

Specification

METHOD AND APPARATUS FOR AUTHENTICATING USER, METHOD AND APPARATUS FOR REGISTERING WEARABLE DEVICE

TECHNICAL FIELD

The present application relates to the field of Internet technologies, and in particular, to a method and an apparatus for authenticating a user and a method and an apparatus for registering a wearable device.

BACKGROUND ART

With rapid development of Internet technologies, users do all kinds of activities, such as handling official businesses, entertainment, shopping, and money management, by using networks increasingly. A user usually obtains these services from multiple service providers. The user registers with servers of the service providers, and needs to provide an account and a password each time the user obtains a service, so that the server authenticates the user and provides the corresponding service.

For the sake of security, the user should try to avoid using the same account and the same password at the multiple service providers. When the user wants to obtain increasingly more services, memorizing an account at each service provider and a corresponding password becomes a growing burden on the user. At the same time, as network services are increasingly popularized in all aspects of life, the user always needs to input accounts and passwords to accomplish authentication, which has complex operations and reduces the efficiency for acquiring the network services.

SUMMARY OF THE INVENTION

In view of the above, the present application provides a method for authenticating a user, applied to a server, wherein the server stores a corresponding relationship between a user identification, a wearable device identification, and a server authentication key of the user, and the method includes:

receiving an authentication request sent by the user through a terminal, the authentication request carrying the user identification and/or the wearable device identification of the user;

acquiring downlink authentication information, and issuing to the terminal a detection instruction that carries the downlink authentication information and the wearable device identification of the user;

receiving a detection acknowledgment, returned by the terminal, which carries uplink authentication information, the uplink authentication information being generated, by a wearable

device designated in the detection instruction, according to a device authentication key and the downlink authentication information, and the device authentication key being the same as or corresponding to the server authentication key; and

matching the downlink authentication information with the uplink authentication information by using the server authentication key of the user, wherein the user passes the authentication if the matching succeeds.

The present application provides a method for authenticating a user, applied to a terminal connected to a wearable device of the user, wherein the method includes:

sending an authentication request to a server according to an operation of the user, the authentication request carrying a user identification and/or a wearable device identification of the user;

receiving a detection instruction of the server, the detection instruction carrying downlink authentication information and the wearable device identification;

sending the downlink authentication information to a wearable device designated in the detection instruction, and receiving uplink authentication information returned by the wearable device; the uplink authentication information being generated by the wearable device according to a stored device authentication key and the downlink authentication information, and the device authentication key being the same as or corresponding to a server authentication key stored in the server;

sending to the server a detection acknowledgment that carries the uplink authentication information; and

receiving a user authentication result determined by the server according to the uplink authentication information, the downlink authentication information, and the server authentication key.

The present application provides a method for registering a wearable device, applied to a server, including:

receiving a wearable device registration request sent by a user through a terminal, the registration request carrying a user identification and a wearable device identification of the user;

acquiring a server authentication key of the user and a device authentication key, and issuing to the terminal a write instruction that carries the device authentication key and the wearable device identification of the user; and

receiving a write acknowledgment returned by the terminal, and if the write acknowledgment indicates that the device authentication key has been successfully stored in a wearable device designated in the write instruction, storing a corresponding relationship between the user identification, the wearable device identification, and the server authentication key of the

user.

The present application provides a method for registering a wearable device, applied to a terminal, including:

- sending a wearable device registration request to a server according to an operation of a user, the registration request carrying a user identification and a wearable device identification of the user;

- receiving a write instruction of the server, the write instruction carrying a device authentication key and the wearable device identification of the user;

- executing an operation of writing the device authentication key on a wearable device designated in the write instruction; and

- sending a write acknowledgment to the server, the write acknowledgment carrying a message indicating whether the device authentication key is successfully written.

The present application further provides an apparatus for authenticating a user, applied to a server, wherein the server stores a corresponding relationship between a user identification, a wearable device identification, and a server authentication key of the user, and the apparatus includes:

- an authentication request receiving unit configured to receive an authentication request sent by the user through a terminal, the authentication request carrying the user identification and/or the wearable device identification of the user;

- a detection instruction issuing unit configured to acquire downlink authentication information, and issue to the terminal a detection instruction that carries the downlink authentication information and the wearable device identification of the user;

- a detection acknowledgment receiving unit configured to receive a detection acknowledgment, returned by the terminal, which carries uplink authentication information, the uplink authentication information being generated, by a wearable device designated in the detection instruction, according to a device authentication key and the downlink authentication information, and the device authentication key being the same as or corresponding to the server authentication key; and

- a matching unit configured to match the downlink authentication information with the uplink authentication information by using the server authentication key of the user, wherein the user passes the authentication if the matching succeeds.

The present application provides an apparatus for authenticating a user, applied to a terminal connected to a wearable device of the user, wherein the apparatus includes:

- an authentication request sending unit configured to send an authentication request to a server according to an operation of the user, the authentication request carrying a user

identification and/or a wearable device identification of the user;

a detection instruction receiving unit configured to receive a detection instruction of the server, the detection instruction carrying downlink authentication information and the wearable device identification;

an uplink authentication information unit configured to send the downlink authentication information to a wearable device designated in the detection instruction, and receive uplink authentication information returned by the wearable device; the uplink authentication information being generated by the wearable device according to a stored device authentication key and the downlink authentication information, and the device authentication key being the same as or corresponding to a server authentication key stored in the server;

a detection acknowledgment sending unit configured to send to the server a detection acknowledgment that carries the uplink authentication information; and

an authentication result receiving unit configured to receive a user authentication result determined by the server according to the uplink authentication information, the downlink authentication information, and the server authentication key.

The present application provides an apparatus for registering a wearable device, applied to a server, including:

a registration request receiving unit configured to receive a wearable device registration request sent by a user through a terminal, the registration request carrying a user identification and a wearable device identification of the user;

a write instruction issuing unit configured to acquire a server authentication key of the user and a device authentication key, and issue to the terminal a write instruction that carries the device authentication key and the wearable device identification of the user; and

a write acknowledgment receiving unit configured to receive a write acknowledgment returned by the terminal, and if the write acknowledgment indicates that the device authentication key has been successfully stored in a wearable device designated in the write instruction, store a corresponding relationship between the user identification, the wearable device identification, and the server authentication key of the user.

The present application provides an apparatus for registering a wearable device, applied to a terminal, including:

a registration request sending unit configured to send a wearable device registration request to a server according to an operation of a user, the registration request carrying a user identification and a wearable device identification of the user;

a write instruction receiving unit configured to receive a write instruction of the server, the write instruction carrying a device authentication key and the wearable device identification of

the user;

a write operation execution unit configured to execute an operation of writing the device authentication key on a wearable device designated in the write instruction; and

a write acknowledgment sending unit configured to send a write acknowledgment to the server, the write acknowledgment carrying a message indicating whether the device authentication key is successfully written.

The present application provides a payment method, including:

receiving a payment request sent by a user through a payment client terminal, the payment request carrying a user identification and/or a wearable device identification of the user;

acquiring downlink authentication information, and issuing to the payment client terminal an authentication instruction that includes the downlink authentication information and the wearable device identification;

receiving authentication response information, returned by the payment client terminal, which carries uplink authentication information, the uplink authentication information being generated, by a wearable device designated in the authentication instruction, according to a device authentication key and the downlink authentication information, and the device authentication key being the same as or corresponding to a server authentication key; and

matching the downlink authentication information with the uplink authentication information by using the server authentication key of the user, wherein the user passes the authentication if the matching succeeds, and a payment operation is performed after the authentication is successful.

The present application provides a payment method, including:

sending a payment request to a server in response to a payment operation of a user on a payment client terminal, the payment request carrying a user identification and/or a wearable device identification of the user;

receiving an authentication instruction, issued by the server, which includes downlink authentication information and the wearable device identification, and sending the downlink authentication information to a wearable device, so that the wearable device generates uplink authentication information by using a device authentication key stored by the wearable device and the downlink authentication information; and

receiving the uplink authentication information returned by the wearable device, and sending the uplink authentication information to the server, so that the server authenticates the user according to the uplink authentication information and performs a payment operation after the authentication is successful.

The present application provides a payment method for a wearable device, including:

receiving payment authentication information sent by a payment client terminal, the payment authentication information including downlink authentication information issued by a server based on a payment request of a user sent by the payment client terminal; and

generating uplink authentication information based on a stored device authentication key and the downlink authentication information, and sending the uplink authentication information to the payment client terminal, so that the payment client terminal sends the uplink authentication information to the server, such that the server can authenticate the user based on the uplink authentication information and perform a payment operation after the authentication is successful.

The present application provides a payment apparatus, including:

a payment request receiving unit configured to receive a payment request sent by a user through a payment client terminal, the payment request carrying a user identification and/or a wearable device identification of the user;

an authentication instruction issuing unit configured to acquire downlink authentication information, and issue to the payment client terminal an authentication instruction that includes the downlink authentication information and the wearable device identification;

an authentication response receiving unit configured to receive authentication response information, returned by the payment client terminal, which carries uplink authentication information, the uplink authentication information being generated, by a wearable device designated in the authentication instruction, according to a device authentication key and the downlink authentication information, and the device authentication key being the same as or corresponding to a server authentication key; and

a payment matching unit configured to match the downlink authentication information with the uplink authentication information by using the server authentication key of the user, wherein the user passes the authentication if the matching succeeds, and a payment operation is performed after the authentication is successful.

The present application provides a payment apparatus, including:

a payment request sending unit configured to send a payment request to a server in response to a payment operation of a user on a payment client terminal, the payment request carrying a user identification and/or a wearable device identification of the user;

an authentication instruction receiving unit configured to receive an authentication instruction, issued by the server, which includes downlink authentication information and the wearable device identification, and send the downlink authentication information to a wearable device, so that the wearable device generates uplink authentication information by using a device authentication key stored by the wearable device and the downlink authentication information;

and

an authentication response sending unit configured to receive the uplink authentication information returned by the wearable device, and send the uplink authentication information to the server, so that the server authenticates the user according to the uplink authentication information and performs a payment operation after the authentication is successful.

The present application further provides a payment apparatus for a wearable device, including:

a payment authentication information receiving unit configured to receive payment authentication information sent by a payment client terminal, the payment authentication information including downlink authentication information issued by a server based on a payment request of a user sent by the payment client terminal; and

an uplink authentication information generation unit configured to generate uplink authentication information based on a stored device authentication key and the downlink authentication information, and send the uplink authentication information to the payment client terminal, so that the payment client terminal sends the uplink authentication information to the server, such that the server can authenticate the user based on the uplink authentication information and perform a payment operation after the authentication is successful.

It can be seen from the above technical solutions that, according to embodiments of the present application, a server authentication key and a device authentication key are set on a server and a wearable device, and the server authenticates, through interaction with a terminal, a designated wearable device by using the set server authentication key and the set device authentication key, thereby accomplishing authentication on a user corresponding to the wearable device. The user neither needs to memorize any account and any password nor needs to input any account and any password during the authentication, which reduces the burden on the user and improves the efficiency of the user for acquiring a network service.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a network structure diagram of an application scenario according to the present application;

FIG. 2 is a flowchart of a method for authenticating a user applied to a server according to an embodiment of the present application;

FIG. 3 is a flowchart of a method for authenticating a user applied to a terminal according to an embodiment of the present application;

FIG. 4 is a flowchart of a method for registering a wearable device applied to a server according to an embodiment of the present application;

FIG. 5 is a flowchart of a method for registering a wearable device applied to a terminal

according to an embodiment of the present application;

FIG. 6 is a hardware structure diagram of a server, a wearable device or a terminal;

FIG. 7 is a logic structure diagram of an apparatus for authenticating a user applied to a server according to an embodiment of the present application;

FIG. 8 is a logic structure diagram of an apparatus for authenticating a user applied to a terminal according to an embodiment of the present application;

FIG. 9 is a logic structure diagram of an apparatus for registering a wearable device applied to a server according to an embodiment of the present application; and

FIG. 10 is a logic structure diagram of an apparatus for registering a wearable device applied to a terminal according to an embodiment of the present application.

DETAILED DESCRIPTION

A wearable device is a portable device that can be worn by a user or integrated into a user's clothing or accessory, for example, wristbands, smart watches, smart shoes, smart clothes, smart glasses, smart helmets, smart rings, and so on. The wearable device has some computing functions, can be connected to a terminal such as a smart phone, a tablet computer, and a personal computer through a hardware interface or a wireless local area network, and implements a variety of functions by exchanging data with the terminal.

A wearable device is generally specific to one user. Some wearable devices may be worn on users whenever and wherever possible. To some extent, such a wearable device represents a user. An embodiment of the present application proposes a method for authenticating a user, which authenticates the user by utilizing storage and computing functions of a wearable device without requiring the user to memorize and frequently input an account and a password, thereby solving the problems existing in the prior art.

A network environment to which the embodiment of the present application is applied is as shown in FIG. 1. A wearable device is connected to a terminal through a hardware interface or a wireless local area network. The hardware interface may be an audio interface, a Universal Serial Bus (USB) interface, or the like. The wireless local area network may be Bluetooth, Wireless-Fidelity (Wi-Fi), ZigBee (ZigBee protocol), or the like. The terminal may be a smart phone, a tablet computer, a personal computer, or the like. The terminal communicates with a server through a communication network (such as the Internet and/or a mobile communication network). A user sends an access request to the server with the terminal, and the server authenticates the user. In the embodiment of the present application, no limitations are made to the type of the terminal, the hardware interface or a wireless local area network protocol through which the wearable device is connected to the terminal, the protocol and network structure of the communication network, and a specific implementation of the server.

In an embodiment of the present application, a process of the method for authenticating a user on a server is as shown in FIG. 2, and a process thereof on a terminal is as shown in FIG. 3.

In this embodiment, the server stores a corresponding relationship between a user identification, a wearable device identification, and a server authentication key of a user. The user identification is a unique identity identification according to which a user is distinguished from other users for the server, for example, a user name, a registered mail, or the like. If the user is bound to a mobile terminal, the user identification may also be a number, an International Mobile Equipment identity (IMIE), or the like of the mobile terminal to which the user is bound. The wearable device identification is used to uniquely represent the wearable device, and varies with a different specific device type and a different wireless local area network protocol adopted. The wearable device identification may generally be a hardware address of the wearable device, for example, a Media Access Control (MAC) address. The server authentication key is stored on the server, and is the same as or corresponds to a device authentication key stored on the wearable device according to an encryption algorithm using the server authentication key. The wearable device identification and the server authentication key stored on the server are one-to-one corresponding to each other. If a user can have more than one wearable device for authentication, a user identification may correspond to two or more wearable device identifications and server authentication keys. It should be additionally noted that the corresponding relationship between the user identification, the wearable device identification, and the server authentication key may be stored in the server locally, and may also be stored in other storage devices accessible to the server, for example, a disk array for storing local area networks or a cloud storage network, which is not limited in this embodiment.

On the terminal, in step 310, an authentication request is sent to a server according to an operation of a user, the authentication request carrying a user identification and/or a wearable device identification of the user.

On the server, in step 210, an authentication request sent by a user through a terminal is received.

When the user requests, from a server, a service requiring identity authentication (e.g., login, access to a personal account, payment, or the like) on the terminal, the server requires, from the terminal, related information for authenticating the user. The terminal sends an authentication request to the server. The authentication request carries the user identification of the user, or the wearable device identification of the user, or the user identification and the wearable device identification of the user.

After the server receives the authentication request of the terminal, which user requesting authentication can be determined through the user identification and/or the wearable device

identification in the authentication request.

On the server, in step 220, downlink authentication information is acquired, and a detection instruction that carries the downlink authentication information and the wearable device identification of the user is issued to the terminal.

The downlink authentication information may be a piece of authentication data, and may also be a ciphertext after the authentication data is encrypted by using the server authentication key stored on the server. The server may obtain the authentication data in any manner, for example, the server randomly generates the authentication data, or captures a certain number of bytes from a file or an image. The server may generate the authentication data locally by its own, and may also acquire the authentication data from another server. This embodiment makes no limitations thereto.

After receiving the authentication request of the terminal, the server extracts the user identification and/or the wearable device identification in the authentication request, finds, in the stored corresponding relationship between the user identification, the wearable device identification, and the server authentication key, whether the user identification and/or the wearable device identification are/is included. If the user identification and/or the wearable device identification are/is not included or the user identification and the wearable device identification in the authentication request do not belong to a same user, the server rejects the authentication request of the terminal. Otherwise, the server acquires authentication data. For downlink authentication information as a plaintext, the server encapsulates the authentication data and the wearable device identification of the user in a detection instruction, and issues the detection instruction to the terminal. For downlink authentication information as a ciphertext, the server encrypts the authentication data by using a server authentication key corresponding to the user identification or the wearable device identification in the authentication request to generate downlink authentication information, encapsulates the downlink authentication information and the wearable device identification of the user in a detection instruction, and issues the detection instruction to the terminal.

On the terminal, in step 320, a detection instruction of the server is received, the detection instruction carrying downlink authentication information and the wearable device identification.

On the terminal, in step 330, the downlink authentication information is sent to a wearable device designated in the detection instruction, and uplink authentication information returned by the wearable device is received; the uplink authentication information being generated by the wearable device according to a stored device authentication key and the downlink authentication information.

The terminal receives a detection instruction of the server, extracts the wearable device

identification and the downlink authentication information therefrom, and sends the downlink authentication information to a wearable device designated in the detection instruction (i.e., a wearable device having the wearable device identification in the detection instruction). If the wearable device designated in the detection instruction has not yet been connected to the terminal, the terminal needs to first complete a connection with the wearable device according to a wireless local area network protocol supported by the wearable device.

As stated previously, the wearable device designated by the server stores the device authentication key the same as or corresponding to the server authentication key. After the wearable device receives the downlink authentication information, for the downlink authentication information as a plaintext, the wearable device encrypts the downlink authentication information by using the device authentication key, to generate uplink authentication information as a ciphertext. For the downlink authentication information as a ciphertext, the wearable device decrypts the downlink authentication information by using the device authentication key, to generate uplink authentication information as a plaintext. The downlink authentication information as a plaintext corresponds to the uplink authentication information as a ciphertext, and the downlink authentication information as a ciphertext corresponds to the uplink authentication information as a plaintext. The wearable device returns the uplink authentication information to the terminal.

On the terminal, in step 340, a detection acknowledgment that carries the uplink authentication information is sent to the server.

After receiving the uplink authentication information returned by the wearable device, the terminal encapsulates the uplink authentication information in a detection acknowledgment and sends the detection acknowledgment to the server. The detection acknowledgment generally further carries the wearable device identification.

On the server, in step 230, a detection acknowledgment, returned by the terminal, which carries uplink authentication information is received.

On the server, in step 240, the downlink authentication information is matched with the uplink authentication information by using the server authentication key of the user, wherein the user passes the authentication if the matching succeeds.

The server receives the detection acknowledgment returned by the terminal, extracts the uplink authentication information therefrom, and judges whether the uplink authentication information is matched with the downlink authentication information by using the server authentication key of the user, to determine an authentication result of the user. Specifically, for the uplink authentication information as a plaintext, it is possible to compare the uplink authentication information with authentication data for generating a ciphertext or compare the

uplink authentication information that has been encrypted by using the server authentication key with the downlink authentication information, if they are the same, the user passes the authentication, and otherwise, the authentication fails. For the uplink authentication information as a ciphertext, the uplink authentication information may be decrypted by using the server authentication key and then compared with the downlink authentication information, if they are the same, the user passes the authentication, and otherwise, the authentication fails.

The server returns to the terminal an authentication result indicating whether the user passes the authentication.

On the terminal, in step 350, a user authentication result determined by the server according to the uplink authentication information, the downlink authentication information, and the server authentication key is received.

In this embodiment, a server authentication key and a device authentication key which are the same or correspond to each other are set on a server and a wearable device, the server authenticates, through interaction with a terminal, a designated wearable device by using the device authentication key stored on the wearable device and the server authentication key stored on the server, thereby accomplishing authentication on a user corresponding to the wearable device. The user neither needs to memorize any account and any password nor needs to input any account and any password during the authentication, which reduces the burden on the user and improves the efficiency of the user for acquiring a network service.

In an implementation, a user public key of the user may be stored on the server, a user private key of the user may be stored on the terminal, a different user identification uses a different user public key and a different user private key, and the user public key and the user private key are a pair of keys in asymmetric encryption. The user public key stored on the server corresponds to the user identification, the wearable device identification, and the server authentication key of the user. In such an implementation, the terminal signs data carried in the detection acknowledgment (which includes the uplink authentication information, and may also include the wearable device identification, the user identification, and other data) by using the stored user private key, and sends the signed detection acknowledgment to the server. The server performs signature verification on the detection acknowledgment by using the user public key of the user. If the detection acknowledgment passes the verification, step 240 is performed to match the uplink authentication information with the downlink authentication information. If the detection acknowledgment fails to pass the signature verification, the terminal is notified that the authentication fails. Such an implementation requires that a terminal to which a wearable device is connected should store a user private key of a user when the user uses the wearable device for authentication, which can achieve better security.

In addition, a terminal identification may be added to the corresponding relationship between the user identification, the wearable device identification, and the server authentication key of the user stored on the server, to restrain the terminal capable of performing user authentication through the wearable device connected thereto. Under such a situation, the server stores a corresponding relationship between the user identification, the wearable device identification, and the server authentication key of the user and the terminal identification. An authentication request sent by the terminal to the server carries a terminal identification of the terminal. After receiving the authentication request, the server finds, in the stored corresponding relationship, a terminal identification corresponding to the user identification or the wearable device identification in the authentication request, and compares the terminal identification with the terminal identification for sending the authentication request. If they are the same, step 220 is performed to continue the authentication process. If they are different, the authentication request of the terminal is rejected, and the user authentication fails. Such an implementation is equivalent to binding a wearable device to a terminal capable of performing user authentication through the wearable device. As a terminal (especially a mobile terminal) generally is also specific to a user, binding a wearable device to the terminal may significantly improve the security of user authentication.

The above authentication process in this embodiment is applicable to any scenario that requires authenticating a user identity, for example, user identity authentication in the case of login, identity authentication when a user accesses a personal account, identity authentication when a user makes a payment through a third-party payment platform, and so on. After the user passes the authentication, the server may provide a subsequent service in the scenario, and the terminal executes a subsequent operation in the scenario. For example, when this embodiment is used for identity authentication in a payment scenario, the authentication request sent by the terminal to a payment server is a payment request. After the user passes the authentication, the payment server may provide a payment service for the user passing the authentication. After receiving, from the server, an authentication result indicating that the user passes the authentication, the terminal may cooperate with the payment server to complete a payment operation of the user.

In this embodiment, it is possible to preset the corresponding relationship between the user identification, the wearable device identification, and the server authentication key of the user on the server and preset the corresponding device authentication key on the wearable device. It is also possible to first generate the above corresponding relationship on the server and write the device authentication key on the wearable device through a registration process before the above authentication process.

Another embodiment of the present application provides a method for registering a wearable device. A process of the method on a server is as shown in FIG. 4, and a process thereof on a terminal is as shown in FIG. 5.

On the terminal, in step 510, a wearable device registration request is sent to a server according to an operation of a user.

On the server, in step 410, a wearable device registration request sent by a user through a terminal is received.

The user registers a wearable device with the server on the terminal, and the terminal sends a wearable device registration request to the server according to an operation of the user. The registration request includes a user identification and a wearable device identification of the user.

On the server, in step 420, a server authentication key of the user and a device authentication key are acquired, and a write instruction that carries the device authentication key and the wearable device identification of the user is issued to the terminal.

After receiving the wearable device registration request of the terminal, the server acquires, according to an encryption algorithm adopted for the uplink authentication information or downlink authentication information in the authentication process, a server authentication key and a device authentication key that are used for the encryption algorithm and correspond to the wearable device identification. The server authentication key and the device authentication key may be one key (e.g., a key of a symmetric encryption algorithm), and may also be a pair of keys (e.g., a public key and a private key of an asymmetric encryption algorithm). The server may generate the server authentication key and the device authentication key by itself and may also obtain the server authentication key and the device authentication key from another server.

The server encapsulates the acquired device authentication key and the corresponding wearable device identification in a write instruction, and sends the write instruction to the terminal.

On the terminal, in step 520, a write instruction of the server is received, the write instruction carrying a device authentication key and the wearable device identification of the user.

On the terminal, in step 530, an operation of writing the device authentication key is executed on a wearable device designated in the write instruction.

After the terminal receives the write instruction of the server, the terminal sends the device authentication key in the write instruction to a wearable device, to request the wearable device to store the device authentication key. According to a different wearable device and a different setting permission thereof, the wearable device may complete storage of the device authentication key only after the user confirms the write operation. For example, for a wristband,

the user generally needs to tap the wristband for confirmation.

On the terminal, in step 540, a write acknowledgment is sent to the server, the write acknowledgment carrying a message indicating whether the device authentication key is successfully written. After completing the write operation with the wearable device, the terminal encapsulates a message indicating whether the device authentication key is successfully written in a write acknowledgment, and sends the write acknowledgment to the server.

On the server, in step 430, a write acknowledgment returned by the terminal is received, and if the write acknowledgment indicates that the device authentication key has been successfully stored in a wearable device designated in the write instruction, a corresponding relationship between the user identification, the wearable device identification, and the server authentication key of the user is stored, and registration of the wearable device is successful. If the message carried in the write acknowledgment is that the device authentication key is not successfully written, the registration process fails. The server sends a registration result to the terminal.

The server may require the terminal to provide a password of the user to improve security of registration of the wearable device. Specifically, the server receives the write acknowledgment of the terminal, and if the message carried in the write acknowledgment is that the device authentication key has been successfully stored in the wearable device, the server issues a password confirmation request to the terminal, to require the terminal to provide a password of the user identification corresponding to the wearable device identification. The terminal receives the password confirmation request of the server, and returns a password confirmation acknowledgment carrying a user password input by the user to the server. The server receives, from the terminal, the password confirmation acknowledgment that carries the user password, and if the user password is correct, stores the corresponding relationship between the user identification, the wearable device identification, and the server authentication key of the user. Registration of the wearable device is successful. If the user password is incorrect, the registration request of the terminal is rejected, and registration fails. The server sends a registration result to the terminal.

In an implementation, a user public key and a user private key of the user may be generated automatically in the registration process. Specifically, after the operation of writing the device authentication key in the wearable device by the terminal is successful, the terminal generates a user public key and a user private key of the user according to an algorithm, stores the generated user private key locally, and encapsulates the user public key in a write acknowledgment and sends the write acknowledgment to the server. After the terminal successfully writes the device authentication key in the wearable device or it is verified that the user password is correct, the server stores a corresponding relationship between the user identification, the wearable device

identification, the server authentication key, and the user public key of the user.

In some application scenarios, a server public key and a server private key are preset on the server, and a terminal private key and a terminal public key are preset on the terminal, wherein the server public key and the terminal private key are a pair of keys, and the server private key and the terminal public key are a pair of keys. In these scenarios, in the authentication method embodiment, the server may sign the detection instruction by using the stored server private key, and send the signed detection instruction to the terminal. The terminal performs signature verification on the received detection instruction by using the stored terminal public key, and rejects the detection instruction if the verification fails, and thus the authentication fails. In the registration method embodiment, the server may sign the write instruction by using the stored server private key, and send the signed write instruction to the terminal; the terminal performs signature verification on the received write instruction by using the stored terminal public key, and rejects the write instruction if the verification fails, and thus the registration fails. The terminal may sign the write acknowledgment by using the stored terminal private key, and send the signed write acknowledgment to the server; the server performs signature verification on the received write acknowledgment by using the stored server public key, and rejects the registration request of the terminal if the verification fails.

The server and the terminal may conduct communication through an encrypted channel, to further improve security of wearable device registration and user authentication. For example, the detection instruction and the detection acknowledgment in the authentication method embodiment and the write instruction and the write acknowledgment in the registration method embodiment all can be transmitted in an encrypted channel. Reference may be made to the prior art for implementation of the encrypted channel and an encryption method adopted, which are not repeated.

In an embodiment of the present application, a payment client terminal running on the terminal authenticates a user identity in a payment process by using a wearable device connected to the terminal. A specific process of this embodiment is as follows:

On the wearable device, a payment binding request of the payment client terminal is received, the payment binding request including a device authentication key of the wearable device. The wearable device stores, in response to the payment binding request issued by the user through the payment client terminal, the device authentication key carried in the payment binding request in a local memory.

When making a payment operation on the payment client terminal, the user selects the wearable device to make a payment, triggers a response of the payment client terminal to the above user operation, and sends a payment request to the server. The payment request carries a

user identification and/or a wearable device identification of the user.

After receiving the payment request sent by the user through the payment client terminal, the server acquires downlink authentication information, and issues to the payment client terminal an authentication instruction that includes the downlink authentication information and the wearable device identification.

The payment client terminal receives the authentication instruction issued by the server, and carries the downlink authentication information in payment authentication information and sends the payment authentication information to a wearable device designated in the authentication instruction.

The wearable device receives the payment authentication information sent by the payment client terminal, extracts, from the payment authentication information, the downlink authentication information issued by the server based on the payment request of the user sent by the payment client terminal; and generates uplink authentication information according to the stored device authentication key and the downlink authentication information, and sends the uplink authentication information to the payment client terminal.

The payment client terminal receives the uplink authentication information returned by the wearable device, and carries the uplink authentication information in authentication response information and sends the authentication response information to the server.

The server receives the authentication response information that carries the uplink authentication information returned by the payment client terminal, matches the downlink authentication information with the uplink authentication information by using the server authentication key of the user, wherein the user passes the authentication if the matching succeeds, and performs a payment operation after the authentication is successful. The server authentication key of the user is the same as or corresponds to the device authentication key of the wearable device designated in the authentication instruction.

In this embodiment, a server authentication key and a device authentication key which are the same or correspond to each other are set on a server and a wearable device, and the wearable device is authenticated by using the device authentication key and the server authentication key, thereby completing payment authentication on a user corresponding to the wearable device, such that the user can make a payment on a payment client terminal by using the wearable device, and the user neither needs to memorize any account and any password nor needs to input any account and any password during the authentication, which reduces the burden on the user and improves the efficiency of payment.

In an application example of the present application, after registering a wristband with a payment server through a client terminal Application (App) running on a mobile phone terminal,

the user can complete network payment through the wristband without inputting any account and any password. A server public key and a terminal private key in a pair as well as a server private key and a terminal public key in a pair are preset on the payment server and the client terminal App. Wherein the payment server may be a server that runs a server terminal program corresponding to the client terminal App, and may also be a server of a third-party payment platform that supports the client terminal App. A specific process is as follows:

A user sends a wearable device registration request to a payment server through a client terminal App (hereinafter referred to as client terminal) running on a mobile phone terminal, to apply for opening of wristband payment, and the client terminal uploads a user identification (an account of the user on the payment server), a mobile phone terminal identification (an IMEI), and a wristband identification (a wristband MAC address) in the registration request to the server.

The payment server generates, through a predetermined algorithm, a symmetric key for authenticating a wristband (that is, a server authentication key and a device authentication key which are the same), signs the symmetric key, the user identification, and the wristband identification together through a preset server private key, encapsulates the signed symmetric key, user identification, and wristband identification in a write instruction, and sends the write instruction to the client terminal through an encrypted channel between the payment server and the client terminal.

After receiving the write instruction of the server terminal, the client terminal first verifies validity of data in the write instruction according to a preset terminal public key, and directly rejects the write instruction if the data is invalid. After the validity verification succeeds, the client terminal is connected to a wristband designated in the write instruction, and after the connection is successful, writes the symmetric key issued by the payment server in the wristband. In the process of writing the symmetric key in the wristband, the user needs to tap the wristband to confirm the write operation, and after the user taps the wristband, the symmetric key is written in a storage area of the wristband.

After the write operation is successful, the client terminal generates a pair of asymmetric keys according to the user identification, i.e., a user public key and a user private key corresponding to the user identification. The client terminal signs a result indicating whether the write operation is successful, the wristband identification, and the generated user public key through a preset terminal private key, encapsulates the signed information in a write acknowledgment, and sends the write acknowledgment to the payment server through an encrypted channel. The user private key is stored locally by the client terminal.

After receiving the write acknowledgment of the client terminal, the payment server verifies the signature of the client terminal through a preset server public key, and rejects the registration

request of the client terminal if the verification fails. After the signature verification succeeds, the payment server issues a password confirmation request to the client terminal, to require the client terminal to provide a password of an account of the user on the payment server.

The client terminal displays to the user prompt information of inputting a password, and the user inputs the password of his/her account on the payment server. The client terminal sends a password confirmation acknowledgment carrying the received password to the payment server.

The payment server verifies the user password in the password confirmation acknowledgment, after the verification succeeds, stores a corresponding relationship between the symmetric key (the server authentication key), the user identification, the mobile phone identification, the wristband identification, and the user public key generated by the client terminal, and notifies the client terminal that the wristband is registered successfully. The registration process ends.

After the wristband is registered successfully on the payment server, the user sends, when hoping to make a payment through the wristband, a payment authentication request to the server through the client terminal. The authentication request includes information of an order to be paid, a user identification, a mobile phone terminal identification, and a wristband identification.

After receiving the authentication request of the client terminal, the payment server compares the mobile phone terminal identification in the authentication request with the mobile phone terminal identification in the stored corresponding relationship which corresponds to the wristband identification in the authentication request. If they are different, the authentication request is rejected, and the payment fails. If they are the same, the payment server generates random plaintext data, and uses the plaintext data as downlink authentication information. The payment server signs the downlink authentication information, the user identification, and the wristband identification by using a preset server private key, encapsulates them in a detection instruction, and sends the detection instruction to the client terminal through an encrypted channel between the payment server and the client terminal.

After receiving the detection instruction of the payment server, the client terminal first verifies validity of signature data in the detection instruction according to a preset terminal public key. If the data is invalid, the detection instruction is rejected, and the payment fails. After validity verification of the signature is successful, the client terminal is connected to a wristband designated in the detection instruction, and after the connection is successful, sends the downlink authentication information in the detection instruction to the wristband. The wristband encrypts the downlink authentication information by using the stored symmetric key to generate uplink authentication information, and returns the uplink authentication information to the client terminal. The process of encrypting the downlink authentication information by the wristband

does not require the user to tap for confirmation, which can further reduce user operations and optimize user experiences.

After receiving the uplink authentication information generated by the wristband, the client terminal signs the uplink authentication information by using a locally stored user private key, encapsulates the signed data and the signed wristband identification in a detection acknowledgment, and sends the detection acknowledgment to the payment server through an encrypted channel between the client terminal and the payment server.

After receiving the detection acknowledgment uploaded by the client terminal, the payment server may perform signature verification on the detection acknowledgment according to the user public key corresponding to the wristband identification in the detection acknowledgment. If the signature verification fails, the authentication request fails. After the signature verification succeeds, the payment server encrypts the downlink authentication information by using a symmetric key corresponding to the wristband identification, compares the encrypted data with the uplink authentication information in the detection acknowledgment, that is, compares whether the downlink authentication information encrypted by the payment server is the same as the downlink authentication information encrypted by the wristband, and if they are the same, returns a message of successful authentication to the client terminal and continues paying an order. If they are different, the payment server returns a message of unsuccessful authentication to the client terminal. After receiving the message of successful authentication, the client terminal completes a user order payment operation together with the payment server. If receiving the message of unsuccessful authentication, the client terminal notifies the user that this payment cannot be completed due to unsuccessful authentication.

Corresponding to implementation of the above process, embodiments of the present application further provide an apparatus for authenticating a user applied to a server, an apparatus for authenticating a user applied to a terminal connected to a wearable device of the user, an apparatus for registering a wearable device applied to a server, an apparatus for registering a wearable device applied to a terminal, a payment apparatus applied to a server, a payment apparatus applied to a terminal, and a payment apparatus applied to a wearable device. All these apparatuses may be implemented through software, and may also be implemented through hardware or through a combination of software and hardware. By taking software implementation as an example, an apparatus in a logical sense is formed by reading a corresponding computer program instruction into a memory through a CPU of a server, a terminal or a wearable device and running the computer program instruction. In terms of the hardware level, in addition to the CPU, the memory, and the non-volatile memory shown in FIG. 6, the terminal or wearable device where the apparatus is located generally further includes other

hardware such as a chip for sending and receiving wireless signals, and the server where the apparatus is located generally further includes other hardware such as a board card for implementing a network communication function.

FIG. 7 shows an apparatus for authenticating a user according to this embodiment. The apparatus is applied to a server, and the server stores a corresponding relationship between a user identification, a wearable device identification, and a server authentication key of the user. The apparatus includes an authentication request receiving unit, a detection instruction issuing unit, a detection acknowledgment receiving unit, and a matching unit, wherein the authentication request receiving unit is configured to receive an authentication request sent by the user through a terminal, the authentication request carrying the user identification and/or the wearable device identification of the user; the detection instruction issuing unit is configured to acquire downlink authentication information, and issue to the terminal a detection instruction that carries the downlink authentication information and the wearable device identification of the user; the detection acknowledgment receiving unit is configured to receive a detection acknowledgment, returned by the terminal, which carries uplink authentication information, the uplink authentication information being generated, by a wearable device designated in the detection instruction, according to a device authentication key and the downlink authentication information, and the device authentication key being the same as or corresponding to the server authentication key; and the matching unit is configured to match the downlink authentication information with the uplink authentication information by using the server authentication key of the user, wherein the user passes the authentication if the matching succeeds.

Optionally, the server further stores a user public key of the user, the user public key corresponds to the user identification, the wearable device identification, and the server authentication key of the user, and the user public key and a user private key stored in the terminal are a pair of keys. The detection acknowledgment returned by the terminal is signed by using the user private key stored in the terminal. The apparatus further includes: a detection acknowledgment verification unit configured to perform signature verification on the detection acknowledgment of the terminal according to the user public key of the user, wherein the authentication on the user fails if the verification fails.

Optionally, the server further stores a terminal identification, and the terminal identification corresponds to the user identification, the wearable device identification, and the server authentication key of the user. The authentication request further includes: a terminal identification for sending the authentication request. The apparatus further includes: a terminal identification verification unit configured to, when the terminal identification corresponding to the user identification or the wearable device identification in the authentication request is

different from the terminal identification for sending the authentication request, verify that the authentication on the user fails.

Optionally, the server further stores a server private key, and the server private key and a terminal public key stored in the terminal are a pair of keys;. The apparatus further includes: a detection instruction signing unit configured to sign the detection instruction by using the server private key.

Optionally, the server is a payment server, and the authentication request is a payment request. The apparatus further includes: a payment service unit configured to provide a payment service for a user passing the authentication.

FIG. 8 shows an apparatus for authenticating a user according to this embodiment. The apparatus is applied to a terminal connected to a wearable device of the user. The apparatus includes an authentication request sending unit, a detection instruction receiving unit, an uplink authentication information unit, a detection acknowledgment sending unit, and an authentication result receiving unit, wherein the authentication request sending unit is configured to send an authentication request to a server according to an operation of the user, the authentication request carrying a user identification and/or a wearable device identification of the user; the detection instruction receiving unit is configured to receive a detection instruction of the server, the detection instruction carrying downlink authentication information and the wearable device identification; the uplink authentication information unit is configured to send the downlink authentication information to a wearable device designated in the detection instruction, and receive uplink authentication information returned by the wearable device; the uplink authentication information being generated by the wearable device according to a stored device authentication key and the downlink authentication information, and the device authentication key being the same as or corresponding to a server authentication key stored in the server; the detection acknowledgment sending unit is configured to send to the server a detection acknowledgment that carries the uplink authentication information; and the authentication result receiving unit is configured to receive a user authentication result determined by the server according to the uplink authentication information, the downlink authentication information, and the server authentication key.

Optionally, the terminal stores a user private key of the user, and the user private key and a user public key stored in the server are a pair of keys. The apparatus further includes: a detection acknowledgment signing unit configured to sign the detection acknowledgment by using the user private key of the user.

Optionally, the terminal stores a terminal public key, and the terminal public key and a server private key stored in the server are a pair of keys. The detection instruction issued by the

server is signed by using the server private key. The apparatus further includes: a detection instruction verification unit configured to perform signature verification on the detection instruction of the server according to the terminal public key, and reject the detection instruction if the verification fails.

Optionally, the authentication request is a payment request, and the terminal completes a payment operation of the user after the user authentication result is the authentication being successful.

FIG. 9 shows an apparatus for registering a wearable device according to this embodiment. The apparatus is applied to a server. When being divided in terms of functions, the apparatus further includes a registration request receiving unit, a write instruction issuing unit, and a write acknowledgment receiving unit, wherein the registration request receiving unit is configured to receive a wearable device registration request sent by a user through a terminal, the registration request carrying a user identification and a wearable device identification of the user; the write instruction issuing unit is configured to acquire a server authentication key of the user and a device authentication key, and issue to the terminal a write instruction that carries the device authentication key and the wearable device identification of the user; and the write acknowledgment receiving unit is configured to receive a write acknowledgment returned by the terminal, and if the write acknowledgment indicates that the device authentication key has been successfully stored in a wearable device designated in the write instruction, store a corresponding relationship between the user identification, the wearable device identification, and the server authentication key of the user.

Optionally, the write acknowledgment receiving unit includes: a password confirmation request issuing module configured to issue a password confirmation request to the terminal when the write acknowledgment indicates that the device authentication key has been successfully stored in the wearable device designated in the write instruction; and a password confirmation acknowledgment receiving module configured to receive, from the terminal, a password confirmation acknowledgment that carries a user password, and if the user password is correct, store the corresponding relationship between the user identification, the wearable device identification, and the server authentication key of the user.

Optionally, the write acknowledgment returned by the terminal further includes a user public key generated by the terminal; and the password confirmation acknowledgment receiving unit is specifically configured to: receive, from the terminal, a password confirmation acknowledgment that carries a user password, and if the user password is correct, store a corresponding relationship between the user identification, the wearable device identification, the server authentication key, and the user public key of the user.

Optionally, the server further stores a server private key and a server public key. The server private key and a terminal public key stored in the terminal are a pair of keys; and the server public key and a terminal private key stored in the terminal are a pair of keys. The apparatus further includes: a write instruction signing unit configured to sign the write instruction by using the server private key. The apparatus further includes: a write acknowledgment verification unit configured to perform signature verification on the write acknowledgment of the terminal by using the server public key, and reject the registration request if the verification fails.

FIG. 10 shows an apparatus for registering a wearable device according to this embodiment. The apparatus is applied to a terminal. By dividing in terms of functions, the apparatus further includes a registration request sending unit, a write instruction receiving unit, a write operation execution unit, and a write acknowledgment sending unit, wherein the registration request sending unit is configured to send a wearable device registration request to a server according to an operation of a user, the registration request carrying a user identification and a wearable device identification of the user; the write instruction receiving unit is configured to receive a write instruction of the server, the write instruction carrying a device authentication key and the wearable device identification of the user; the write operation execution unit is configured to execute an operation of writing the device authentication key on a wearable device designated in the write instruction; and the write acknowledgment sending unit is configured to send a write acknowledgment to the server, the write acknowledgment carrying a message indicating whether the device authentication key is successfully written.

Optionally, the apparatus further includes a password confirmation request receiving unit configured to, after the write acknowledgment is sent to the server, receive a password confirmation request of the server, and return to the server a password confirmation acknowledgement carrying a user password input by the user.

Optionally, the apparatus further includes a user key generation unit configured to, after the operation of writing the device authentication key is successful, generate a user private key and a user public key of the user, and store the user private key; and the write acknowledgment further carries the user public key of the user.

Optionally, the terminal stores a terminal public key and a terminal private key. The terminal public key and a server private key stored in the server are a pair of keys; and the terminal private key and a server public key stored in the server are a pair of keys. The apparatus further includes: a write instruction verification unit configured to perform signature verification on the write instruction of the server by using the terminal public key, and reject the write instruction if the verification fails. The apparatus further includes: a write acknowledgment signing unit configured to sign the write acknowledgment by using the terminal private key.

An embodiment of the present application provides a payment apparatus, applied to a server. By dividing in terms of functions, the apparatus includes a payment request receiving unit, an authentication instruction issuing unit, an authentication response receiving unit, and a payment matching unit, wherein the payment request receiving unit is configured to receive a payment request sent by a user through a payment client terminal, the payment request carrying a user identification and/or a wearable device identification of the user; the authentication instruction issuing unit is configured to acquire downlink authentication information, and issue to the payment client terminal an authentication instruction that includes the downlink authentication information and the wearable device identification; the authentication response receiving unit is configured to receive authentication response information, returned by the payment client terminal, which carries uplink authentication information, the uplink authentication information being generated, by a wearable device designated in the authentication instruction, according to a device authentication key and the downlink authentication information, and the device authentication key being the same as or corresponding to a server authentication key; and the payment matching unit is configured to match the downlink authentication information with the uplink authentication information by using the server authentication key of the user, wherein the user passes the authentication if the matching succeeds, and a payment operation is performed after the authentication is successful.

Optionally, the payment request is triggered by information which is selected by the user on the payment client terminal and indicates making a payment by a wearable device.

An embodiment of the present application provides a payment apparatus, applied to a terminal. By dividing in terms of functions, the apparatus includes a payment request sending unit, an authentication instruction receiving unit, and an authentication response sending unit, wherein the payment request sending unit is configured to send a payment request to a server in response to a payment operation of a user on a payment client terminal, the payment request carrying a user identification and/or a wearable device identification of the user; the authentication instruction receiving unit is configured to receive an authentication instruction, issued by the server, which includes downlink authentication information and the wearable device identification, and send the downlink authentication information to a wearable device, so that the wearable device generates uplink authentication information by using a device authentication key stored by the wearable device and the downlink authentication information; and the authentication response sending unit is configured to receive the uplink authentication information returned by the wearable device, and send the uplink authentication information to the server, so that the server authenticates the user according to the uplink authentication information and performs a payment operation after the authentication is successful.

Optionally, the payment operation of the user on the payment client terminal is specifically an operation which is selected by the user and indicates making a payment by a wearable device.

An embodiment of the present application provides a payment apparatus for a wearable device, applied to the wearable device. By dividing in terms of functions, the payment apparatus includes a payment authentication information receiving unit and an uplink authentication information generation unit, wherein the payment authentication information receiving unit is configured to receive payment authentication information sent by a payment client terminal, the payment authentication information including downlink authentication information issued by a server based on a payment request of a user sent by the payment client terminal; and the uplink authentication information generation unit is configured to generate uplink authentication information according to a stored device authentication key and the downlink authentication information, and send the uplink authentication information to the payment client terminal, so that the payment client terminal sends the uplink authentication information to the server, such that the server can authenticate the user based on the uplink authentication information and perform a payment operation after the authentication is successful.

Optionally, the apparatus further includes: a payment binding unit configured to store, in response to a payment binding request issued by the user through the payment client terminal, a device authentication key carried in the payment binding request.

The above are merely preferred embodiments of the present application, which are not used to limit the present application. Any modification, equivalent replacement, and improvement made without departing from the spirit and principle of the present application should be included in the protection scope of the present application.

In a typical configuration, the computing device includes one or more processors (CPUs), an input/output interface, a network interface, and a memory.

The memory may include a volatile memory, a random access memory (RAM) and/or a non-volatile memory or the like in a computer readable medium, for example, a read-only memory (ROM) or a flash RAM. The memory is an example of the computer readable medium.

The computer readable medium includes non-volatile or volatile, and movable or non-movable media, and can implement information storage by means of any method or technology. Information may be a computer readable instruction, a data structure, and a module of a program or other data. A storage medium of a computer includes, for example, but is not limited to, a phase change memory (PRAM), a static random access memory (SRAM), a dynamic random access memory (DRAM), other types of random access memories (RAMs), a read-only memory (ROM), an electrically erasable programmable read-only memory (EEPROM), a flash memory or other memory technologies, a compact disc read-only memory (CD-ROM), a

digital versatile disc (DVD) or other optical storages, a cassette tape, a magnetic tape/magnetic disk storage or other magnetic storage devices, or any other non-transmission medium, and can be used to store information accessible to the computing device. According to the definition in this text, the computer readable medium does not include transitory media, such as a modulated data signal and a carrier.

It should be further noted that, the terms "include", "comprise", or any other variants thereof are intended to cover a non-exclusive inclusion, such that a process, a method, a commodity or a device that includes a series of elements not only includes such elements but also includes other elements not specified expressly, or may further include inherent elements of the process, method, commodity, or device. Without more restrictions, an element limited by the phrase "include a/an..." does not exclude other same elements existing in the process, method, commodity, or device that includes the element.

Persons skilled in the art should understand that, the embodiments of the present application may be provided as a method, a system, or a computer program product. Therefore, the present application may be implemented in the form of a complete hardware embodiment, a complete software embodiment, or an embodiment combining software and hardware. Moreover, the present application may employ the form of a computer program product implemented on one or more computer usable storage media (including, but not limited to, a magnetic disk memory, a CD-ROM, an optical memory, and the like) including computer usable program code.

CLAIMS

What is claimed is:

1. A computer-implemented method, comprising:

receiving, at a server, an authentication request from a terminal, the authentication request including at least one of a user identifier of a user and a wearable device identifier of the user, the server storing a relationship between the user identifier, the wearable device identifier, a server authentication key, and a terminal identifier, the terminal identifier corresponding to the user identifier and the wearable device identifier;

acquiring, by the server, downlink authentication information, and issuing, to the terminal, a detection instruction that includes the downlink authentication information and the wearable device identifier;

receiving, by the server, a detection acknowledgment returned by the terminal that includes uplink authentication information, the uplink authentication information being generated by a wearable device designated in the detection instruction according to a device authentication key and the downlink authentication information, the device authentication key being the same as, or corresponding to, the server authentication key;

authenticating, by the server, the user including matching the downlink authentication information with the uplink authentication information by using the server authentication key of the user, wherein the user passes the authentication if the matching succeeds; and

wherein the authentication request further includes the terminal identifier of the terminal sending the authentication request, and the method further comprising the step of failing the authentication of the user when the terminal identifier corresponding to the user identifier or the wearable device identifier in the authentication request is different from the terminal identifier of the terminal.

2. The computer-implemented method of claim 1, wherein:

the server further stores a user public key of the user, wherein the user public key corresponds to the user identifier, the wearable device identifier, and the server authentication key of the user, and wherein the user public key and a user private key stored in the terminal are a pair

of keys;

the detection acknowledgment returned by the terminal is signed by using the user private key stored in the terminal; and

the computer-implemented method further comprises performing signature verification on the detection acknowledgment of the terminal according to the user public key of the user, wherein authenticating the user fails if the verification fails.

3. The computer-implemented method of claim 1, wherein:

the server further stores a server private key, wherein the server private key and a terminal public key stored in the terminal are a pair of keys; and

the computer-implemented method further comprises signing the detection instruction by using the server private key.

4. The computer-implemented method of claim 1, wherein the detection instruction and the detection acknowledgment are transmitted through an encrypted channel between the server and the terminal.

5. The computer-implemented method of claim 1, wherein:

the server is a payment server and the authentication request is a payment request; and

the computer-implemented method further comprises providing a payment service for users passing the authentication.

6. The computer-implemented method of claim 1, wherein authenticating the user includes authenticating an identity of the user relative to a login by the user to a personal account.

7. The computer-implemented method of claim 1, wherein authenticating the user includes authenticating an identity of the user making a payment through a third-party payment platform.

8. A computer-implemented method, comprising:

sending, by a terminal connected to a wearable device of a user, an authentication request

to a server according to an operation of the user, the authentication request including a terminal identifier of the terminal, and at least one of a user identifier and a wearable device identifier of the user;

receiving, at the terminal, a detection instruction of the server, the detection instruction including downlink authentication information and the wearable device identifier;

sending, by the terminal, the downlink authentication information to a wearable device designated in the detection instruction, and receiving uplink authentication information returned by the wearable device, the uplink authentication information being generated by the wearable device according to a stored device authentication key and the downlink authentication information, and the device authentication key being the same as, or corresponding to, a server authentication key stored in the server;

sending, to the server, a detection acknowledgment that includes the uplink authentication information;

authenticating the user, including receiving a user authentication result determined by the server according to the uplink authentication information, the downlink authentication information, and the server authentication key; and

receiving a failed user authentication result when a terminal identifier stored in the server corresponding to the user identifier or the wearable device identifier in the authentication request is different from the terminal identifier of the terminal.

9. The computer-implemented method of claim 8, wherein:

the terminal stores a user private key of the user, wherein the user private key and a user public key stored in the server are a pair of keys; and

the computer-implemented method further comprises signing the detection acknowledgment by using the user private key of the user.

10. The computer-implemented method of claim 8, wherein:

the terminal stores a terminal public key, wherein the terminal public key and a server private key stored in the server are a pair of keys;

the detection instruction issued by the server is signed by using the server private key.

11. The computer-implemented method of claim 8, wherein the authentication request is a payment request, and wherein the terminal completes a payment operation of the user after the user authentication result is the authentication being successful.
12. The computer-implemented method of claim 11, further comprising:
 - performing signature verification on the detection instruction of the server according to the terminal public key; and
 - rejecting the detection instruction if the verification fails.
13. The computer-implemented method of claim 1, wherein the authentication request includes an identity of the user relative to a login by the user to a personal account.
14. The computer-implemented method of claim 1, wherein the authentication request includes an identity of the user making a payment through a third-party payment platform.
15. The computer-implemented method of claim 1, further comprising providing, for display to the user, a message indicating that authorization has occurred.
16. A non-transitory, computer-readable medium storing one or more instructions executable by a computer system to perform operations according to the method as claimed in any one of claims 1 to 7, 13 to 15.
17. A non-transitory, computer-readable medium storing one or more instructions executable by a computer system to perform operations according to the method as claimed in any one of claims 8 to 12.
18. A computer-implemented system, comprising:
 - one or more computers; and
 - one or more computer memory devices interoperably coupled with the one or more computers and having tangible, non-transitory, machine-readable media storing instructions, that when executed by the one or more computers, perform operations according to the method as claimed in any one of claims 1 to 7, 13 to 15.

19. A computer-implemented system, comprising:
- one or more computers; and
 - one or more computer memory devices interoperably coupled with the one or more computers and having tangible, non-transitory, machine-readable media storing instructions, that when executed by the one or more computers, perform operations according to the method as claimed in any one of claims 8 to 12.