Journal of Industrial Automation and Electrical Engineering
Vol. 01, No. 01, June, pp. 118~124

Smart trolley based on client server and computer vision

Gusvito Habiby[1], Mukhlidi Muskhir[1], Riki Mukhaiyar[1], Habibullah[1], Afdal Luthfi[1]
[1]Department of Electrical Engineering, Faculty of Engineering, Universitas Negeri Padang, Padang, Indonesia

Article Info

Article history:

Received April 21, 2024
Revised May 12, 2024
Accepted June 22, 2024

Keywords:

Smart trolley
Raspberry pi
Barcode Scanner
LCD

ABSTRACT

Technological advances have significantly changed many aspects of human life, including shopping activity. The modern retail environment must provide extraordinary customer satisfaction in order to remain competitive. With the Smart Trolley, an automated shopping cart integrated with a payment and pricing system, offers solutions to a shopping challenge that can scan the price of goods. The study explores the development and implementation of Smart Trolley based on client-server architecture and computer vision technology. The Smart Trolley is equipped with a mini PC (Raspberry Pi), a barcode scanner, and an LCD display to display the total cost of goods when they are added to the cart. In addition, it supports non-cash payments and can reduce waiting time at the cashier. Server connections allow real-time monitoring by store staff and prevent fraud. The results of the implementation show that Smart Trolley effectively helps consumers to see the prices of goods, imitate the quarters at the cashier, and improve the security of transactions. This innovative solution aims to simplify the shopping experience, providing a more efficient and comfortable process for consumers in a modern market shopping experience.

Corresponding Author:

Gusvito Habiby
Department of Electrical Engineering, Faculty of Engineering, Universitas Negeri Padang
Kampus UNP Pusat, Jl. Prof. Hamka, Air Tawar, Padang 25131, Indonesia
Email: gusvitohabiby@gmail.com

1. INTRODUCTION

Technology is the result of a scientific discovery process to achieve certain goals, such as easing the burden on humans to meet their needs and facilitating human activities. In addition, technology brings humans in a more advanced and modern direction [1]. Technology has become a major driver of change in many fields, including transportation and communication. Technology continues to change the way we work, interact, and shop. Shopping is an activity that involves considering a product or service, finding a store that provides the best product or service, and making decisions [2]. The variety of prices and services makes market competition increasingly tight [3]. The development of the world today, especially Indonesia, is entering the era of the 4.0 revolution, which is inseparable from automatic technology or automatic systems [4]. With technology, companies can take advantage of this to achieve the company's goals. The company's ability to utilize technology has a major influence on achieving results [5]. Modern markets provide various types of trolleys to carry shopping items. Some people find it difficult to push a trolley due to limited hand movement; therefore, a trolley that can move automatically is needed so that customers can move freely [6]. In a busy world, waiting in long queues while shopping is a protracted action that also wastes consumers' time in the shopping market [7]. Long queues can occur because the cashier operator has to scan the price of each item purchased [8].

Trolleys are very useful items when shopping [9]-[10]. The presence of smart trolleys is one solution that can be used to shorten shopping time. Smart trolleys are equipped with calculation and payment technology and offer significant advantages in the shopping experience [11]-[13]. Smart shopping trolleys will help shorten the payment path, thereby helping customers in retail stores [14]. This trolley also supports non-cash payments, so the use of non-cash payments is also very easy [15]. The positive impact of non-cash

money has resulted in Bank Indonesia launching a policy that supports a non-cash payment system [16]. This payment is supported by using a mini PC [17]. An automatic trolley is a robot that functions as a trolley to carry shopping items that can make it easier for humans to shop [18]. Many researchers have made smart trolleys with automatic designs that prioritize automatic trolley movement systems [19]-[21]. Meanwhile, making a trolley with a barcode scanning system (to find out the price of goods) has also been developed and a billing system that is connected to the server [22]-[25]. The results of the research on the sources that have been explained refer more to the automatic movement of the trolley, the price-checking system for goods, and the payment system.

2. METHOD

One crucial stage in choosing the elements that will be utilized in the finished project is designing the tool. This seeks to guarantee that the developed tool can function as intended. This research approach involves the design and production of both software and hardware. In software design, Visual Studio is used as a product manager that can be used to develop and modify source code for different programming languages, while Autodesk Inventor is utilized in hardware design. For instance, TypeScript, JavaScript, and so forth. A block diagram is a thorough description of a system. The rule in the analysis process is that the system must be defined in its entirety, which means that a block diagram must be used to clearly illustrate the breadth of the discussion [26]. A block diagram of the system on the tool is shown in Figure 1 below.

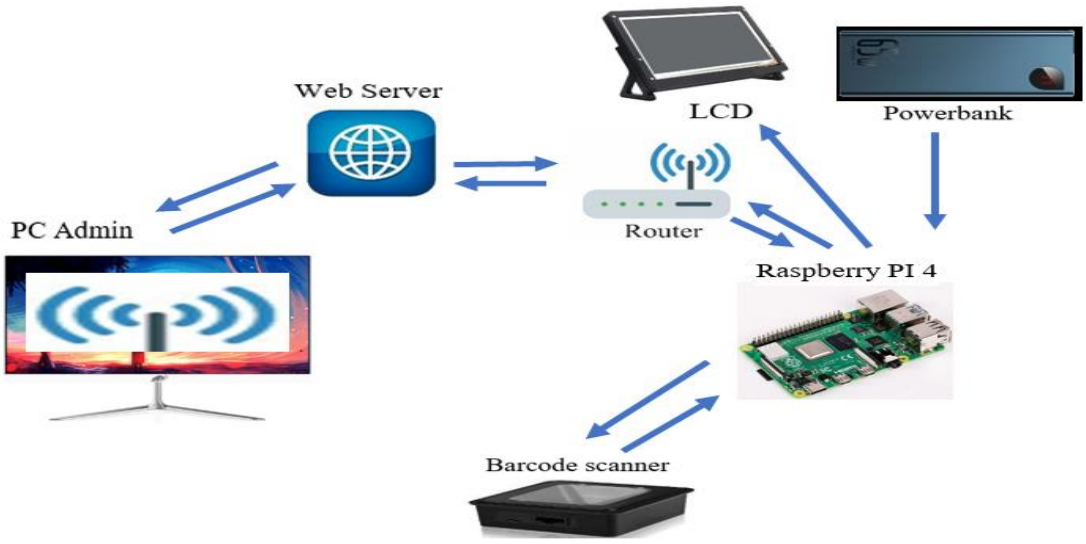


Figure 1. Diagram block of proposed smart trolley

Based on the block diagram above, the design of each block diagram has the following functions: Power supply is a device that supplies electrical energy to one or more electrical loads [27]. The 5V 3A Power Supply functions as a power source in the operation of the device [28]. Mini PC is a small and lightweight computer that can do many computing things, its capabilities allow it to handle data processing tasks faster and more efficiently [29]-[30]. Mini PC is the main component in this system which functions as a web server that produces an interface in the form of a website page display in controlling the system. In addition, Mini PC also functions as an output controller in the form of a barcode scanner, and the appearance of the server on the LCD installed on the trolley. Router is one of the operating systems that can be used as a reliable network router, covering a variety of complete features for networks and wireless [31]. The router functions as a connector from the mini PC to the web server, to be able to access the website with a mini PC using another device must be connected to the same network. Web server is software that provides data-based services [32]-[33]. Web server is used as a recipient of requests from web browsers, translates the request, and returns it to the web browser. Web can be created using HTML and PHP languages with a display using CSS language. Barcode scanner is a detection sensor to find out the specifications of goods [34]. Barcode scanner is used as a barcode scanner on goods in minimarkets or supermarkets, the output of which will be forwarded to a mini PC. LCD is a layer of organic mixture between a layer of clear glass with transparent indium oxide electrodes in the form of a seven segment display and a layer of electrodes on the back glass [35]. The LCD used is a 7 inch LCD which functions as a display screen for a mini PC, this LCD

is equipped with a touch screen feature so that users can freely transact or just see the price. The admin PC functions as a place to control the server which will be monitored by the cashier at the minimarket.

The working principle of the designed tool is, the process carried out by the microcontroller is an important part of data processing in the tool control system. The data issued by the microcontroller is control data sent to the H-bridge module as a component used to control the direction and speed of the DC motor as a driver on the trolley. The DC motor used is a DC motor that works at a voltage of 24 VDC, the DC motor can be controlled using the control method with PWM, with this method the speed and torque of the DC motor can be adjusted according to needs [36]-[37]. The movement of this trolley is assisted by a four-wheel mechanical configuration that allows the trolley to move more efficiently. To make it easier to take data, this trolley can be controlled using a PS2 joystick which is a game controller from the Sony Playstation game manufacturer. The wireless PS2 stick consists of a receiver module and a transmitter module. This research uses several components such as mini PC, barcode scanner, LCD, and power bank. At the hardware design stage, it certainly also begins with determining the port or GPIO pin on the mini PC in controlling the barcode scanner in the form of output such as a bar code that is read. Figure 2 hardware scheme that will be made

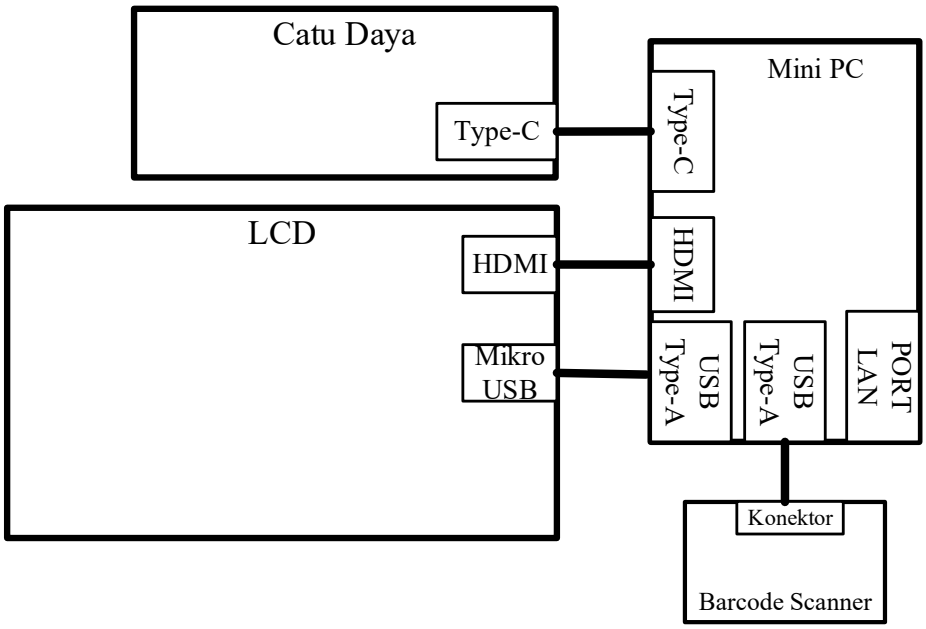


Figure 2. Hardware scheme of proposed smart trolley

After ensuring that the hardware can work according to its capabilities, the next stage is the product configuration stage. In this plan, the specialist does the coding to make the web server a convection point as a site display. For this situation, a smaller than expected mini PC is used to create a web server and output regulator as an electronic gadget starting from the GPIO pin. The site page is created using HTML with a display style involving CSS language for convection points to the entry framework and control framework and PHP programming for back-end creation. Using a mini PC work system is a recommended authority work system for use on mini PC devices, while Visual Studio is a product manager that can be used to create and change source code for other programming languages. It comes with built-in support for JavaScript, TypeScript, and so on, has a rich extension ecosystem for other languages (such as C ++, C #, Java, Python, PHP, Go) [38]. At the time of making this software there is also a systematic way of working of the interface or website page that will be made. Figure 3 is a display of control and monitoring and flowchart of the software.

Based on Figure 3, it can be seen that the main thing that needs to be done is to design an IP address on a computer with a single access point or local network convection. Connect the device to the user with a local network via an access point that comes from a router or wifi. After that, open the web by entering the IP address into the question page on the site. The site page will display the payment screen. The buyer has control over the framework by pressing the button on the site page.



Figure 3. Display of control & monitoring and flowchart of software

3. RESULTS AND DISCUSSION

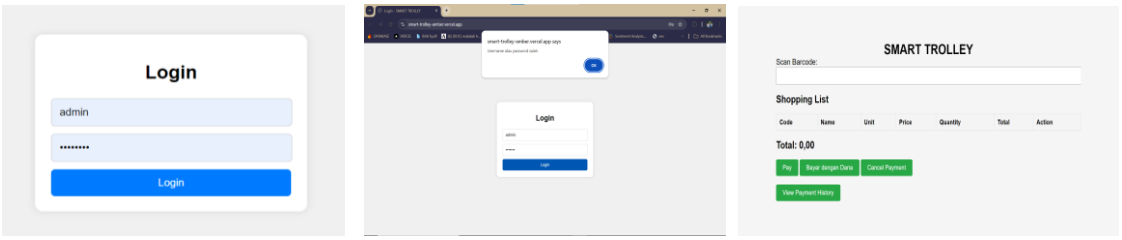
In this trolley test, several components are used to be able to carry out the payment system, consisting of Raspberry pi as a mini PC that is useful for storing data and accessing the payment website, 7 inch LCD as a display screen, barcode scanner as a barcode reader on each item to be purchased, and a power supply (Power Bank) that will supply power to all components, with a capacity of 20000 mah. All components are protected by a casing made of acrylic which can be seen in Figure 4.



(a) (b)

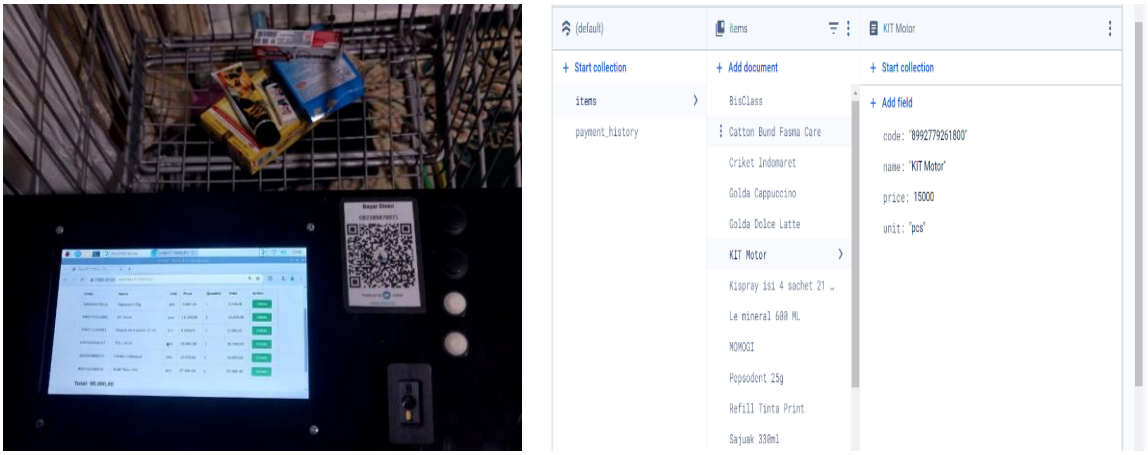
Figure 4. Hardware smart trolley, (a) outside view, (b) inside view

The login feature plays an important role in this payment system, because the login feature is useful for maintaining security, so that only the mini market can access the web. The type of login can be seen in Figure 5. If the password or username is wrong, the application cannot be opened, and if the password is correct, the payment page display will appear.



Login attempt Login Fails Login Successful

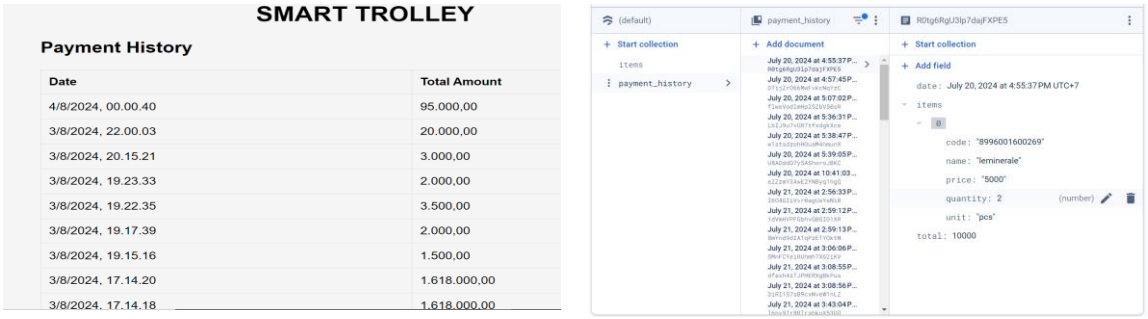
Figure 5. Display login page



(a) (b)

Figure 6. Barcode scanner test, (a) the barcode has been read by the barcode scanner, (b) item data

After testing the login, we must test the barcode scanner to read the item data through the barcode, to make it easier to read the item without having to write it down. In this study, the barcode scanner has been synchronized with the payment application. Figure 6 (a) the barcode has been read by the barcode scanner and Figure 6 (b) shows the process of inputting item data. After testing the Barcode Scanner, it was continued with testing the database. A database is a server that is useful for storing data. In this study, the database is useful for storing data on goods sold at minimarkets and consumer shopping history. It can be seen in Figure 7 (a) a system that uses a database in the payment application. And the shopping data recorded in detail on the database server can be seen in Figure 7 (b).



SMART TROLLEY

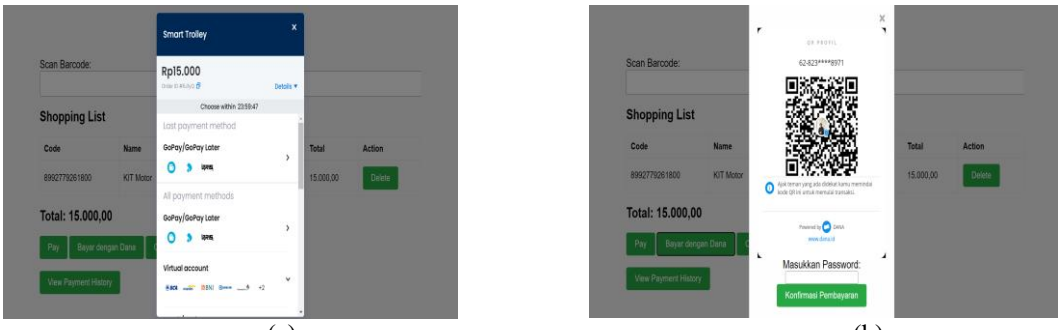
Payment History

Date	Total Amount
4/8/2024, 00.00.40	95.000,00
3/8/2024, 22.00.03	20.000,00
3/8/2024, 20.15.21	3.000,00
3/8/2024, 19.23.33	2.000,00
3/8/2024, 19.22.35	3.500,00
3/8/2024, 19.17.39	2.000,00
3/8/2024, 19.15.16	1.500,00
3/8/2024, 17.14.20	1.618.000,00
3/8/2024, 17.14.18	1.618.000,00

(a) (b)

Figure 7. Barcode scanner test, (a) payment application, (b) Database server

Finally tested the payment system made on the smart trolley. Payment on the smart trolley aims to make it easier for customers and reduce queues during payment. Figure 8 shows the types of payments, this tool has 2 payment methods on the application and 1 qris payment attached to the trolley.



(a) (b)

Figure 8. Payment method, (a) Using a 2nd Party (Mitrans), (b) qris

The payment system in Figure 8 has the same purpose, which is to pay for shopping, in the Mitran payment system, namely payments that are directly synchronized using a 2nd party application, while the QRIS payment system that is connected to the system is a payment assisted by the cashier via a server computer because there is a password that can only be accessed from the server, and the QRIS payment system funds that are attached outside the system are useful as the last system because if the first and second systems cannot or are having problems, then you can use the 3rd payment system which will later show proof of transfer to the cashier.

4. CONCLUSION

From the results of testing and analysis in research on Smart Trolley Based on Client Server and Computer Vision, with direct online payment media on the Trolley to speed up the shopping process, it can be concluded that the application of the payment system on the smart trolley was successful, proven by the results obtained in accordance with the planned program. In addition, the barcode scanner system was also successful in helping customers see the price of goods. And the payment method made 3 (three) types can minimize failure in transactions, although the first method (1) (mitrans method) has not been successful due to business licensing factors.

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