

Development of Traffic Control Device for Road Construction

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Abstract : Roads are a fundamental component of transportation infrastructure, enabling the movement of people and goods. However, in order to maintain their functionality and ensure safe travel, roads must undergo regular maintenance and modifications to remain in a good state. This often requires partial closures of roads and the employment of flagmen to control traffic flow. Flagmen play a crucial role in ensuring the smooth flow of traffic and alerting road users of construction activity at a road construction site. Despite the importance of their work, previous records have shown that the role has a high level of hazard that needs to be addressed. Thus, a new device is necessary to replace the flagman in order to minimize the risk of accidents and fatalities. This research paper presents the design and development of a new device, a portable traffic controller, that has the potential to replace flagman workers in road construction. The device is comprised of three main components: the input, the processor, and the output. The input is a smartphone connected via Bluetooth to an Arduino Uno processor, which serves as the device's brain. The processor uses the information from the smartphone to control the output, which is a light that functions as a traffic controller. The device's design and development were guided by the principles of safety, efficiency, and ease of use. The device's portability allows it to be easily transported and deployed to different road construction sites, and its intuitive design ensures that it can be easily operated by anyone. The device's potential to replace flagmen has significant implications for improving safety at road construction sites, reducing the risk of accidents, and increasing the efficiency of traffic flow during construction activities. This research represents an important step towards enhancing the safety and effectiveness of road construction practices.

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1. Introduction

Improving traffic safety is a critical concern, and one approach is to avoid endangering the life of the flagman [1]. Unfortunately, contractors have inadvertently put the flagman's life in danger in many fatal circumstances. To address this issue, the project aims to adopt a technology-driven strategy to replace conventional flagman work. This is becoming increasingly feasible with the development of new technologies aimed at improving human existence in various ways [2]. An intelligent traffic signal is essential to optimize traffic flow, ensure safety inside work zones, and minimize fatalities and injuries caused by crashes [3]. However, many contractors lack the competence to follow road safety rules, posing a risk to both workers and the public. To protect safety, regulations established by authorities like the Department of Occupational Safety and Health (DOSH) contain legal standards. Nevertheless, some contractors disregard rules established by the Ministry of Works, leading to inadequate training for flagmen employed by these contractors [1]. This increases the risk of accidents. Despite the flagmen's efforts to guide traffic, they can occasionally have negative effects on their own safety and that of the public [4]. Therefore, improving training and adopting technological solutions are necessary to protect the safety of workers and the public.

In **Figure 1**, a flagman can be seen controlling the road without proper consideration for his own safety. He is using incomplete equipment to control traffic, notably lacking the most critical equipment, a safety helmet. The head is the most important part of the body and must be protected at all times. Additionally, the flagman is not providing any signboards such as 'SLOW' or 'STOP' signs that traffic users need to be aware of from a distance. Finally, there are no safety cones in place to indicate where the project starts and ends. To ensure the safety of workers and the public, it is essential to provide flagmen with proper equipment, including safety helmets, and to use signboards and safety cones to communicate effectively with traffic users. This will help to minimize the risk of accidents and injuries in the workplace.



Figure 1: Flagman working in high risk hazard condition

Adopting technological solutions are necessary to protect the safety of flagman workers and the public [5]. However, currently only a few devices have been created and marketed as alternative to replace the flagman. Among the device that have been created is the Micro Portable Traffic Signal which was invented by Madison Technologies as shown in **Figure 2**. The device is intended for traffic control around roadworks loaded with STOP/SLOW signs function [6]. The device is easy to set-up and operate with minimal training. The Portable Traffic Light includes a highly stable tripod fabricated from steel to stand up to the rigours of harsh environments and provide a long-lifespan. Each tripod leg is adjustable to enable upright operation on uneven terrain. Mounting of the lantern head is at waist height, minimising back strain and pinch points. Stability is enhanced with legs fully extended, reducing

the need for additional ballast in stronger winds or for when the quick-fit target board is required. However this device has a drawback interm of controlling the light [7]. The light is on and off depending on the presetting which could not sensitive to the real traffic condition. Beside that the devise also cannot be controlled via telecommunication device.



Figure 2: Micro portable traffic signal

2. Design and Development

In this project, a new traffic control device with a new features have been designed as illustrated in **Figure 3**. The device consist of various component. It is fitted with caster wheel that is free-rolling to enable easy movement across a road or other hard surface. Boom gate were used as door system that can be opened and closed. The gate was synchronized in real time with traffic signals of green and red color. The traffic signal can be manage on smartphone that is connected to the device via bluetooth communication. To power this Traffic Control Device Model, power bank were used to supply the required electrical energy. The power bank is capable of converting the incoming electric current into the appropriate voltage, current, and frequency, ensuring that our device operates effectively.

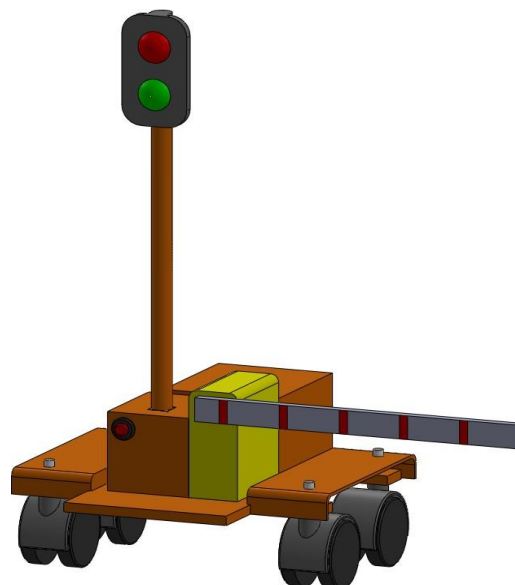


Figure 3: 3D model of of a new portable traffic control device

Table 1: Estimated cost of the traffic control device

No.	Materials and Parts	Quantity	Per Unit(RM)	Total (RM)
1.	PVC Model Board	5	7.40	37.00
2.	Caster Wheels	1 set	12.00	12.00
3.	Arduino Nano Set	2	47.80	95.60
4.	LED (red & green)	10pcs/2sets	1.17	2.34
5.	Connecting Wires Set	3	4.60	13.80
6.	Micro Servo Motor Set	2	10.85	21.70
7.	Ultrasonic Sensor	2	3.30	6.60
8.	HC-06 Bluetooth	2	13.90	27.80
9.	Push button	2	0.95	1.90
10.	Breadboard	2	0.93	1.86
Total Amount (RM)				220.60

Table 1 shows estimated cost of the device. There are ten parts in total. The most expensive part is the Arduino set, and it costs RM 95.00. On the other hand, the breadboard is the least expensive part, with a cost of RM 0.95. Add up the costs of all the parts, the total cost of making the device is RM 220.00. This shows that the tool is affordable for all road builders.

3. Results and Discussion

Figure 4 shows the design of traffic control device system. The traffic control device can be controlled using mobile phones from a certain distance via bluetooth. With phones, the user can send the signal to the HC-06 bluetooth module then to the Arduino processor. The processor will send the signal to both actuator which are the led light and also the servo motor which controls the barrier. All this can be done from a distance so the flagman's life is not at risk while working near the construction or in the middle of the road. Thus, reducing the risk of any accidents happening while they are on the job.

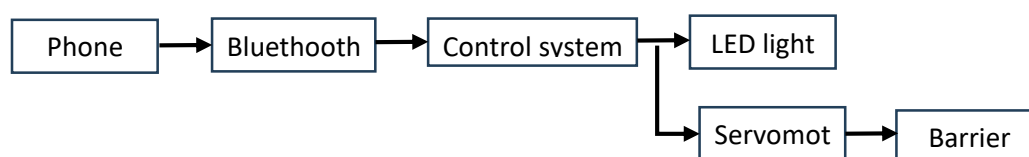
**Figure 4: Traffic control device system**

Figure 5(a) shows the serial monitor of the Arduino IDE software to control the output. This serial monitor can be used to test the function of the arduino in controlling the output component. A preliminary test has been conducted on the component of the device. The test is conducted by triggering the push button on the traffic control device. The ultrasonic sensor detecting the the simulated object and finally closing the barrier. Consequently, the red LED will received the signal and activated by producing red lightning indicating the user to stop the car (**Figure 5 (b)**). The system will turn on the green LED when the barrier is is up as shown in **Figure 5(c)** indicating the user to pass to the destination. **Figure 5(d)** and **Figure 5(e)** shows the final prototype of the traffic control device with the condition of barrier close with LED red light on and the barrier open with LED green on respectively.

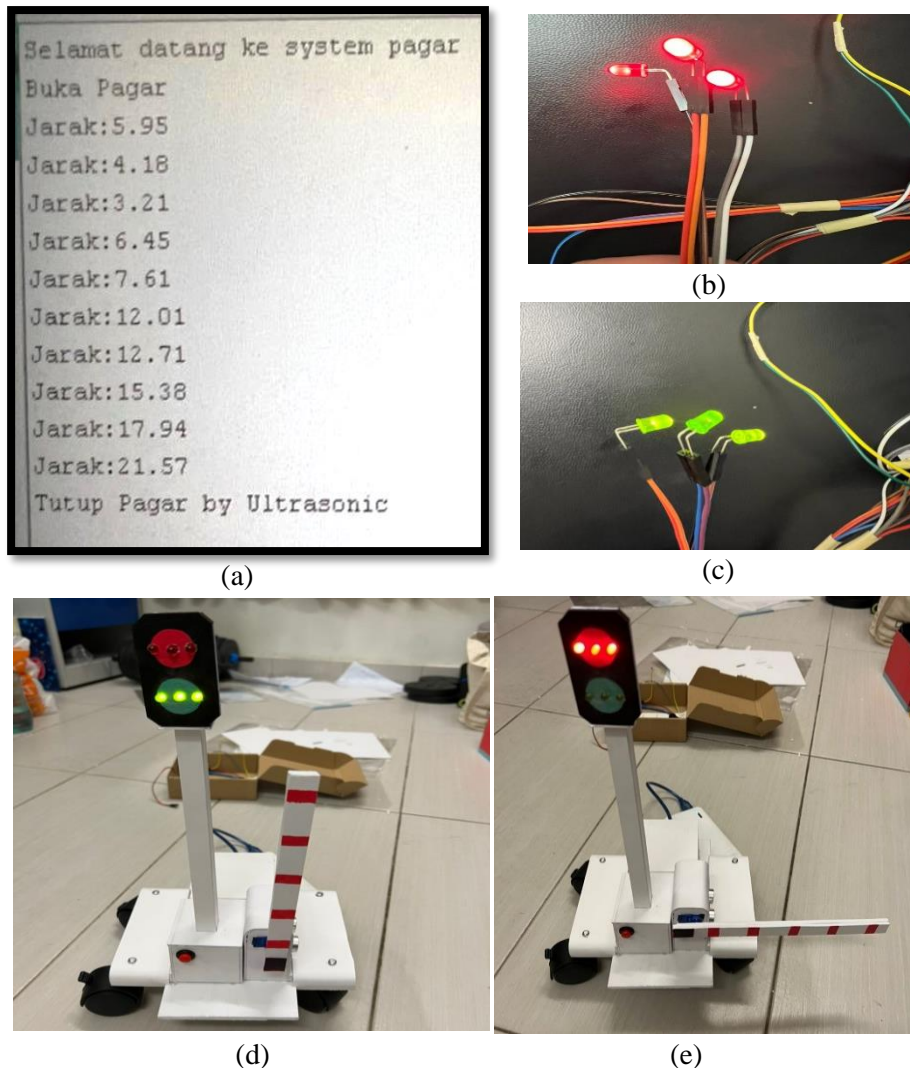


Figure 5 : Testing functionality of the device (a) Adruino serial monitor (b) testing red light LED (c) testing green light LED (d) Final prototype showing barrier open and LED green lightning (e) Final prototype showing barrier close and LED red lightning

While working on this traffic control device, we encountered a problem with the bluetooth connection as it cannot receive repeated signals from the phone. This is due to it disconnecting from our mobile device and the disconnection is due to the lack of power from the power bank and problems with finding another power source that is better suited for powering the entire device. As of now, the bluetooth module cannot function properly together with the servo motor as both these devices are known for taking large amounts of power simultaneously .

4. Conclusion

Utilizing a flagman is essential for ensuring safety and controlling traffic at road construction sites. The flagman, responsible for managing traffic, faces significant risks. To prevent accidents, both contractors and road users need to adhere to safety signs and regulations. Authorities should take measures to decrease risks for flagmen. Adopting new technology can greatly improve safety for flagmen and road users. Technological advancements have had a profound impact on daily life. A notable example is the Traffic Control Device developed in this project. This device can be controlled through a mobile phone. The system allows a single user located outside the construction area to manage it, reducing the need for flagmen at construction sites. This innovation enhances safety for contractors and the general public, potentially saving lives and costs. To address safety concerns in road

construction, authorities should actively encourage contractors to implement the device and adhere to safety regulations. This approach would contribute to minimizing accidents.

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