A Proposed Touchless Hand-Gesture and Voice Based Model Eliminating COVID-19 Infection Risk While Using ATM Machines

Farhan Alebeisat[1], Zaid T. Alhalhouli[1], Hassan A. Yacoub[1], Mohammad Alsaaydeh[1] and Hazim Al-Rawashdeh[2]

1 Information Technology Department, College of Information & Communications Technology,
Tafila Technical University,Tafila, Jordan

2 Cyber Security Department, College of Engineering and Information Technology, Onaizah Private Colleges, Onaizah, Saudi Arabia

Abstract
With the tremendous advancements in science and technology over the last few years, hand gesture recognition technology and its applications have emerged as an effective tool for reducing the risk of covid-19 spread, such as touchless devices and the use of personal identification tools as solutions to avoid touching equipment and screens. In this paper, we propose a model for using touchless ATM machines services and the method for authenticating the user using The ATM camera for identification, and a computer vision model for enabling it to recognize an individual's hand motions.

Keywords:
Vision-based, Human Computer Interaction (HCI), Hand-gesture, COVID-19, Computer-vision (CV)

1. Introduction

Most of our interactions with devices and machines are touch-based, whether it's browsing the internet on a mobile device, engaging with vending machines, entering a Personal Identification Number (PIN) at a Point of Sale (POS), or executing an Automated Teller Machine (ATM) transaction.

At the moment, given the existence of the Corona pandemic, the interest of researchers across disciplines, particularly those in the information technology sector, has shifted to reducing the level of direct contact between people and technological tools in all aspects of daily life, particularly financial and monetary transactions.

In the banking sector, which conducts the majority of its transactions through Automated Teller Machines (ATM), customers interact with ATM machines primarily through "Touch" interactions, and thus the machine is used by multiple people concurrently, which may increase the risk of infection with Coronavirus due to the devices' lack of self-sterilization.

The emerging trend in human-machine interfaces is toward "Touchless" control and interaction. One of the most common techniques is to perform specific tasks via intelligent voice commands. One of the most well-known applications is "Amazon Alexa," an artificial intelligence-based virtual assistant developed by Amazon. Additionally, vision-based technology has been and continues to be a critical component of "Touchless" human-computer interaction. Gesture recognition is a rapidly growing area of research.

Gestures are the movement of body parts (e.g., head, mouth, eyes, and hands) to express an emotion or to deliver a message, similar to the underwater diver's hand-gestures that have been used for decades.

Today, gesture recognition is being used in a wide range of application that includes gaming, home automation, mobile, cameras, and personal computers.

Touchless technology is becoming increasingly important not only as a component of the technological revolution, but also as a means of protecting human health. COVID-19 and other highly contagious diseases can be transmitted by touching a contaminated surface, such as an ATM that has been used by a COVID-19 infected user.

This research is focused on developing a practical, cost-effective, backward-compatible, and simple-to-implement touchless interface with publicly accessible self-service equipment such as ATMs, Cash Deposit machines, vending machines, point-of-sale (POS), ticketing kiosks, and parking tickets.This strategy significantly reduces the risk of contracting an infection. In summary, the suggested approach relies on tracking hand movement to move the cursor or highlight and focus on a field or button. For the Clicking action, voice activation via a term such as "choose" can be used. The proposed approach is illustrated in Figure I.

Manuscript received March 5, 2022
Manuscript revised March 20, 2022
https://doi.org/10.22937/IJCSNS.2022.22.3.62

Figure 1: curser movement and clicking action

This article addressed security concerns, particularly when combining such a model with ATMs to conduct financial transactions and similar applications. Additionally, the paper contains suggested security methods that address both physical and user authentication-related concerns.

To ensure successful end-user adoption, the proposed solution additionally emphasizes the critical nature of usability and user experience in achieving desired results.

2. Literature Review

Technology has progressed from touch-sensitive digital devices such as ATMs, and following the spread of the CONID-19, touch devices have become a problem without mitigating the risks associated with them. The way you handle a hand gesture without touching is dependent on a comprehensive authentication system that verifies the user from multiple sources. Using the memory-saving CNN form, you can correct the authentication code. The unique authentication code is a numeric value between 0 and 9. One technique to recognize motions that involve image processing is to match shapes or evaluate the difference between hand shapes using bypass neural networks (CNN) [1]. This paper provides a novel method for verifying air fingerprints by studying finger movements and brain activity using sensors. By monitoring projections, assessing three-dimensional geometric features, and analyzing electroencephalogram (EEG) responses, the similarity between gesture and non-gesture frames limits the measurement's usefulness [2]. It is difficult to define the boundaries of continuous movements while implementing the hand gesture detection system from start to finish in real time [3]. The employment of a real-time hand gesture identification approach based on side-by-side RGB frames and a lightweight semantic segmentation method (FASSD-Net) to improve the accuracy of time-segment networks (TSNs) and time shift modules (TSMs) that are used in place of hand segmentation.

Methods of depth and optical flow [4], The movement of the hand is classified in real time using ultrasound sensors, and a three-dimensional ray-tracing model is provided for non-touch sensing of hand motions utilizing microwaves or millimeter-wave radar [5]. [6], End users can customize gesture detection from demos, although hand detection is challenging, particularly in abnormal settings, for smartphones with RGB cameras on top [7]. A unified convolutional neural network technique for recognizing hand gestures and detecting fingertips [8] the dynamic hand gesture recognition system, which segments the hand using multiple deep learning architectures [9], is one example of a system with a promising future. Anvekar proposes to address the need for a touchless ATM during the covid-19 pandemic by designing a device and method for key or keyboard operation based on the detection of the user's finger with low energy consumption. Whereas Kumamoto and colleagues created a method that enables offline operation of a variety of public devices using personal smartphones while reducing the impact on currently deployed public devices [16]. Rubanagudi proposes a mechanism for dealing with ATMs based on the recognition of hand movement using British Sign Language, which benefits the blind through study, but it cannot be applied to natural people because everyone must learn sign language, which makes this proposal difficult to implement without special circumstances [17]. The researchers determined the use of hand gestures by placing the thumb and palm of the hand in the ATM and detecting the location of the hand with a high-quality camera and a well-lit backlight. This compromises privacy and security due to the lighting that is heard when an embezzler sees the movement of the hand through any embezzler, save for the development of ATMs and the introduction of cost-increasing modifications [18]. The researchers developed an authentication model using a combination of hand gestures and online signature. The user uses the hand gesture movement to authenticate through the accelerometer, the hand gesture device of the 3-axis accelerometer, and the controlled transmission to sense and collect the hand gesture, the signature can be dispensed with, to avoid security problems and maintain Privacy and to reduce the complications in the use of the ATM [19].

Recognizing non-touch hand gestures is the safest way to prevent the spread of diseases and viruses such as covid-19, particularly in public spaces such as elevators and automated teller machines, or even in closed spaces such as operating rooms that require a high level of sterilization maintenance, which contributes to the use of non-touch hand movements to accomplish the goal, and here the researchers used non-touch hand movements to accomplish the goal.

3. Methodology

To carry out this paper's methodology, a full-scale, transaction-focused study of existing ATM transaction requirements was completed, along with a feasibility study to implement touchless use. A conceptual design was then developed and implemented, based on all functional and non-functional requirements.

The changes that need to be made to the ATM software and hardware are also factored into this area. Additionally, this section pays attention to making minimal changes to current assets.

This section details a functional (minimum viable product, MVP) implementation of the Touchless ATM user experience. The MVP will employ CV to detect and monitor the user's hand movement; a cursor will be displayed on the ATM screen that will move in response to the user's hand movement. The click action will be detected via sound; in our case, any sound peak will be deemed a click; the sound can be human voice or just snapping your fingers.

To obtain an MVP version, a complete transaction lifecycle must be implemented; the following two sub-sections address a complete ATM transaction lifecycle in detail and a recommended touchless lifecycle in detail.

3.1 ATM Transaction Lifecycle.

All ATMs worldwide follow the same three basic steps:

1. Account identification and User authentication
2. Performing transaction
3. Ending the ATM session

Each of the above points is explained in the context of what is currently being used in the industry and what is required to implement a touchless experience.

3.1.1 Account Identification and User Authentication

Typically, before a user can do any action on an ATM, the user must first be linked to an account and then confirmed to ensure that the user is the true owner of the account. Usually, Two-Factor Authentication (2FA) is used to authorize a transaction; the 2FA is associated with something you own (a bank card) and something you know (PIN number).

Several banks have begun utilizing biometrics for the purposes of identity verification, authentication, and permission. [1] Defines biometrics as the features of the human body and behavior. They are outstanding characteristics for identity management. [12, 13] Biometric authentication is defined as the process of recognizing and verifying an individual's identity based on their unique physical characteristics, such as the patterns on their fingerprint, iris, voice, or face.

In the context of information technology and computer security, [14] defines biometrics as a method of identifying, authenticating, and controlling access using quantifiable human biological data that are unique and specific to that individual, in order to verify and confirm that individual's identity.

Having said that, the following methods are appropriate for account identification and authentication:

Table 1: Identification and Authentication Methods

Method	Identification	Authentication	Touchless
Insertion of Bank cards in to the ATM and with PIN number	Card	PIN	No
Using Wireless card enabled cards (Near field communication) NFC with PIN number	Card	PIN	No
Multifactor authentication, using card, PIN and biometric [13]	Card	PIN + Biometric	No
Biometrics (face recognition, iris recognition, etc.)	Biometric	Biometric	Yes
Biometric for identification and a PIN for authentication [12]	Biometric	PIN	No
Bank card for identification and Biometric for Authentication [12]	Card	PIN	No
Card-less Withdraw	Phone No + Amount	One Time Token	Yes

3.1.2 Performing a Transactions

Ordinary ATM transactions are initiated by the bank customer by pressing buttons or touching the screen, and to begin a transaction, the customer do the following:

- Select the transaction
- Fill transaction details (if needed)
- Confirming/Canceling the transaction

There are two ways to achieve a touchless user experience while using the ATM. The first is to modify the existing ATM application to support touchless user experience. The second is to introduce a new ATM application that is specifically designed for a touchless user experience using gestures and/or voice commands. Regardless of the approach taken, each operation mode must enable easy switching between touch-based and touchless operation. Optionally, each strategy should support both simultaneously; doing so enables consumers to adjust to new modifications without jeopardizing their ability to conduct ATM transactions owing to technical issues or adoption/misuse scenarios.

3.1.2.1 Changing existing ATM Application

This approach will require modifications to the existing ATM application; the modifications will consist of

displaying a cursor that moves in response to hand movement or directly selecting a transaction using voice instructions.
Most of data that is usually entered on an ATM are numeric characters that are entered using the PIN pad, accordingly, in a touchless user experience, and when the user opt to perform a transaction that requires user input, a software/virtual PIN pad must appear on the screen to allow the touchless data entry using hand-gesture or voice commands combination.

3.1.2.2 Building a New ATM Application

This approach proposes that the ATM application be modernized to accommodate new technology and user experiences. ATMs currently run on Microsoft's Windows operating system. This should allow for the development of more intuitive programs that support a touchless user experience. To prevent misleading customers, the new design should be inspired by the original ATM user experience and should feature an animated gesture transition where screens flip forward and backward in response to hand movement. Additionally, it should be capable of supporting a touch-based experience.

3.1.3 Ending a Transactions

Usually, after a cash withdrawal transaction, the ATM will automatically terminate the session; if the transaction is based on a card, the card will come out first, followed by the cash. Alternatively, the bank customer can simply press the cancel button on the ATM PIN pad or use the screen choices to terminate the transaction. However, with a touchless (card-less) experience, it is critical to have a rapid session termination strategy in place to protect the bank customer in the event of an emergency; this can be accomplished by adding a "End Now" button/icon to all touchless model screens. By selecting "End Now," the ATM automatically terminates the session and rolls back/reverses any pending transactions. End Now can be triggered with a hand gesture, a voice command, or by simply moving the cursor and selecting "End Now."

3.1.3.1 Recommended Touchless ATM Transaction Lifecycle

The following is the suggested procedure for doing a touchless ATM transaction. For the ATM application portion, this solution is dependent on the previously described "Changing current ATM Application." There is no need to alternate between touchless and touch.

To facilitate identification and authentication, like the cordless withdrawal process that use a one-time token or one-time password (OTP), the Touchless approach will leverage mobile or internet banking to generate a one-time volatile token associated with a pre-determined amount. Details about the token are entered using a virtual/soft PIN pad that appears on the screen.
With regards to transaction selection, this is accomplished through the use of the moving cursor and the sound command combination. And a virtual PIN pad will display to complete transaction details.
Finally, ending the session is done by having an “End Now” icon that is linked to hand-gesture and/or voice command.

4. Results and Discussion

In this section we will embed answers to the following design related question.

- What will the users be doing when carrying out their tasks?
- How will the system support these?
- What kind of interface metaphor, if any, will be appropriate?
- What kinds of interaction modes and styles to use?

The purpose of this paper is to introduce a user interaction with an ATM that is modern, safe, successful, user-friendly, simple to grasp, and backward compatible. The proposed approach must be complete and adhere to all functional and non-functional requirements already in use by banks.
To accomplish the aforementioned, the approach should be non-invasive and reversible, which means that after attempting to use the touchless experience, the user can switch back to touch-based interaction at any time without having to repeat previously completed processes.
The new design will offer suggestions to encourage users to engage in touchless contact, as well as helpful hints to guide users along the touchless interaction. Additionally, the final User Interface (UI) must incorporate large icons and buttons to make it easier for the user to conduct screen tasks using hand-gesture.
As discussed in the methodology section, the following are the list of activities:

- Account identification
- Interaction selection (Touchless or Touch based)
- User authentication
- Hand gesture based number selection
- Moving a courser and tapping click a virtual PIN Pad
- Transaction Selection
- Screen flipping to reach desired transaction
- Filling transaction details
- Confirming transaction
- Ending the ATM session

4.1 Account Identification

To begin, the customer is advised to input the bank card or just use the contactless option. We recommend displaying a masked video stream in the top right corner to indicate to the user that this ATM utilizes a front-facing

camera to capture user movement; we believe that displaying such films may encourage the user to try the touchless experience.

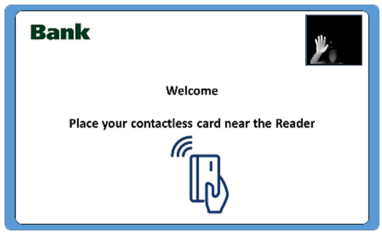

Figure 2: Account Identification

4.1.1 Interaction selection (Touchless or Touch based)

After identifying the account, the user is prompted to begin a touchless user experience by simply aligning his/her hand in the RED rectangle area in the center of the screen. At any point, the user is automatically transferred to a touch-based experience if the user interacts with the ATM's buttons or touch screen.

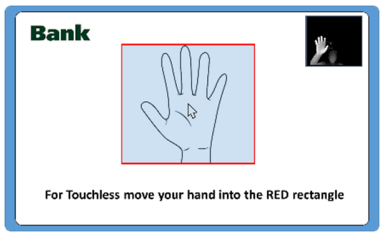

Figure 3: Interaction selection

4.1.2 User Authentication

Authentication can be accomplished by the use of a PIN, a token, or an OTP. The identification number can be submitted via hand gestures, in which the user just presents the number with his or her fingers, and the CV module counts the number of fingers and enters it in the input area.

Figure 4: finger counting

Alternatively, a virtual PIN pad is displayed to the user and using hand-gesture the use moves the curser over the number and chose the numbers accordingly.

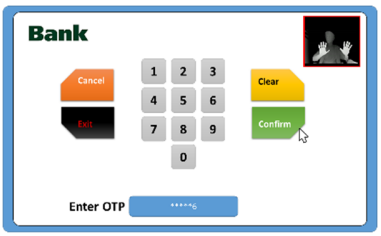

Figure 5: moving curser over a virtual PIN pad

4.1.3 Transaction Selection

There are numerous transaction selection possibilities and scenarios while utilizing a touchless experience. Selecting a transaction can be accomplished by vocal instructions, such as "user says: CASH WITHDRAW," or by simply moving the cursor over transaction options on the screen. Our suggestion is to introduce new screens that can be flipped sideways, allowing the user to navigate to the desired transaction; however, to ensure a friendly user experience, the screens should be ordered according to the most frequently performed transactions using logged-in user historical data.

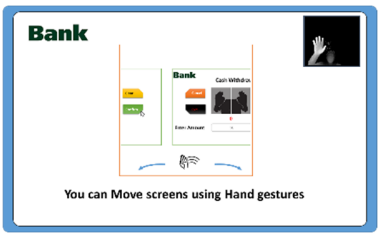

Figure 6: Transaction Selection

Filling transaction details is as easy as filling the PIN number, same approach is adopted, the user can choose to use the virtual PIN pad or the hand gesture screen.

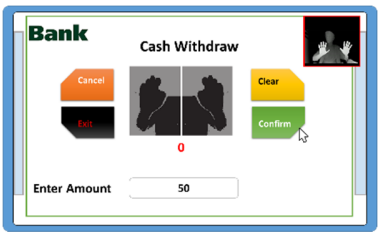

Figure 7: finger counting

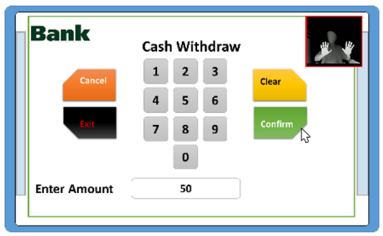

Figure 8: Virtual PIN pad

By moving the cursor over the green confirmation button, you can confirm the transaction. While the transaction is typically completed once it is confirmed or canceled, an additional "Exit" button can be used to immediately exit the session and cancel any pending transactions; this button is supposed to be utilized in emergencies.

5. Conclusion

In this study, we suggest a model for the use of ATMs during the Corona pandemic, which also takes into consideration the fact that hand gestures can be used to confirm occurrences with voice commands. At this point, the user is known and the identification is verified. The ATM features a camera for identification, and a computer vision model enables it to recognize the individual's hand motions.The proposed applicable model achieves the use of ATMs without touching a solution to limit the spread of the Corona virus, so we can enter the category of people with special cases or those who are blind as a target category to deal with ATMs, in addition to using British Sign Language for people who are speechless.

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