

Arduino Uno based Vein detection design using High Power LED (HPL)

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Article Info

Article history:

Received July 31, 2025

Revised September 16, 2025

Accepted October 25, 2025

Keywords:

Vein detector

Arduino uno

High power LED

PWM

Touch sensor

ABSTRACT

Difficulty in locating veins often poses a challenge in medical procedures such as intravenous catheterization or blood sampling, especially in children, adolescents, adults, and the elderly. This study designed and developed a vein detection device based on an Arduino Uno, utilizing a high-power LED (HPL) as the primary light source for locating veins. The device is equipped with a TTP223 touch sensor as the LED activation trigger and a PWM module to adjust light intensity according to the user's skin characteristics. The testing process was conducted on various age groups (children, adolescents, adults, and the elderly), with results showing that the device can clearly display veins, particularly in adolescents, adults, and the elderly, with optimal light intensity above 900 lux. The lowest average intensity was found in the children's group, indicating the need for more adaptive intensity adjustments. The device demonstrated stable and responsive performance and can assist medical personnel in accelerating the process of vein detection in a non-invasive, practical, and economical manner.

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1. INTRODUCTION

Health is a basic need that is very important if we pay attention to someone who experiences pain requires fast, precise handling and does not increase the pain, for example, such as searching for veins before infusion. The main problem related to venous access actions that can hamper help to patients is the difficulty of finding the right vein location. According to [1] establishing peripheral intravenous access is one of the most common and important steps in the management of critically ill patients. The challenge faced by clinicians over the years is that DIVA adversely affects patient outcomes by causing delays in diagnosis (difficulty in obtaining blood samples and administering intravenous contrast for advanced imaging). DIVA is a persistent problem faced by healthcare providers across various disciplines. Errors in determining the location of intra-venous insertion can lead to serious complications such as phlebitis. Location errors in intra-venous insertion can cause phlebitis, phlebitis is an infection by microorganisms of infused patients obtained during hospitalization followed by clinical manifestations that appear for at least 3x24 hours [4]. According to [5], phlebitis is caused by irritation of the venous tunica intima due to chemical, mechanical, bacterial factors, or post-infusion effects. This condition not only causes discomfort to the patient, but also risks worsening the clinical condition and prolonging the hospitalization period.

The development of technology has opened up new opportunities for paramedics and patients to make it easier to find accurate veins. Research to developed a vein visualization system using infrared imaging based on embedded system on Raspberry Pi 2 by [6], which is able to produce vein images. Visual quality improvement is done through Histogram Equalization (HE) and Contrast Limited Adaptive Histogram Equalization (CLAHE) methods. Meanwhile, [7] designed a vein detector using RGB LEDs with

adjustable wavelengths in the range of 600-696 nm. The vein detector can be used to detect veins from 10 patients with different ages, BMI, and skin color.

Based on the urgency of the problem and the potential solutions that exist, researchers propose the design of a vein detection tool, namely to find veins based on Arduino Uno using high power LEDs. This tool uses light from high power LED (HPL) as a vein object detector. This tool is designed to be able to show venous blood vessels by utilizing light from HPL characterized by the emission of light that is brought closer to the palm of the hand

2. METHOD

This research uses the design method, which aims to design an arduino uno-based vein detection tool using high power LED (HPL). This method was chosen because it is in accordance with the research objectives, namely to produce a tool that can facilitate medical personnel in detecting the location of veins that can facilitate medical personnel in finding the location of veins quickly.

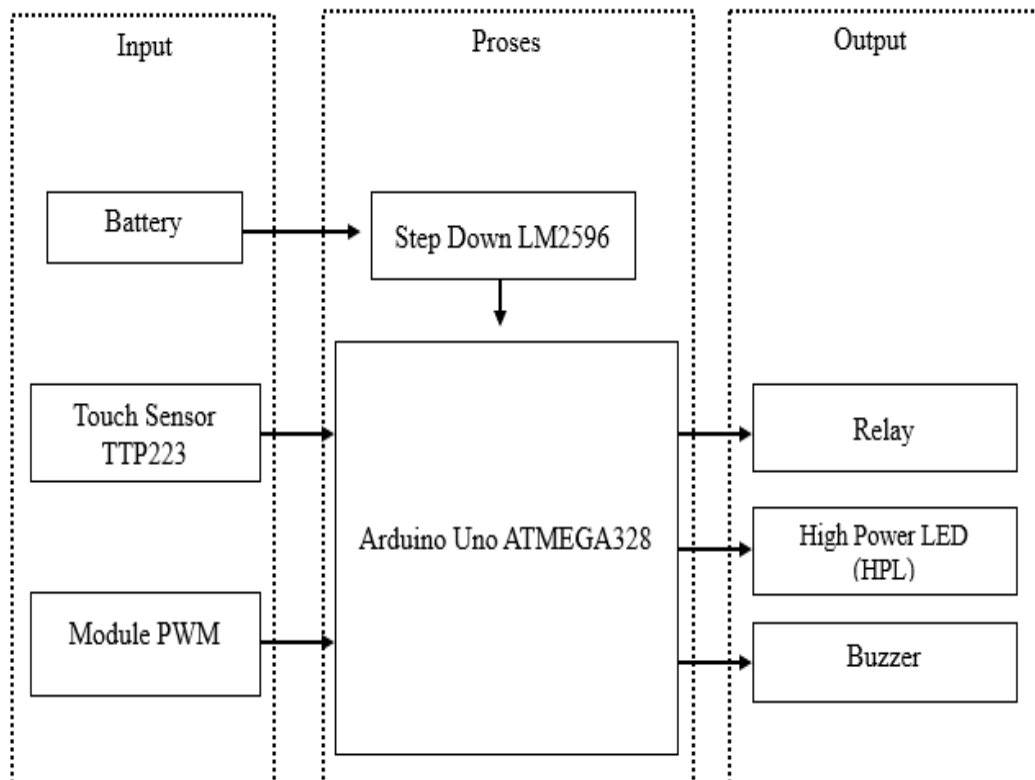


Figure 1. Block Diagram

This tool has the main components, namely the PWM Module, Touch sensor TTP223, Arduino Uno Atmega328, Step Down LM2596, Relay, High Power LED. LM2595 step down module to regulate and stabilize the voltage from the battery that will enter the device according to the needs of the device. Touch sensor TTP223 serves to respond to a touch then the sensor will send a signal that will be sent to the arduino, arduino acts as a microcontroller that will forward the signal from the touch sensor TTP223 to turn on the high power LED through the relay intermediary as normally open and normally closed [8]-[12]. The PWM module functions to regulate the intensity of light emitted by the high power LED, the PWM module adjusts how much light intensity is needed for the skin type [13]-[17].

Flowchart or also referred to as a flow chart is a diagram that shows what steps must be taken to carry out the process in a program. consists of several elements such as boxes, arrows, and other shapes that represent steps in a process, decisions to be made, or data processed. By using flowcharts, the complexity of a system or process can be simplified so that it is more easily understood by various parties, both technicians, developers and users. Figure 2 shows the proposed system.

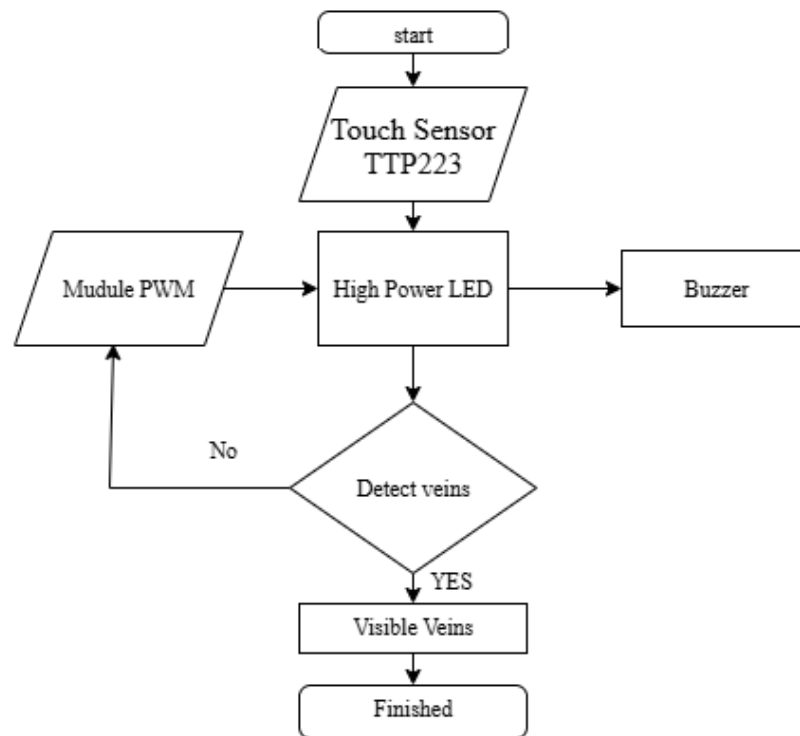


Figure 2. Flowchart

Hardware design is a technical process that combines mechanical and electrical aspects. The design for mechanics is to make a form of mechanical design of the tool system and electrical design is to make an electrical circuit that will be used in the tool. Figure 3 shows the electrical circuit of proposed system.

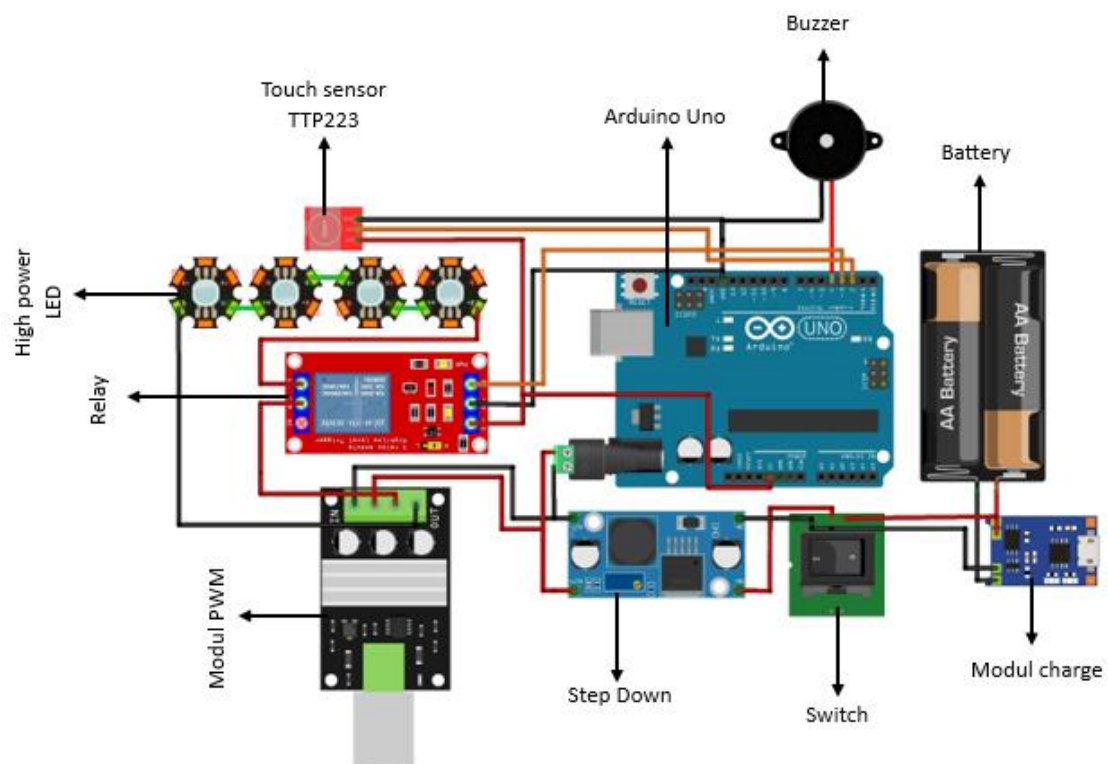


Figure 3. Electrical Circuit

This circuit is made using the fritzing application to make it easier to see the system of the circuit. There is a charger module to charge the battery and then this battery is connected to the switch for ON / OFF arduino. The source is channeled through a step-down module to adjust the voltage to suit the needs of the Arduino and other components. Once the system is active, the user can touch the TTP223 touch sensor to give commands to the arduino. When the sensor is touched, the Arduino will send a signal to the relay module to turn on the high power LED that serves as the main light source. In order for the lighting to be adjusted to the needs, a PWM module is used that allows setting the light intensity. Meanwhile, the buzzer is used as a sound indicator to provide feedback that the system is active or the sensor has been touched.

In mechanical design aims to see a picture of the physical form of a series of mechanical devices that are useful for knowing the placement of component positions so that they can function as desired. This mechanical design is made in 3D using work software and this can also help facilitate the assembly process.

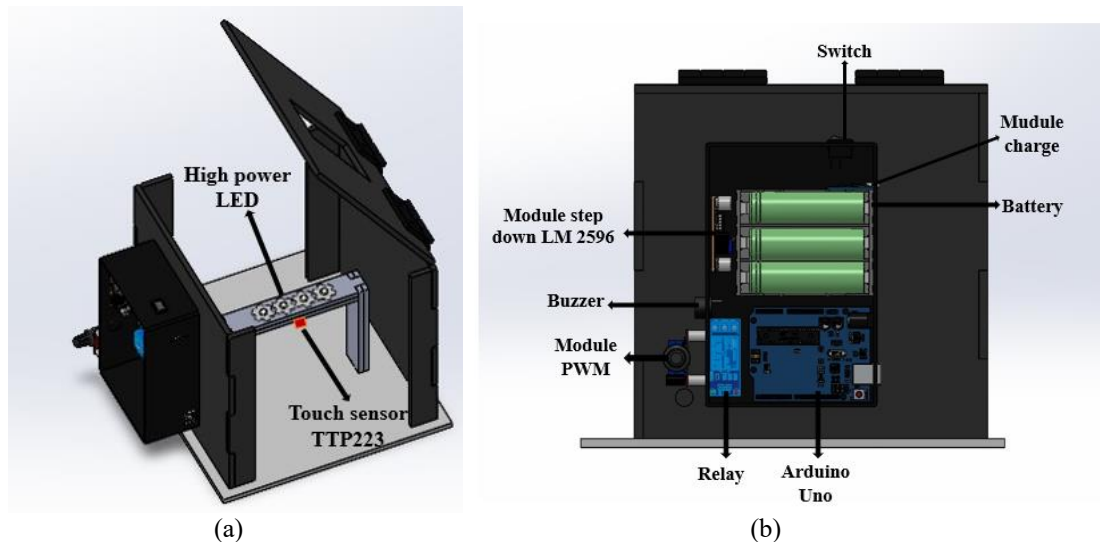


Figure 4. Mechanical design of proposed system. a) Top view drawing, b) Side view drawing.

3. RESULTS AND DISCUSSION

Testing the visibility of veins is done to find out how accurate the tool has been designed, testing the visibility of veins is targeting 5 samples of children, adolescents, adults, and the elderly.

Table 1. Test results on 5 children samples

No	Information	Body weight	Height	Visibility	Light Intensity
1	Female / 5 years old	20 kg	104 cm	Visible and less clear	70 lux
2	Male / 7 years old	25 kg	123 cm	Visible and clear	100 lux
3	Female / 9 years old	31 kg	136 cm	Visible and clear	290 lux
4	Male / 10 years old	28 kg	145 cm	Visible and clear	490 lux
5	Male / 11 years old	38 kg	144 cm	Visible and less obvious	790 lux

Table 2. Test results on 5 teenage samples

No	Description	Body weight	Height	Visibility	Light Intensity
1	Male / 13 years old	48 kg	154 cm	Visible and clear	1300 lux
2	Female / 14 years old	44 kg	145 cm	Visible and clear	850 lux
3	Male / 15 years old	50 kg	163 cm	Visible and clear	1400 lux
4	Female / 18 years old	61 kg	162 cm	Visible and clear	950 lux
5	Male / 20 years old	55 kg	170 cm	Visible and clear	600 lux

Table 3. Test results on 5 adult samples

No	Description	Body weight	Height	Visibility	Light Intensity
1	Male / 26 years old	60 kg	160 cm	Visible and clear	1200 lux
2	Female / 27 years old	50 kg	146 cm	Visible and clear	850 lux
3	Male / 29 years old	57 kg	159 cm	Visible and clear	950 lux
4	Female / 32 years old	58 kg	156 cm	Visible and clear	450 lux
5	Male / 35	83 kg	169 cm	Visible and clear	1550 lux

Table 4. Test results on 5 elderly samples

No	Description	Body weight	Height	Visibility	Light Intensity
1	Male / 53 years old	68 kg	157 cm	Visible and clear	1100 lux
2	Female / 62 years old	60 kg	180 cm	Visible and clear	450 lux
3	Female / 63 years old	65 kg	152 cm	Visible and clear	1200 lux
4	Male / 65 years old	58 kg	180 cm	Visible and clear	1500 lux
5	Female / 67 years old	35 kg	145 cm	Visible and clear	1050 lux

From the visibility testing results, the children's group had an average light intensity of 348 lux, which was the lowest value compared to the other age groups. From the test results, it can be seen that two of the five samples showed less clear vein visibility, even though one of the samples used an intensity as high as 790 lux. This indicates that the thinner vein structure of children is due to the fact that when given a very high light intensity, only the light is visible while the vein is covered by the light. The average light intensity in the adolescent group was 1020 lux. Just like the adult group, all samples showed very clear vein visibility. Although this group is still growing up, the physiological characteristics of adolescents are close enough to adults for the device to work optimally. This suggests that setting the LED intensity in this range is adequate for clinical needs.

The adult group showed an average light intensity of 1000 lux. All samples from this group showed very clear and consistent visibility results. This intensity proved effective in penetrating the skin tissue and visualizing the veins well. This shows that the body structure and skin thickness of adults tend to be optimal for high power LED lighting systems, so the device functions well without the need for special adjustments. The elderly group had the highest average intensity of 1060 lux, and all samples showed very clear vein visibility results. This can be explained by the skin condition of the elderly, which tends to be thinner and has decreased elasticity, making it easier for light to penetrate. These results show that the device works very effectively in the elderly population, even in those with varying height and weight

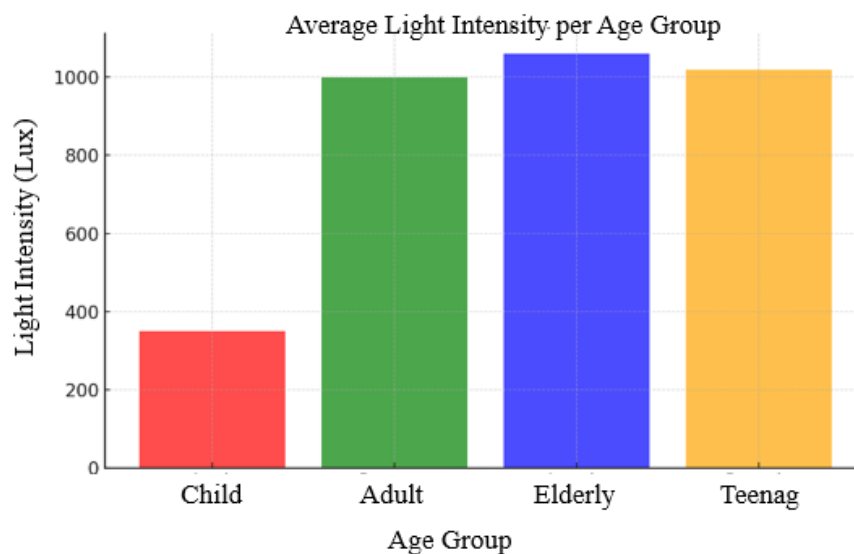


Figure 5. Graph of average light intensity

4. CONCLUSION

Based on the results of the design and testing that has been done, it can be concluded that the arduino uno-based venous blood vessel detection device using high power LED (HPL) is successfully designed and functions as intended. Successfully designed and made an arduino uno microcontroller-based venous blood vessel detection device using high power LED that is able to increase the visibility of veins. Setting the light intensity through the PWM module proved to be effective in increasing the accuracy of detection of veins, especially in the age group of adolescents, adults, and the elderly. This device can be used in various age groups and shows responsive and adaptive performance to different user skin conditions. This tool has the potential to assist medical personnel in accelerating the process of finding veins, in children, adolescents, adults, and the elderly. With a simple design, economical use of components and automatic response to touch, this device provides a practical and affordable alternative for non-invasive vein detection.

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