CLAIMS

What is claimed is:

1. A method of automatically generating a calibration file for a card handling device, the method comprising:

capturing, with an imaging device of the card handling device, a raw image from at least a portion of a card passing through the card handling device from an input tray to an output tray of the card handling device; and

using a processor of the card handling device, automatically generating and storing a calibration file in memory of a main control system of the card handling device without user input, the calibration file being unique to the card handling device for a specific deck that includes the card such that the card handling device is trained for the specific deck during a subsequent card recognition mode, wherein automatically generating the calibration file comprises:

identifying at least one parameter associated with a rank area around a rank of the at least a portion of the card;

identifying at least one parameter associated with a suit area around a suit of the at least a portion of the card; and

storing the at least one parameter associated with the rank area and the at least one parameter associated with the suit area in the calibration file.

2. The method of claim 1, wherein automatically generating and storing the calibration file comprises identifying a location and at least one parameter associated with a region of interest that is relatively larger than the rank area and the suit area, the method further comprising storing the location and the at least one parameter associated with the region of interest in the calibration file.

3. The method of claim 1, wherein capturing a raw image includes capturing a plurality of raw images from a plurality of different cards passing through the card handling device.

4. The method of claim 1, wherein storing the calibration file in a file system of an operating system running on the processor.

5. The method of claim 3, wherein identifying at least one parameter associated with the rank area includes:

identifying at least one parameter associated with a plurality of rank areas from the plurality of different cards; and

selecting the at least one parameter associated with the rank area to include a rank width parameter having a number of pixels representative of a width that is a widest dimension from the plurality of rank areas, and to include a rank depth parameter having a number of pixels representative of a depth that is a longest dimension from the plurality of rank areas.

6. The method of claim 3, wherein identifying at least one parameter associated with the suit area includes:

identifying at least one parameter associated with a plurality of suit areas from the plurality of different cards; and

selecting at least one parameter associated with the rank area to include a suit width parameter having a number of pixels representative of a width that is a widest dimension from the plurality of suit areas, and to include a suit depth parameter having a number of pixels representative of a depth that is a longest dimension from the plurality of suit areas.

7. A method of automatically generating one or more deck libraries for one or more decks of cards, the method comprising:

using an imaging device of a card handling device to capture raw images of playing cards passing through the card handling device from an input tray to an output tray;

using a processor of the card handling device to automatically generate a first calibration file without user input in identifying at least one parameter associated with a rank area and at least one parameter associated with a suit area from the raw images for a first deck type of cards, the calibration file including the parameters associated with the rank area and the suit area;

storing, in memory of the card handling device, the first calibration file in a first deck library for the first deck type;

using the processor to automatically generate a plurality of master images for the cards of the first deck type using the parameters from the calibration file; and

storing, in memory, the plurality of master images for the cards of the first deck type in the first deck library such that the card handling device is trained to the first deck type for a subsequent card recognition mode.

8. The method of claim 7, further comprising:

using the processor to automatically generate a second calibration file for a second deck type of cards;

storing, in memory, the second calibration file in a second deck library for the second deck type;

using the processor to automatically generate a second plurality of master images for the cards of the second deck type using the parameters from the second calibration file; and

storing, in memory, the second plurality of master images for the cards of the second deck type in the deck library such that the card handling device is trained to the second deck type for a subsequent card recognition mode.

9. The method of claim 7, wherein identifying at least one parameter associated with a rank area and at least one parameter associated with a suit area for a first deck type of cards

includes performing a blob analysis to locate a rank and a suit for a card of the first deck type within a region of interest.

10. The method of claim 9, wherein performing a blob analysis includes first locating the 10 rank to determine a width for the at least one parameter associated with the rank area.

11. The method of claim 7, further comprising automatically linking, using the processor, each master image of the plurality of master images with an appropriate rank or suit.

12. The method of claim 11, wherein linking each master image of the plurality of master images includes linking each master image according to an expected order that the cards were read into a card handling device.

13. The method of claim 11, wherein linking each master image of the plurality of master images includes linking each master image from a deck that is unsorted.

14. The method of claim 13, wherein linking each master image of the plurality of master images includes performing optical character recognition to each master image.

15. The method of claim 13, wherein linking each master image of the plurality of master images includes comparing each master image of the plurality of master images with a set of images from a plurality of different deck types.

16. The method of claim 13, wherein linking each master image of the plurality of master images includes comparing a normalized version of each master image of the plurality of master images with a set of normalized images from a plurality of different deck types.

17. The method of claim 16, wherein comparing a normalized version of each master image of the plurality of master images with a set of normalized images from a plurality of different deck types includes performing a pixel by pixel comparison.

18. The method of claim 17, wherein performing a pixel by pixel comparison further includes comparing a middle pixel with at least one additional neighboring pixel.

19. A card processing apparatus, comprising:

an input tray;

an output tray;

a memory device;

an imaging device operably coupled with the memory device, the imaging device configured to capture raw images of playing cards passing from the input tray through the card processing apparatus to the output tray for storage of the raw images in the memory device; and

a main control system coupled with the imaging device, wherein the main control system is configured to run an operating system having a file directory system configured to store a plurality of deck libraries for a plurality of different deck types, wherein the main control system is configured to receive the raw images from the memory device, and automatically generate a calibration file having parameters related to a rank area and a suit area for each deck type without user input.

20. The card processing apparatus of claim 19, including a card shuffler housing the memory device, the imaging device, and the main control system.

21. The card processing apparatus of claim 19, wherein the main control system is further configured to automatically generate a plurality of master images from the raw images according to the parameters of the calibration file.

22. The card processing apparatus of claim 21, wherein the main control system is configured to link the plurality of master images from an unsorted deck of cards with an appropriate rank and suit.

23. The card processing apparatus of claim 22, wherein the main control system is configured to link the plurality of master images from an unsorted deck of cards with an appropriate rank and suit by:

generating a normalized version of each master image of the plurality of master images; and

comparing the normalized version of each master image of the plurality of master images with a plurality of normalized images corresponding to a plurality of different deck types.

24. The card processing apparatus of claim 21, further comprising a card recognition processor configured to load the plurality master images and the calibration file from the main control system, and compare an unknown image from the imaging device with the plurality of master images.

25. The card processing apparatus of claim 24, wherein the card recognition processor is configured to compare the unknown image with the plurality of master images by comparing the unknown image with each master image pixel by pixel and sum the result of the comparing.

26. The card processing apparatus of claim 24, wherein the card recognition processor includes a field-programmable gate array.

AMENDED CLAIMS
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What is claimed is:

1. A method of automatically generating a calibration file during a calibration mode for use during a card recognition mode of a card handling device, the method comprising:

capturing a raw image from at least a portion of a card passing through a card handling device; and

using a processor, automatically generating a calibration file during the calibration mode, and storing the calibration file in memory of a main control system of the card handling device, wherein automatically generating the calibration file during the calibration mode comprises:

identifying at least one parameter associated with a rank area around a rank of the at least a portion of the card;

identifying at least one parameter associated with a suit area around a suit of the at least a portion of the card; and

storing the at least one parameter associated with the rank area and the at least one parameter associated with the suit area in the calibration file.

2. The method of claim 1, wherein automatically generating the calibration file during the calibration mode comprises identifying a location and at least one parameter associated with a region of interest that is relatively larger than the rank area and the suit area, the method further comprising storing the location and the at least one parameter associated with the region of interest in the calibration file.

3. The method of claim 1, wherein capturing a raw image includes capturing a plurality of raw images from a plurality of different cards passing through the card handling device.

4. The method of claim 3, wherein identifying at least one parameter associated with the rank area includes:

identifying a at least one parameter associated with a plurality of rank areas from the plurality of different cards; and

selecting the at least one parameter associated with the rank area to include a rank width parameter having a number of pixels representative of a width that is a widest dimension from the plurality of rank areas, and to include a rank depth parameter having a number of pixels representative of a depth that is a longest dimension from the plurality of rank areas.

5. The method of claim 3, wherein identifying at least one parameter associated with the suit area includes:

identifying at least one parameter associated with a plurality of suit areas from the plurality of different cards; and

selecting at least one parameter associated with the rank area to include a suit width parameter having a number of pixels representative of a width that is a widest dimension from the plurality of suit areas, and to include a suit depth parameter having a number of pixels representative of a depth that is a longest dimension from the plurality of suit areas.

6. The method of claim 1, further comprising storing the calibration file in a file system of an operating system running on the processor.

7. A method of automatically generating one or more deck libraries for one or more decks of cards during a calibration mode, the method comprising:

using a processor to automatically generate a first calibration file during the calibration mode without user input in identifying at least one parameter associated with a rank area and at least one parameter associated with a suit area for a first deck type of cards, the calibration file including the parameters associated with the rank area and the suit area;

storing the first calibration file in a first deck library for the first deck type during the calibration mode;

using the processor to automatically generate a plurality of master images for the cards of the first deck type using the parameters from the calibration file during the calibration mode; and

storing the plurality of master images for the cards of the first deck type in the first deck library during the calibration mode.

8. The method of claim 7, further comprising:

using the processor to automatically generate a second calibration file for a second deck type of cards during the calibration mode;

storing the second calibration file in a second deck library for the second deck type during the calibration mode;

using the processor to automatically generate a second plurality of master images for the cards of the second deck type using the parameters from the second calibration file during the calibration mode; and

storing the second plurality of master images for the cards of the second deck type in the deck library during the calibration mode.

9. The method of claim 7, further comprising linking each master image of the plurality of master images with an appropriate rank or suit during the calibration mode.

10. The method of claim 9, wherein linking each master image of the plurality of master images during the calibration mode includes linking each master image according to an expected order that the cards were read into a card handling device.

11. The method of claim 9, wherein linking each master image of the plurality of master images during the calibration mode includes linking each master image from a deck that is unsorted.

12. The method of claim 11, wherein linking each master image of the plurality of master images during the calibration mode includes performing optical character recognition to each master image.

13. The method of claim 11, wherein linking each master image of the plurality of master images during the calibration mode includes comparing each master image of the plurality of master images with a set of images from a plurality of different deck types.

14. The method of claim 11, wherein linking each master image of the plurality of master images during the calibration mode includes comparing a normalized version of each master image of the plurality of master images with a set of normalized images from a plurality of different deck types.

15. The method of claim 14, wherein comparing a normalized version of each master image of the plurality of master images with a set of normalized images from a plurality of different deck types includes performing a pixel by pixel comparison.

16. The method of claim 15, wherein performing a pixel by pixel comparison further includes comparing a middle pixel with at least one additional neighboring pixel.

17. The method of claim 7, wherein identifying at least one parameter associated with a rank area and at least one parameter associated with a suit area for a first deck type of cards includes performing a blob analysis to locate blobs indicating a rank and a suit for a card of the first deck type within a region of interest.

18. The method of claim 17, wherein performing a blob analysis includes first locating the 10 rank to determine a width for the at least one parameter associated with the rank area.

19. A card processing apparatus, comprising:

a memory device;

an imaging device operably coupled with the memory device, such that raw images captured from the imaging device are stored in the memory device; and

a main control system coupled with the imaging device, wherein the main control system is configured to run an operating system having a file directory system configured to store a plurality of deck libraries for a plurality of different deck types, wherein the main control system is configured to receive the raw images from the memory device, automatically generate a calibration file during the calibration mode, the calibration file having parameters related to a rank area and a suit area for a deck type.

20. The card processing apparatus of claim 19, including a card shuffler housing the memory device, the imaging device, and the main control system.

21. The card processing apparatus of claim 19, wherein the main control system is further configured to automatically generate a plurality of master images from the raw images during the calibration mode according to the parameters of the calibration file.

22. The card processing apparatus of claim 21, further comprising a card recognition processor configured to load the plurality master images and the calibration file from the main control system, and compare an unknown image from the imaging device with the plurality of master images during a card recognition mode.

23. The card processing apparatus of claim 22, wherein the card recognition processor is configured to compare the unknown image with the plurality of master images during the card recognition mode by comparing the unknown image with each master image pixel by pixel and sum the result of the comparing.

24. The card processing apparatus of claim 22, wherein the card recognition processor includes a field-programmable gate array.

25. The card processing apparatus of claim 21, wherein the main control system is configured to link the plurality of master images from an unsorted deck of cards with an appropriate rank and suit during the calibration mode.

26. The card processing apparatus of claim 25, wherein the main control system is configured to link the plurality of master images from an unsorted deck of cards with an appropriate rank and suit during the calibration mode by:

generating a normalized version of each master image of the plurality of master images; and

comparing the normalized version of each master image of the plurality of master images with a plurality of normalized images corresponding to a plurality of different deck types.

27. A card recognition system, comprising:

an imaging device configured to capture a raw image of at least a portion of a card; and

a processor operably coupled with the imaging device, the processor configured to:

perform an image processing analysis of the raw image during a calibration mode to identify measurements related to at least one of a rank area around a rank of the card, and a suit area around a suit of the card; and

automatically generate a calibration file during the calibration mode based, at least in part, on the image processing analysis.

28. The card recognition system of claim 27, further comprising a memory operably coupled with the imaging device, the memory configured to store a plurality of raw images received from the imaging device.

29. The card recognition system of claim 28, further configured to organize the plurality of raw images within the memory in the order received by the imaging device.

30. The card recognition system of claim 27, wherein the processor is further configured to store the automatically generated calibration file in a subdirectory of a file system during the calibration mode, the subdirectory corresponding to a particular deck type.

31. The card recognition system of claim 27, wherein the image processing analysis includes a blob analysis of the raw image.

32. The card recognition system of claim 31, wherein the blob analysis first identifies a rank to obtain the measurements of the rank area and then identifies a suit to obtain the measurements of the suit area.

33. The card recognition system of claim 32, wherein the blob analysis specifically searches for a ten rank to obtain the measurements of the rank area that is stored in the calibration file.

34. The card recognition system of claim 27, wherein the processor is further configured to generate master images for each rank and suit of a deck of cards read by the imaging device during the calibration.

35. The card recognition system of claim 34, wherein the processor is further configured to associate the master images with their corresponding rank and suit during the calibration mode.

36. The card recognition system of claim 35, wherein the processor is further configured to associate the master images with their corresponding rank and suit according to an order in which the cards from the deck are read in by the imaging device during the calibration mode.

37. The card recognition system of claim 35, wherein the processor is further configured to associate the master images with their corresponding rank and suit for the deck of cards without requiring a predetermined order for the deck of cards during the calibration mode.

38. The card recognition system of claim 37, wherein the processor is further configured to associate the master images with their corresponding rank and suit for the deck of cards by comparing the master images with each other to obtain scores that are compared with scores for known secondary relationships between different master images during the calibration mode.

39. A card handling device, comprising:

a card infeed;

a card output; and

a card recognition system, including:

an image sensor configured to capture an image of a card passing from the card infeed to the card output; and

a card recognition processor configured to automatically generate a calibration file using an image analysis process of the image during a calibration mode, the

calibration file including measurements for at least one of a size of a rank and a suit symbol of the card within the image.

40. The card handling device of claim 39, wherein the card recognition system further includes control logic operably coupled with the image sensor and configured to receive the image from the image sensor.

41. The card handling device of claim 40, wherein the card recognition system further includes a memory operably coupled with the control logic and the card recognition processor, the memory configured to receive the image from the control logic.

42. The card handling device of claim 40, wherein the control logic is configured to generate a master image for at least one of the rank and the suit of the card within the image during the calibration mode.

43. The card handling device of claim 42, wherein the card recognition processor is configured to store the master image and the calibration file in a file system.

44. The card handling device of claim 40, wherein the control logic is configured to convert the image from a grayscale image to a black and white image.

45. The card handling device of claim 44, wherein conversion from the grayscale image to the black and white image is based on a threshold level that dynamically changes over time.

46. The card handling device of claim 45, wherein the threshold level dynamically changes over time based on a change in lighting conditions.

47. The card handling device of claim 44, wherein the threshold level is set at a first level during the calibration mode and set at a second level during a card recognition mode.

48. The card handling device of claim 40, wherein the imaging device includes a fish-eye lens.

49. The card handling device of claim 48, wherein the control logic is configured to compensate for the fish-eye distortion by translating pixels in the image using a look-up table.

50. The card handling device of claim 48, wherein the control logic is configured to compensate for the fish-eye distortion by mathematically translating pixels in the image.

51. A method for tuning a card handling device, the method comprising:
capturing a plurality of images from a deck of cards;
storing the images in memory;
analyzing the plurality of images for card identification information during a calibration mode; and
automatically generating a calibration file including parameters associated with the card identification information during the calibration mode based on the analyzing.

52. The method of claim 51, wherein analyzing the plurality of images includes locating blobs having a centroid and a location and identifying the card identification information within the blobs located.

53. The method of claim 52, further comprising ignoring blobs that have a size below a certain threshold and blobs that are located outside of a desired region of the plurality of images.

54. The method of claim 52, wherein identifying the card identification information includes searching specifically through the plurality of images for a ten rank and using the ten rank to determine the parameters in the calibration file.

55. The method of claim 51, further comprising generating a plurality of master images during the calibration mode from the plurality of images based on the parameters in the calibration file.

56. The method of claim 55, further comprising associating the plurality of master images with an appropriate rank and suit during the calibration mode.

57. The method of claim 55, further comprising comparing master images of the plurality of master images with each other to determine secondary relationships during the calibration mode.

58. The method of claim 57, wherein comparing master images of the plurality of master images with each other is performed as part of a secondary verification after associating the plurality of images with an appropriate rank and suit is performed from a pre-sorted deck.

59. The method of claim 51, wherein a parameter of the calibration file defines a region of interest of a smaller size than a field of view of an imaging device.

60. A method of automatically generating a calibration file during a calibration mode for identifying a specific card type, the method comprising:
capturing a plurality of raw images from a deck of cards during a calibration mode;
storing the plurality of raw images in memory during the calibration mode;
identifying a size of each rank and suit symbol of each stored raw image of the plurality during the calibration mode;
storing a region of interest and symbol size information in a calibration file for the plurality of raw images during the calibration mode;
converting a plurality of raw images into a plurality of master rank files and a plurality of master suit files during the calibration mode; and
storing the plurality of master rank files and the plurality of master suit files corresponding to a specific card type during the calibration mode.

61. The method of claim 60, wherein identifying a size of each rank and suit symbol includes employing a blob analysis to locate each rank and suit symbol within the stored raw image.

62. A method of identifying a card rank and suit, the method comprising:

automatically creating a calibration file during a calibration mode by:

capturing a plurality of raw images from a deck of cards during the calibration mode;

storing the plurality of raw images in memory during the calibration mode;

identifying a size of each rank and suit symbol of each stored raw image of the plurality during the calibration mode; and

storing a region of interest and rank and suit symbol size information in the calibration file for the plurality of raw images during the calibration mode; and

generating a plurality of master rank files and a plurality of master suit files during the calibration mode by:

converting a plurality of raw images into a plurality of master rank files and a plurality of master suit files during the calibration mode; and

storing the plurality of master rank files and the plurality of master suit files corresponding to a specific card type during the calibration mode.

63. The method of claim 61, further comprising:

identifying at least one card during a card recognition mode by:

capturing at least one unknown image as a card passes through a card handling device during the card recognition mode;

comparing at least a portion of the at least one unknown image to one of the plurality of master rank files and the plurality of master suit files during the card recognition mode; and

determine a match of a card identity during the card recognition mode based on a score from the comparing.