SMS communication or access GPS data.
Figure 2 shows the results of bag testing, (a) the SMS informs the user that the bag weight is safe, (b) informs that the bag weight exceeds the standard, (c) The GPS informs the bag's existence. Based on the results of testing on all sub-systems and the overall system that has been carried out, it is known that the criteria for testing each sub-system and system as a whole have been reached and are running well. Based on the role of the test and the results of tests that have been carried out, the system can be applied to monitor the weight of backpacks used by children, monitor the GPS position contained in backpacks, and inform the weight and position of backpacks via SMS.

4. Conclusion
The smart and safe bag system can measure the bag weight of up to 5 Kg with measurement accuracy reaching around 0.3 Kg; can read the user's position with the accuracy of the GPS position reading reaching around 25 meters and can provide bag weight information and user's position through SMS communication. This bag is also capable of working for around 8 hours using a rechargeable Li-Po-3S 1400mAH battery.

Acknowledgments
This work was supported by The Department of Electrical Engineering, Faculty of Engineering, Universitas Negeri Jakarta. The authors would like to thanks for some anonymous reviewers in AASEC 2019 for their constructive comments and insightful suggestions that improved the quality of this paper.

References
[1] Legiran L 2012 Heavy Back Bags and Prevalence of Back Pain in Basic School Students ePrints UNSRI
[2] Zakeri Y, Baraz S, Gheibizadeh M and Saidkhani V 2016 Relationship between Backpack Weight and Prevalence of Lordosis, Kyphosis, Scoliosis and Dropped Shoulders in Elementary Students Int J Pediatr. 4(6) 1859–66
[3] Navya M, Rafi S M and Reddy K N 2015 Android Based Children Tracking System Using Voice Recognition Int J Comput Sci Mob Comput. 41(1) 229–35
[4] Indonesian Child Protection Commission 2016 Details of Case Data Based on the 2011-2016 Protection Cluster [Online] Retrieved from: http://bankdata.kpai.go.id/tabulasi-data/data-kasus-per-tahun/rincian-data-kasus-berdasarkan-klaster-perlindungan-anak-2011-2016

[5] Kusriyanto M and Saputra A 2017 Design of Integrated Digital Scales BMI Information with Voice Output-Based Arduino Mega2560 Teknoin. 22(4) 269–75

[6] Phulphagar V 2017 Arduino Controlled Weight Monitoring with Dashboard Analysis Int J Res Appl Sci Eng Technol. V(XI) 1164–7

[7] Lau S, Wong Y W, Luk F W and Kwok S S 2015 The effectiveness of a smart school bag system for reminding students of forgotten items and reducing the weight of their bags Springerplus 4(Suppl 2) O2

[8] Hermono I H, Rusdinar A and Ramdhani M 2015 Security Car System Based GPS and SMS e-Proceeding Appl Sci. 1(3) 2613–23

[9] Alshamsi H, Veton K and Alshamsi H 2016 Real Time Vehicle Tracking using Arduino Mega Int J Sci Technol. 5(12) 624–7

[10] Gall M D, Joyce P Gall, Walter R Borg 2017 Educational Research: An Introduction, 8th Edition [Online]. Pearson Education Retrieved from: https://www.pearson.com/us/higher-education/program/Gall-Educational-Research-An-Introduction-8th-Edition/PGM63179.html