

Hands-free and Ticketless Fare Collection System

Field of Invention

[001] The present invention relates to a hands-free and ticketless fare collection system, for example, for entering a pay area or a defined area. In particular, this invention dispenses away with physical farecards and relies on face recognition of commuters or customers for identification.

Background

[002] Conventional mass transit fare collection gates rely on commuters carrying stored value farecards. Each farecard includes a near-field electronic chip for short range non-contact tapping at a reader/writer upon entering into or exiting from a transit station. A disadvantage of such fare collection is that customers must carry a farecard with sufficient stored value in order to travel.

[003] It can thus be seen that there exists a need for another method of collecting fares from commuters or customers in an expeditious and reliable manner using face recognition, without relying on a farecard.

Summary

[004] The following presents a simplified summary to provide a basic understanding of the present invention. This summary is not an extensive overview of the invention, and is not intended to identify key features of the invention. Rather, it is to present some of the inventive concepts of this invention in a generalised form as a prelude to the detailed description that is to follow.

[005] The present invention seeks to provide another fare collection system, for eg., for mass transit of commuters or customers to enter and exit a pay area. The fare collection system is ticketless and commuters/customers do not have to carry store value farecards; this will allow hands-free entry into or exit from a mass transit system, bus, stadium, concert hall, passenger lobby at a departure or arrival hall, and so on.

[006] In one embodiment, the present invention provides a new hands-free, ticketless fare collection system. The hands-free, ticketless fare collection system comprises: a server running a software, which comprises a face recognition subroutine; a commuter ID database and a commuter account database are linked to the server; a gate for entry into or exit from a designated pay area delineated by the fare collection system; and a multifunctional kiosk for enrolment of a commuter, where a camera captures a portrait of the commuter and the face recognition subroutine associates unique facial characteristics of the commuter with the customer identity, and the fare collection system stores the commuter identity in the commuter ID database and commuter account database, so that after enrolment, the commuter can enter into or exit from within the designated pay area without having to carry a store value farecard.

[007] In another embodiment, the present invention provides a system or a method for collecting fares from commuters/customers by enrolling commuters, storing commuter portraits in an ID database, storing commuter payment and bank records in a commuter accounts database, and identifying commuters/customers by face recognition and/or long range RFID. Preferably, the commuter IDs are stored in separate categories, such as, name, gender, ethnic race, date of birth, height and privileged group, and so on, to allow quick and accurate identification.

[008] Preferably, the server runs a subroutine to interject a greeting to a commuter/customer as a commuter/customer identity is found in the ID database. When a system fault is triggered, the commuter/customer who triggered the system fault is identified by a beam tracer, highlight on a monitor screen or highlight in an augmented reality (AR) glasses worn by a controller. Preferably, the display screen on the multi-functional kiosk is operable to display an advertising/information screen and an operating menu screen upon detecting presence of a commuter/customer; where these multi-functional kiosks are placed side by side to one another, the advertising/information screen is dynamically composed of two or more display screens upon detecting non-presence of a commuter/customer with a predetermined range.

Brief Description of the Drawings

[0009] This invention will be described by way of non-limiting embodiments of the present invention, with reference to the accompanying drawings, in which:

[0010] FIG. 1 illustrates a fare collection system for mass transit according to an embodiment of the present invention;

[0011] FIG. 2A illustrates an arched gate, whilst FIG. 2B illustrates a barrier gate and FIGs. 2C-2D illustrate two barrier-free gates for use with the fare collection system shown in FIG. 1;

[0012] FIGs. 3A-3B illustrate a multifunctional gang kiosk for use with the system shown in FIG. 1;

[0013] FIG. 4A illustrates a portrait of a commuter as seen by a camera of the above fare collection system, whilst FIG. 4B illustrates a face used in facial recognition; and

[0014] FIG. 5A illustrates facial recognition in a group of commuters, whilst FIG. 5B illustrates its use when passengers are boarding a bus, and FIG. 5C illustrates its use when passengers are going to alight from the bus.

Detailed Description

[0015] One or more specific and alternative embodiments of the present invention will now be described with reference to the attached drawings. It shall be apparent to one skilled in the art, however, that this invention may be practised without such specific details. Some of the details may not be described at length so as not to obscure the present invention. For ease of reference, common reference numerals or series of numerals will be used throughout the figures when referring to the same or similar features common to the figures.

[0016] FIG. 1 shows a hands-free ticketless fare collection system 100 according to an embodiment of the present invention. Broadly, the fare collection system 100 includes gates 110, 110a, 110b separating a paid entry area from a public area, for eg., at a transit station; in addition, a plurality of multi-functional kiosks 120 for enrolling commuters/customers are located in the public area. The gates 110, 110a, 110b and kiosks 120 are linked to a server 140 via a gateway 10. The server 140 runs a software 142 and is connected to workstations 150 located at all the transit stations; in addition, some workstations 150 may be located in some backend control rooms. After enrolment, the commuters' identities are stored in an ID database 160, whilst commuters' accounts are stored in an account database 170. The commuter account database 170 is also linked by the software 142 to banks 180 associated with the commuters' accounts. The working of the fare collection system 100 becomes clearer as components of the system are described below; in this description, commuters, passengers, customers or patrons are used synonymously.

[0017] FIG. 2A shows a gate 110 according to one embodiment. The gate 110 includes an upright arch 112, which is dimensioned to a height and a width for passage of commuters, preferably, one at a time. A camera 114 is mounted on an overhead member of the arch and is directed to capture the faces of the commuters, such as the portrait shown in FIG. 4A and the face shown in FIG. 4B, before they enter through the gate 110. When the gate 110 is configured for bi-directional passage, another camera 114 is mounted on an opposite side of the overhead member to capture the faces of commuters who are going to exit through the gate. The gate 110 also includes a pair of green and red light indicators 116, 117. The green light indicator 116 is illuminated when a commuter entering or exiting the gate 110 is identified positively and the associated commuter account is time-stamped or logged for calculating the correct fare to pay. The red light indicator 117 is illuminated when the fare collection system 100 fails to identify positively a commuter identity as the commuter enters or exits the gate 110, or fails to log a charge for a correct fare from the commuter account; when the red light indicator is illuminated, the commuter can re-track and approach the gate again; in case of persistent failure, the commuter can approach a station controller to manually address the system fault. In another embodiment, the fare collection system includes a buzzer linked to the red light indicator 117 to give an additional audible warning in the event of a fare collection fault.

[0018] FIG. 2B shows two gates 110a according to another embodiment. Each gate 110a has two barrier flaps 118, 118a that are retractable or rotatable into their associated cabinets. Two cameras 114a are suspended from above each of the gates; one camera 114a is directed to capture the faces of commuters entering the gate 110a, while the other camera is directed to capture the faces of commuters exiting the gate 110a when the gate 110a is configured for bidirectional human traffic. When a commuter identity is found to match an identity enrolled in the ID database 160, the barrier flaps 118, 118a are actuated to retract/rotate and the commuter is allowed to pass through; the commuter account is logged during entry and a payment is deducted from the commuter account during exit, for eg., after completing a journey and, preferably, a green light indicator 116a is illuminated; when a commuter identity is not found in the commuter ID database 160 or an error in logging a fare charge or deducting payment from the commuter account occurs, the barrier flaps 118, 118a remain in the obstructed position and a red light indicator 117a becomes illuminated; an additional audible warning may be sounded, so that the commuter can be alerted to go to the station control to rectify the fare collection fault.

[0019] FIG. 2C shows a barrier-free gate 110b according to another embodiment of the present invention. The barrier-free gate 110b has a pair of dividing members 119 and a pair of cameras 114a suspended above the barrier-free gate 110b; preferably, the dividing members 119 define discrete lanes for passage through the barrier-free gate; it is also possible that the lanes for passage through the barrier-free gate 110b can alternatively be defined by markings on the ground. When a commuter approaches the barrier-free gate 110b for entering or exiting, one of the pair of camera 114a detects the commuter and a commuter photo is captured; the commuter photo, together with the entry or exit station IDs, are then relayed to the server 140, 140a and are matched with records in the ID database 160; once the commuter is positively identified by the fare collection system 100, the commuter account is time-stamped or logged for entering the pay/designated area; preferably, the commuter ID and/or commuter account is/are flagged or entered into entry records in the ID database 160 and/or a list of pending deductible fare stored in account database 170. In a similar manner, when a commuter is going to exit from the pay/designated area and comes within the range of the camera 114a, the commuter portrait is captured, relayed to the server 140,140a and is matched with records in the ID database

160, entry records in the ID database 160; once the commuter is positively identified, a fare charge is then logged in and deducted from the commuter account. In case of a fare collection system failure, such as, failing to identify positively a commuter, logging a fare charge or deducting a fare from the commuter account, a red indicator light 117a may be illuminated, the commuter and a station controller are notified of a system error.

[0020] To notify the commuter of an error, a tracing beam may be emitted to identify the commuter who triggered the system error, for eg., by shining the tracing beam on or around the commuter. In addition or alternatively, the commuter who triggered the system error is highlighted on a monitor screen at the station control room; further, a station controller may be equipped with augmented reality (AR) glasses and the commuter can be identified/traced by the station controller on the go. With the AR glasses, the commuter ID (such as, name), fare amount, entry time, station ID of entry into pay/designated area, transaction history, and other relevant information, are made available to the station controller through the AR glasses.

[0021] FIG. 2D shows a barrier-free gate 110c according to a variation of the above embodiment. Each barrier-free gate 110c has a pair of RF detectors 119a and a pair of cameras 114a suspended above the barrier-free gate 110c. The RF detector 119a is built inside the associated dividing member 119 and is configured as a long range antenna. Preferably, each RF detector 119a is dimensioned substantially to a height of an adult commuter; also preferably, the long range antenna 119a has a detecting range of substantially 1-1.5m and is tuned to a frequency to interrogate with an RFID chip embedded in a commuter RFID media 119b carried by each commuter. For eg., in FIG. 2D, the RFID media 119b is worn as a wrist band. When a commuter approaches the barrier-free gate 110c for entering or exiting, one of the pair of camera 114a detects the commuter and a commuter photo is captured; as the commuter goes nearer and comes within the range of the RF detector 119a, the commuter ID and/or commuter photo are sent to a local workstation 150, for eg., located at the local transit station. The commuter ID and commuter photo, together with the entry station ID and transfer records, are then relayed to the server 140, 140a and are matched with records in the ID database 160 or entry records in the ID database; once the commuter is positively identified by the fare collection system 100, the commuter account is time-stamped or logged for calculating a correct fare to pay

when exiting from the pay/designated area; in addition or alternatively, a list of pending deductible fare is stored as a subset in the account database 170. In a similar manner, when a commuter is going to exit from the pay/designated area and comes within the range of the RF detector 119a, the commuter ID and/or commuter photo is/are relayed to the ID database, entry records in the commuter ID database 160 and/or the list of pending deductible fare in the account database 170, and a fare charge is then logged in and deducted from the commuter account when the commuter exits from the pay/designated area. In this embodiment, both the commuter photo and commuter RFID are used for identification or verification; with this embodiment, the response time of the fare collection system is shortened to substantially less than 1 second, yet improving on reliability of ID verification. When deducting the fare from the commuter account, the commuter RFID need only be used for verification and this adds further to the advantage of using this barrier-free fare collection system 100.

[0022] In cases when commuters are engrossed with electronic gadgets and their faces cannot be captured by the cameras 114a or when their faces are partially covered up by head dresses, the commuter RFIDs can still be used to identify individual commuters; this is another advantage of this barrier-free fare collection system 100. In the cases of commuters whose faces cannot be captured by the cameras 114a and do not carry any commuter RFIDs, these commuters can be identified by directing a tracing beam of light on the person or highlighting these commuters on a monitor screen; a station controller, preferably wearing AR glasses (as described above) can then approach these commuters and have the fare collection fault remedied.

[0023] FIG. 3A shows a gang of multi-functional kiosks 120 located in a public area, for eg., outside a transit station. Each kiosk 120 has a touch screen 122. Above the touch screen is a camera 124, and below the touch screen are: a coin insert slot 125, an electronic transaction terminal 126 with a keypad; a near field card reader 127; a receipt printer 128; and a currency note slot 129. A microphone 123 may also be provided near a side of the touch screen or a directional microphone 123 may be located at a lower part of the kiosk. A speaker 132 is also located at a lower part of the kiosk, whilst a virtual call button 131 is located on a menu screen 130b on the touch screen 122. The call button 131, microphone 123 and speaker 132 allow a customer to communicate with an operator manning a call

centre that is connected to the fare collection system 100. In another embodiment, an RFID media slot 128a may be provided; the RFID media slot 128a may dispense a commuter RFID media 119b after a commuter enrolment is successful; it is also possible that a commuter registers oneself remotely, say from home and a QR code is digitally issued to one's mobile device; with the QR code, the commuter goes to a kiosk 120 and authenticates one's identity before a RFID media 119b is issued; preferably, the authentication process employs a two-factors two-channels for secure verification, with the first factor being the QR code, whilst the second factor may be a random code generated by a coding machine and is sent to the commuter's mobile device. These RFID media 119b may be in the form of a card, a ring, a wrist band, a key chain, a token and so on. It is possible that the positions of the components on the kiosks 120 may vary according to designs without affecting their functionalities. In one embodiment, in use, the touch screen 122 may be virtually and dynamically divided into an upper advertising or information display screen 130a and a lower operating menu screen 130b.

[0024] A number of kiosks 120 are placed side by side and the touch screens 122 or any number of adjacent touch screens 122 can be configured dynamically as a large composite display screen 122a, for example, for advertising or displaying some public information when no commuter within a predetermined distance is detected by the cameras 124; the large composite display screen 122a may cover the display screens 122 of two or more kiosks for displaying an advertisement or public information. When a commuter approaches a kiosk 120, the camera 124 detects a person and the menu screen 130b appears, whilst the touch screens 122 of the adjacent kiosks adjust dynamically to a new composite display size.

[0025] At the kiosk 120, a commuter can choose to perform a number of functions from the menu screen 130b. For example, a commuter can choose to enroll for a new account by entering one's name, then selecting a portrait already captured by the camera 124, tapping one's payment card at the near field card reader, entering the payment card personal identification number (PIN) on the electronic transaction terminal 126, and identifying oneself by entering one's gender, race, date of birth, height, category of travel, and so on, on the menu screen 130b. The category of travel may include student, national serviceman, disabled person, senior citizen, tourist or staff, who may enjoy special discounts, privileges

or promotions. After enrolment, the commuter identity is stored in the commuter ID database 160 with the personal records being additionally stored under respective ID categories; with the personal records being additionally stored under different ID categories, a commuter identity can be located in the commuter ID database 160 very quickly and accurately, so that the time required for identifying a commuter from the commuter ID database and deducting a fare from the commuter in the account database 170 is substantially unnoticeable to the commuter. For commuters who have entered the pay area, a dynamic list of commuters are stored as a subset in the ID database 160, thus making identity matching in the ID database quicker; in other words, the ID database 160 is dynamically segregated into two subsets according to commuters inside or outside the pay area for quicker commuter identification; in the way, the account database 170 is dynamically segregated into two subsets according to commuters pending to pay a fare or those outside the pay area.

[0026] When a commuter account is low in value, the commuter can also top-up one's account at the multifunctional kiosk 120 by topping up using a payment card, currency notes or coins or a mobile device via the near field reader 127. In another embodiment, a commuter is able to set a predetermined low value for the fare collection system 100 to automatically top-up one's commuter account.

[0027] From the menu screen 130b on the touch screen 122, a commuter can also access information (such as, a map) about the transit system or to connect to predefined web pages in the internet. Alternatively, browsing of web pages in the internet may be provided by configuring an additional screen 122b on a rear side of each kiosk 120, as seen in FIG. 3B, where a keyboard 138 is located on a slanting panel 139, which allows retrieval of money from the currency and coins slots 125, 129 or maintenance of components from the rear of the kiosk.

[0028] As shown in FIG. 1, the system software 142 is hosted on a server 140. The server 140 is in turn connected to workstations 150 located remotely according to the fare collection system 100, for eg., at all the transit stations. In one embodiment, the server 140 comprises a master server and a plurality of slave servers 140a in order to distribute the computing workload and to respond as quickly as commuters enter into or exit from the

designated pay area; the slave servers 140a may perform parallel computing with the master server 140. In another system, the server 140 comprises a plurality of slave servers 140a operating grid computing. It is also possible for the servers 140, 140a to operate a combination of parallel computing, grid computing and other forms of distributed computing. The system software 142 includes a face recognition subroutine 144. During enrolment, the face recognition subroutine 144 analyses unique characters of a commuter face from the portrait/photo (shown in FIGs. 4A-4B) selected by the commuter during enrolment; in one embodiment, the face recognition subroutine 144 is intelligent enough to distinguish a commuter wearing spectacles. It is also possible that the face recognition subroutine 144 analyses a commuter's mood, such as cheerful, sad, etc.; during use, the face recognition subroutine 144 is configured to interject a personalized greeting to each commuter when a commuter is identified positively in the commuter ID database 160; such personalized greetings may be "good morning, Mr ...", "Cheer up, Mr ...", "Smile, Mr ...", etc. Another feature of this fare collection system 100 is target marketing; for example, when a commuter is identified positively, the face recognition subroutine 144 may be configured with another subroutine to run an appropriate advertisement targeted at the commuter; for example, the advertisement may be gender specific, targeting those wearing spectacles, targeting children, etc. In another embodiment, the fare collection system 100 allows import of a wanted or missing person database 161. The wanted/missing person database 161 is useful when there is a need to locate and trace a wanted/missing person who may be present inside the pay area or in the public area outside the pay area.

[0029] There are other features to make the fare collection system 100 more user friendly. For example, with a camera at each of the entrance/exit gate 110, 110a, 110b the fare collection system 100 can also include a subroutine to detect a crowd. When a crowd is forming at a gate 110, 110a, 110b, 110c, the fare collection system may respond by sending an alert to the station controller at the local transit station who may then divert human traffic to other gates 110, 110a-110c.

[0030] The above described transit system is complex and many systems and sub-systems errors can happen. For example, when entering or exiting a gate, a commuter may wear a hat or a sunglass. The hat or sunglass may obstruct some facial features of a commuter, thereby introducing a difficulty in identification, resulting in a system fault. Such a fault

can be rectified by the commuter seeking help from a station controller, who can then use a camera to capture a portrait of the commuter and link the commuter ID to the portrait. Such a manually linked commuter ID may be stored in a separate ID category in the ID database 160.

[0031] Another feature of the facial recognition subroutine 144 is the capability to identify faces from a crowd of people, as illustrated in FIG. 5A, using a camera 114b. This feature is useful when the fare collection system 100 is used on a bus 210, as shown in FIG. 5B, which application is similar to a barrier-free gate 200 but where people tend to move in a less orderly manner (as in a crowd). As in the above embodiment, when a passenger identity is not found in the commuter ID database or an error in logging a fare charge or deducting a fare from the respective commuter account occurs, the person is identified on a monitor screen, so that the system fault can be addressed. In another embodiment, a pair of RF detectors 119a may be deployed at the entrance door and exit door (as shown in FIG. 5C) on the bus 210 to augment the above face recognition, identification and monitoring.

[0032] While specific embodiments have been described and illustrated, it is understood that many changes, modifications, variations and combinations thereof could be made to the present invention without departing from the scope of the present invention. For eg., the gate 110a in FIG. 2B may employ an additional bar code, QR code and/or NFC scanner.

CLAIMS:

1. A hands-free fare collection system comprising:
 - a server running a software, which comprises a face recognition subroutine;
 - a commuter ID database for storing commuter identities, wherein the stored commuter identities are categorized into name, gender, ethnic race, date of birth, height and privileged group to allow identification, wherein the commuter ID database is linked to the server;
 - a commuter account database for storing account information for commuters, wherein the commuter account database is linked to the server;
 - a gate for entry into or exit from a designated pay area delineated by the fare collection system; and
 - a multifunctional kiosk for enrolment of a commuter, where a camera captures a portrait of the commuter and the face recognition subroutine associates unique facial characteristics of the commuter with a customer identity, and the fare collection system stores the commuter identity in the commuter ID and commuter account databases, so that after enrolment, the commuter can enter into or exit from within the designated pay area without having to carry a store value farecard.
2. The system according to claim 1, wherein the privileged group comprises: children, senior citizens, disabled, students, national servicemen, tourists and staff.
3. The system according to claim 1, wherein the face recognition subroutine makes further categories in the commuter ID database, the further categories comprising a list of people wearing spectacles or a list of wanted or missing persons.
4. The system according to claim 1, wherein the server comprises a master server and a plurality of slave servers.
5. The system according to claim 4, wherein the master server and the slave servers are configured for parallel computing.
6. The system according to claim 4, wherein the master server and the slave servers are configured for grid computing.

7. The system according to any one of the preceding claims, further comprising a subroutine to interject a greeting to a commuter at the multi-functional kiosk, entry gate or exit gate, as a commuter identity is found in the ID database.
8. The system according to any one of the preceding claims, wherein the gate for entry or exit is barrier-free.
9. The system according to claim 8, wherein the commuter or customer who triggered a system fault is identified by a beam tracer, highlighted on a monitor screen or highlighted in an augmented reality (AR) glasses worn by a system controller.
10. The system according to claim 8 or 9, wherein the gate comprises a pair of long range RF detectors.
11. The system according to any one of claim 8-10, wherein the gate is deployed for use at a mass transit station, bus, stadium, concert hall, or passenger lobby at an arrival or departure hall.
12. The system according to any one of the preceding claims, wherein a display screen of the multi-functional kiosk is operable to display an advertising or information screen and an operating menu screen upon presence of a commuter as detected by the camera.
13. The system according to claim 12, wherein there is a plurality of multi-functional kiosks, each placed side by side to one another, and the advertising or information screen is dynamically composed of two or more display screens upon non-presence of a commuter within a predetermined range.
14. The system according to any one of the preceding claims, further comprising a touch screen and a keyboard, both being disposed behind the multi-functional kiosk for a commuter to assess the internet.