exchange. In additions, features of the card, for example metal cards, may cause noise, dampen signal reception, or other reflections that erroneously trigger NFC read transactions. For systems that use contactless cards for authentication and transaction purposes, delays and interruption may result in lost transactions and customer frustration.

SUMMARY

[0005] A system of one or more computers can be configured to perform particular operations or actions by virtue of having software, firmware, hardware, or a combination of them installed on the system that in operation causes or cause the system to perform the actions. One or more computer programs can be configured to perform particular operations or actions by virtue of including instructions that, when executed by data processing apparatus, cause the apparatus to perform the actions.

[0005a] According to a first aspect, there is provided a method to align contactless cards for short-range communications, comprising: generating, on a device, a prompt to communicatively couple a contactless card with the device; detecting, by a proximity sensor of the device, that the contactless card is proximate to the device; capturing, by a camera of the device, a series of images as the contactless card approaches the device; processing the series of images to determine a position and a trajectory of the contactless card as the contactless card approaches the device; detecting, based on the series of images, that the contactless card is at a target location relative to the device; and triggering an interface of the device to perform a short-range communication with the contactless card.

[0005b] According to a second aspect, there is provided a computing device, comprising: processor circuit; a memory coupled with the processor circuit, the memory configured to store instructions that when executed by the processor circuit to cause the processor circuit to: generate a prompt to communicatively couple a contactless card with the computing device; detect, via a proximity sensor, that the contactless card is proximate to the computing device; capture, by a camera, a series of images as the contactless card approaches the computing device; process the series of images to determine a position and a trajectory of the contactless card as the contactless card approaches the computing device; detect, based on the series of images, that the contactless

card is at a target location relative to the computing device; and trigger an interface of the device to perform a short-range communication with the contactless card.

[0005c] According to a third aspect, there is provided a computer-readable medium comprising instructions, that when executed by processing circuitry, cause the processing circuitry to: generate a prompt to communicatively couple a contactless card with a computing device; detect, via a proximity sensor, that the contactless card is proximate to the computing device; capture, by a camera, a series of images as the contactless card approaches the computing device; process the series of images to determine a position and a trajectory of the contactless card as the contactless card approaches the computing device; detect, based on the series of images, that the contactless card is at a target location relative to the computing device; and trigger an interface of the computing device to perform a short-range communication with the contactless card.

[0006] As disclosed, a method for guiding positioning of a card to a target position relative to a device includes the steps of: detecting by a proximity sensor that the card is proximate to the device; responsive to the card being proximate to the device, the device capturing a series of images of a three-dimensional volume proximate to the device; processing the series of images to determine a position and a trajectory of the card within the three-dimensional volume proximate to the device; predicting a projected position of the card relative to the device based on the position of the card and the trajectory of the card; identifying one or more variances between the projected position and the target position including identifying at least one trajectory adjustment predicted to reduce the one or more variances and one or more prompts predicted to achieve the trajectory adjustments; displaying the one or more prompts on a display of the device; repeating the steps of capturing the series of images, determining the position and trajectory of the card, predicting the projected position of the card, identifying the one or more variances, the at least one trajectory adjustment and the one or more prompts and displaying the one or more prompts until the one or more variances are within a predetermined threshold; and triggering an event at the device to retrieve data from the card in response to the one or more variances being within the predetermined threshold. Other embodiments of this aspect include corresponding computer systems, apparatus, and computer programs recorded on one or more computer storage devices, each configured to perform the actions of the methods.

[0008] As disclosed, a device includes a proximity sensor configured to detect whether a card is proximate to the device; an image capture device coupled to the proximity sensor and configured to capture a series of images of a three-dimensional volume proximate to the device; a processor coupled to the proximity sensor and the image capture device; a display interface coupled to the processor; a card reader interface coupled to the processor; and a non-transitory medium storing alignment program code configured to guide a card to a target position relative to the device. The alignment program code operable when executed upon by the processor to: monitor a proximity of the card to the device; enable the image capture device to capture the series of images of the three-dimensional volume proximate to the device; process the series of images to determine a position and a trajectory of the card within the three-dimensional volume proximate to the device and to predict a projected position of the card relative to the device based on the position of the card and the trajectory of the card; identify one or more variances between the projected position and the target position including identifying at least one trajectory adjustment and one or more prompts to achieve the at least one trajectory adjustment, the at least one trajectory adjustment predicted to reduce the one or more variances; display the one or more prompts on the display interface during at least one of prior to and during the card read operation; and trigger a card read operation by the card reader interface when the one or more variances are within a predetermined threshold. Other embodiments of this aspect include corresponding computer systems, apparatus, and computer programs recorded on one or more computer storage devices, each configured to perform the actions of the methods.

[0009] Implementations may include one or more of the following features. The device off claim 11 where the program code that is operable when executed upon to process the series of images to determine the position and a trajectory of the card within the three-dimensional volume proximate to the device uses at least one of a machine learning model or a simultaneous localization and mapping (slam) process. The device where the card read operation is associated with one of a financial transaction and an authorization transaction. The device where the image capture device includes one or more of a camera, an infrared sensor or a dot projector, and the series of images capture one or more of an infrared energy and a visible light energy measured at the device. The device where the series of images include one or both of two-dimensional image information and three-dimensional image information. The device where the alignment program code is further configured to generate a volume map of the three-dimensional volume proximate

to the device using the series of images, the infrared sensor and the dot projector, the volume map including pixel data for a plurality of pixel locations within the three-dimensional volume proximate to the device. The device further including a feature extraction machine learning model is trained to locate the card within the three-dimensional volume proximate to the device and to predict a projected position using a historic attempt to position the card. The device where the historic attempt is a user specific historic attempts. The device where the one or more prompts include at least one of a visible prompt, an audible prompt, or a combination of visible and audible prompts. Implementations of the described techniques may include hardware, a method or process, or computer software on a computer-accessible medium.

[0010] As disclosed, a method for guiding a card to a target position relative to a device includes the steps of: detecting a request by the device to perform a transaction; measuring, using a proximity sensor of the device, a proximity of the card to the device; controlling at least one of a camera and an infrared depth sensor of the device to capture a series of images of a three-dimensional volume proximate to the device when the card is determined to be proximate to the device; processing the series of images to determine a position and trajectory of the card in the three-dimensional volume proximate to the device, the processing performed by at least one of a machine learning model trained using historic attempts to guide the card to the target position or a simultaneous localization and mapping (slam) process; predicting a projected position of the card relative to the device based on the position and the trajectory of the card; identifying one or more variances between the projected position and the target position including identifying at least one trajectory adjustment selected to reduce the one or more variances and identifying one or more prompts to achieve the trajectory adjustments; displaying the one or more prompts on a display of the device; repeating the steps of capturing image information, determining the position and trajectory of the card, predicting the projected position of the card, identifying the one or more variances, the at least one trajectory adjustment and the one or more prompts and displaying the one or more prompts until the one or more variances are within a predetermined threshold; and triggering a read of the card by a card reader of the device when the variances are less than the predetermined threshold. Other embodiments of this aspect include corresponding computer systems, apparatus, and computer programs recorded on one or more computer storage devices, each configured to perform the actions of the methods.

WHAT WE CLAIM IS:

1. A method to align contactless cards for short-range communications, comprising:

generating, on a device, a prompt to communicatively couple a contactless card with the device;

detecting, by a proximity sensor of the device, that the contactless card is proximate to the device;

capturing, by a camera of the device, a series of images as the contactless card approaches the device;

processing the series of images to determine a position and a trajectory of the contactless card as the contactless card approaches the device;

detecting, based on the series of images, that the contactless card is at a target location relative to the device; and

triggering an interface of the device to perform a short-range communication with the contactless card.

2. The method of claim 1, wherein processing the series of images to determine the position and the trajectory of the contactless card uses at least one of a machine learning model or a simultaneous localization and mapping (SLAM) process.

3. The method of claim 1, wherein capturing the series of images is performed by one or more of the camera of the device, an infrared sensor of the device or a dot projector of the device, and wherein the series of images comprises one or both of two-dimensional image information and three-dimensional image information related to one or more of an infrared energy and a visible light energy measured at the device.

4. The method of claim 3, comprising generating a volume map of a three-dimensional volume proximate to the device using the series of images obtained from one or more of the camera, the infrared sensor and the dot projector, the volume map comprising a pixel data for a plurality of pixel locations within the three-dimensional volume proximate to the device.

5. The method of claim 1, wherein processing the series of images to determine the position and the trajectory of the contactless card comprises forwarding the series of images to a feature extraction machine learning model trained to process series of images to detect one or more features of the contactless card and to identify the position and the trajectory of the contactless card in response to the detected one or more features.

6. The method of claim 5, comprising forwarding the series of images to a second machine learning model trained to predict the position and the trajectory based on a historic attempt to position the contactless card.

7. The method of claim 6, wherein the historic attempt used to train the second machine learning model is customized to a user of the device.

8. The method of claim 1, wherein the prompt includes a visible prompt, an audible prompt, or a combination thereof.

9. A computing device, comprising:

processor circuit;

a memory coupled with the processor circuit, the memory configured to store instructions that when executed by the processor circuit to cause the processor circuit to:

generate a prompt to communicatively couple a contactless card with the computing device;

detect, via a proximity sensor, that the contactless card is proximate to the computing device;

capture, by a camera, a series of images as the contactless card approaches the computing device;

process the series of images to determine a position and a trajectory of the contactless card as the contactless card approaches the computing device;

detect, based on the series of images, that the contactless card is at a target location relative to the computing device; and

trigger an interface of the device to perform a short-range communication with the contactless card.

10. The computing device of claim 9, wherein processing the series of images to determine the position and the trajectory of the contactless card uses at least one of a machine learning model or a simultaneous localization and mapping (SLAM) process.

11. The computing device of claim 9, wherein capturing the series of images is performed by one or more of the camera of the computing device, an infrared sensor of the computing device or a dot projector of the computing device, and wherein the series of images comprises one or both of two-dimensional image information and three-dimensional image information related to one or more of an infrared energy and a visible light energy measured at the computing device.

12. The computing device of claim 11, wherein the processor circuit to generate a volume map of a three-dimensional volume proximate to the computing device using the series of images obtained from one or more of the camera, the infrared sensor and the dot

projector, the volume map comprising a pixel data for a plurality of pixel locations within the three-dimensional volume proximate to the computing device.

13. The computing device of claim 9, wherein processing the series of images to determine the position and the trajectory of the contactless card comprises forwarding the series of images to a feature extraction machine learning model trained to process the series of images to detect one or more features of the contactless card and to identify the position and the trajectory of the contactless card in response to the detected one or more features.

14. The computing device of claim 13, wherein the processor circuit to forward the series of images to a second machine learning model trained to predict the position and the trajectory based on a historic attempt to position the contactless card.

15. The computing device of claim 14, wherein the historic attempt used to train the second machine learning model is customized to a user of the computing device.

16. The computing device of claim 9, wherein the prompt includes a visible prompt, an audible prompt, or a combination thereof.

17. A computer-readable medium comprising instructions, that when executed by processing circuitry, cause the processing circuitry to:

generate a prompt to communicatively couple a contactless card with a computing device;

detect, via a proximity sensor, that the contactless card is proximate to the computing device;

capture, by a camera, a series of images as the contactless card approaches the computing device;

process the series of images to determine a position and a trajectory of the contactless card as the contactless card approaches the computing device;

detect, based on the series of images, that the contactless card is at a target location relative to the computing device; and

trigger an interface of the computing device to perform a short-range communication with the contactless card.

18. The computer-readable medium of claim 16, wherein processing the series of images to determine the position and a trajectory of the contactless card uses at least one of a machine learning model or a simultaneous localization and mapping (SLAM) process.

19. The computer-readable medium of claim 16, wherein capturing the series of images is performed by one or more of a camera of the computing device, an infrared sensor of the computing device or a dot projector of the computing device, and wherein the series of images comprises one or both of two-dimensional image information and three-dimensional image information related to one or more of an infrared energy and a visible light energy measured at the computing device.

20. The computer-readable medium of claim 19, wherein the processor circuit to generate a volume map of a three-dimensional volume proximate to the computing device using the series of images obtained from one or more of the camera, the infrared sensor and the dot projector, the volume map comprising a pixel data for a plurality of pixel locations within the three-dimensional volume proximate to the computing device.