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System and method for an agricultural applicator

Abstract

A system for an agricultural operation includes a harvester configured to separate crop material into a harvest material and a non-harvest material. A crop material sensor is operably coupled with the harvester and is configured to capture crop material data. A positioning device is configured to generate location data to geolocate the crop material data relative to a field. A computing system is communicatively coupled with the crop material sensor and the positioning device. The computing system is configured to classify objects within the crop material data as harvest material or non-harvest material generate a map based on the harvest material and the non-harvest material.

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Background/Summary

FIELD
(1) The present disclosure generally relates to agricultural vehicles for performing operations within a field.
BACKGROUND
(2) Agricultural vehicles perform various operations within a field. For example, an agricultural harvesters to harvest and process crops while agricultural applicators (e.g., a sprayer) apply an agricultural product (e.g., a pesticide, a nutrient, and/or the like) onto crops and/or a ground surface as the applicator is traveling across a field. To facilitate such travel, the agricultural vehicles can be configured as self-propelled vehicles or implements towed behind an agricultural tractor or another suitable work vehicle.
(3) While each vehicle performs a defined operation, various information may be generated. Accordingly, an improved system and method for utilizing such information for subsequent operations would be welcomed in the technology.
BRIEF DESCRIPTION
(4) Aspects and advantages of the technology will be set forth in part in the following description, or may be obvious from the description, or may be learned through practice of the technology.
(5) In some aspects, the present subject matter is directed to a system for an agricultural operation that includes a harvester configured to separate crop material into a harvest material and a non-harvest material. A crop material sensor is operably coupled with the harvester and configured to capture crop material data. A positioning device is configured to generate location data to geolocate the crop material data relative to a field. A computing system is communicatively coupled with the crop material sensor and the positioning device. The computing system is configured to classify objects within the crop material data as harvest material or non-harvest material and generate a map based on the harvest material and the non-harvest material.

(6) In some aspects, the present subject matter is directed to a method for operating an agricultural system. The method includes capturing, from a crop material sensor, crop material data while processing crop material through a harvester. The method also includes classifying objects within the crop material data as harvest material or non-harvest material. In addition, the method includes generating a map based on the harvest material and the non-harvest material.
(7) In some aspects, the present subject matter is directed to an agricultural system that includes a harvester configured to separate crop material into a harvest material and a non-harvest material including a crop material sensor configured to capture crop material data of the crop material. A sprayer is communicatively coupled with the harvester and is configured to selectively apply an agricultural product to a field based at least in part on the crop material data.
(8) These and other features, aspects, and advantages of the present technology will become better understood with reference to the following description and appended claims. The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the technology and, together with the description, serve to explain the principles of the technology.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) A full and enabling disclosure of the present technology, including the best mode thereof, directed to one of ordinary skill in the art, is set forth in the specification, which makes reference to the appended figures, in which:
(2) FIG. **1** illustrates a side view of an agricultural harvester in accordance with aspects of the present subject matter;
(3) FIG. **2** illustrates a perspective view of an agricultural sprayer in accordance with aspects of the present subject matter;
(4) FIG. **3** illustrates a block diagram of components of a system for selectively applying an agricultural product in accordance with aspects of the present subject matter;
(5) FIG. **4** is a block diagram illustrating a harvester and a sprayer operably coupled with a remote server in accordance with aspects of the present subject matter;
(6) FIG. **5** is a schematic illustration of the harvester performing a first pass within an agricultural field in accordance with aspects of the present subject matter;
(7) FIG. **6** is a schematic illustration of the harvester performing a second pass within an agricultural field in accordance with aspects of the present subject matter;
(8) FIG. **7** is a schematic illustration of the harvester performing a third pass within an agricultural field in accordance with aspects of the present subject matter;
(9) FIG. **8** illustrates a harvest material yield map in accordance with aspects of the present subject matter;
(10) FIG. **9** illustrates a projected weed concentration map in accordance with aspects of the present subject matter;
(11) FIG. **10** illustrates a prescription map in accordance with aspects of the present subject matter;
(12) FIG. **11** illustrates the prescription map of FIG. **10** including a first suggested application path in accordance with aspects of the present subject matter;
(13) FIG. **12** illustrates the prescription map of FIG. **10** including a second suggested application path in accordance with aspects of the present subject matter; and
(14) FIG. **13** illustrates a flow diagram of a method of selectively applying an agricultural product in accordance with aspects of the present subject matter.
(15) Repeat use of reference characters in the present specification and drawings is intended to represent the same or analogous features or elements of the present technology.

DETAILED DESCRIPTION

(16) Reference now will be made in detail to embodiments of the disclosure, one or more examples of which are illustrated in the drawings. Each example is provided by way of explanation of the discourse, not limitation of the disclosure. In fact, it will be apparent to those skilled in the art that various modifications and variations can be made in the present disclosure without departing from the scope or spirit of the disclosure. For instance, features illustrated or described as part can be used with another embodiment to yield a still further embodiment. Thus, it is intended that the present disclosure covers such modifications and variations as come within the scope of the appended claims and their equivalents.

(17) In this document, relational terms, such as first and second, top and bottom, and the like, are used solely to distinguish one entity or action from another entity or action, without necessarily requiring or implying any actual such relationship or order between such entities or actions. The terms “comprises,” “comprising,” or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that comprises a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus. An element preceded by “comprises . . . a” does not, without more constraints, preclude the existence of additional identical elements in the process, method, article, or apparatus that comprises the element.

(18) As used herein, the terms “first,” “second,” and “third” may be used interchangeably to distinguish one component from another and are not intended to signify a location or importance of the individual components. The terms “coupled,” “fixed,” “attached to,” and the like refer to both direct coupling, fixing, or attaching, as well as indirect coupling, fixing, or attaching through one or more intermediate components or features, unless otherwise specified herein. The terms “upstream” and “downstream” refer to the relative direction with respect to an agricultural product within a fluid circuit. For example, “upstream” refers to the direction from which an agricultural product flows, and “downstream” refers to the direction to which the agricultural product moves. The term “selectively” refers to a component's ability to operate in various states (e.g., an ON state and an OFF state) based on manual and/or automatic control of the component.

(19) Furthermore, any arrangement of components to achieve the same functionality is effectively “associated” such that the functionality is achieved. Hence, any two components herein combined to achieve a particular functionality can be seen as “associated with” each other such that the desired functionality is achieved, irrespective of architectures or intermedial components. Likewise, any two components so associated can also be viewed as being “operably connected” or “operably coupled” to each other to achieve the desired functionality, and any two components capable of being so associated can also be viewed as being “operably couplable” to each other to achieve the desired functionality. Some examples of operably couplable include, but are not limited to, physically mateable, physically interacting components, wirelessly interactable, wirelessly interacting components, logically interacting, and/or logically interactable components.

(20) The singular forms “a,” “an,” and “the” include plural references unless the context clearly dictates otherwise.

(21) Approximating language, as used herein throughout the specification and claims, is applied to modify any quantitative representation that could permissibly vary without resulting in a change in the basic function to which it is related. Accordingly, a value modified by a term or terms, such as “about,” “approximately,” “generally,” and “substantially,” is not to be limited to the precise value specified. In at least some instances, the approximating language may correspond to the precision of an instrument for measuring the value, or the precision of the methods or apparatus for constructing or manufacturing the components and/or systems. For example, the approximating language may refer to being within a ten percent margin.

(22) Moreover, the technology of the present application will be described in relation to exemplary embodiments. The word “exemplary” is used herein to mean “serving as an example, instance, or

illustration." Any embodiment described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other embodiments. Additionally, unless specifically identified otherwise, all embodiments described herein should be considered exemplary.

(23) As used herein, the term "and/or," when used in a list of two or more items, means that any one of the listed items can be employed by itself, or any combination of two or more of the listed items can be employed. For example, if a composition or assembly is described as containing components A, B, and/or C, the composition or assembly can contain A alone; B alone; C alone; A and B in combination; A and C in combination; B and C in combination; or A, B, and C in combination.

(24) In general, the present subject matter is directed to a system for various agricultural operations. In some instances, a first vehicle, such as a harvester, is configured to perform a first agricultural operation within a field. While the first vehicle described below are generally illustrated and described as a harvester, the first vehicle may additionally or alternatively be configured as a tractor, a self-propelled windrower, a self-propelled sprayer, and/or the like. As such, in various examples, the first vehicle may be configured to perform at least one of a planting process, seeding process, a tilling process, a mapping process, a scouting process, a harvesting process, and/or any other process during the operation of the first vehicle. In addition, the first vehicle may be human-controlled, autonomously controlled, and/or semi-autonomously controlled without departing from the teachings provided herein.

(25) When the first vehicle is a harvester, the harvester is configured to separate crop material into a harvest material and a non-harvest material. A crop material sensor is operably coupled with the harvester and configured to capture crop material data. In addition, a positioning device is configured to generate location data to geolocate the crop material data relative to a field

(26) A computing system is communicatively coupled with the crop material sensor and the positioning device. The computing system is configured to generate field data based on the crop material data and the location data. For example, the field data may include identified objects within the crop material data, which may include identifying the objects as harvest material or non-harvest material. In turn, the computing system may generate a map based on the harvest material and the non-harvest material. The map may be in the form of a harvest material yield map, a projected weed concentration map, and/or a prescription map.

(27) In addition, a second vehicle, such as a sprayer, may receive the field data, the crop material data, and/or the location data from the first vehicle. In turn, the sprayer may apply an agricultural product to the field based at least in part on the data. By utilizing the data from the first vehicle, a more effective application of agricultural product to the field may be accomplished.

(28) Referring now to FIG. **1**, a first vehicle configured as an agricultural harvester **10** in the form of a combine is illustrated. In general, the harvester **10** is configured to sever crops **12** from a field **14** and direct the crop material **16** into the harvester **10**. Within the harvester **10**, the crop material **16** may be separated into harvest material **18** (e.g., grain) and non-harvest material **20** (e.g., material other than grain (MOG), straw, previously harvested crop, etc.). The harvest material **18** may be stored within the harvester **10** and/or directed into a storage space, such as a storage cart. The non-harvested crop may be exhausted from the harvester **10** back into the field **14**.

(29) As illustrated, the harvester **10** includes a chassis **22**, ground engaging wheels **24** and **26**, a header **28**, a feeder housing **30**, an operator cab **32**, a threshing and separation system **34**, a cleaning system **36**, a grain tank **38**, and an unloading conveyance **40**. The wheels **14**, **16** may be configured to support the harvester **10** relative to the field **14** (or another ground surface) and move the agricultural harvester **10** in a direction of forward travel **42** across a field **14**.

(30) The cab **32**, or any other form of operator's station, may house various control or input devices (e.g., levers, pedals, control panels, buttons, and/or the like) for permitting an operator to control the operation of the harvester **10**. For instance, as shown in FIG. **1**, the agricultural harvester **10** may include a user interface **44**, such as a human-vehicle interface (HMI), for providing messages

and/or alerts to the operator and/or for allowing the operator to interface with the vehicle's controller through one or more user-input devices **46** (e.g., levers, pedals, control panels, buttons, and/or the like) within the cab **32** and/or in any other practicable location.

(31) The header **28** can be mounted to the front portion of harvester **10** and can include a cutter bar **48** for severing crops **12** from a field **14** during forward motion of harvester **10**. A rotatable reel **50** feeds the crop into the header **28**, and a double auger **52** feeds the severed crop material **16** inwardly from each side toward the feeder housing **30**. The feeder housing **30** feeds the cut crop material **16** to the threshing and separation system **34**.

(32) The threshing and separation system **34** is configured to thresh and separate a flow of the crop material **16** that flows to the threshing and separation system **34** from the feeder housing **30**. The threshing and separation system **34** generally includes a threshing rotor **54** at least partially enclosed by a rotor cage and rotatable within a corresponding perforated concave **56**. The crop material **16** are threshed and separated by the rotation of rotor **54** within the concave **56**, and larger non-harvest material **20**, such as material other than grain, stalks, leaves, and the like are discharged from the rear of harvester **10**. Smaller elements of the crop material **16** including the harvest material **18** and non-harvest material **20**, including particles lighter than grain, such as chaff, dust, and straw, are discharged through perforations of the concave **56**. The threshing and separation system **34** can also be a different type of system, such as a system with a transverse rotor rather than an axial rotor, etc.

(33) The harvest material **18** that has been separated by the threshing and separation system **34** falls onto a grain pan **58** and is conveyed toward the cleaning system **36**. The cleaning system **36** may include an optional pre-cleaning sieve **60**, an upper sieve **62** (also known as a chaffer sieve or sieve assembly), a lower sieve **64** (also known as a cleaning sieve), and a cleaning fan **66**. The crop material **16** on the sieves **60**, **62**, and **64** is subjected to a cleaning action by the fan **66**, which provides airflow through the sieves **60**, **62**, and **64** to remove chaff and other impurities such as dust from the harvest material **18** by making this material airborne for discharge from a straw hood **68** of a residue management system **70** of the harvester **10**. Optionally, the chaff and/or straw can proceed through a chopper **72** to be further processed into even smaller particles before discharging out of the harvester **10** by a spreader assembly **74**. It should be appreciated that the “chopper” **180** referenced herein, which may include knives, may also be what is typically referred to as a “beater”, which may include flails or other construction and that the term “chopper” as used herein refers to any construction which can reduce the particle size of the entering crop material **16** by various actions including chopping, flailing, etc. The grain pan **58** and the pre-cleaning sieve **60** oscillate in a fore-to-aft manner to transport the grain and finer non-harvest material **20** to the upper surface of the upper sieve **62**. The upper sieve **62** and the lower sieve **64** are vertically arranged relative to each other, and likewise oscillate in a fore-to-aft manner to spread the harvest material **18** across the sieves **62**, **64**, while permitting the passage of cleaned harvest material **18** by gravity through the openings of the sieves **62**, **64**.

(34) Clean harvest material **18** falls to a clean grain auger **76** positioned crosswise below and toward the front of the lower sieve **64**. The clean grain auger **76** receives clean harvest material **18** from each sieve **62**, **64**, and a bottom pan **78** of the cleaning system **36**. The clean grain auger **76** conveys the clean harvest material **18** laterally to a grain elevator **80** for transport to the grain tank **38**. Tailings from the cleaning system **36** falls to a tailings auger trough **82**. The tailings are transported via a return auger **84** to the upstream end of the cleaning system **36** for repeated cleaning action. A pair of grain tank augers **86** within the grain tank **38** convey the clean grain laterally within the grain tank **38** to the unloader **160** for discharge from the harvester **10**.

(35) In various examples, the harvester **10** may further include one or more crop material sensors **88** that may be configured to capture data indicative of the crop material **16**. For instance, the crop material sensors **88** may be configured to capture data indicative of an amount or volume of the harvest material **18** and/or an amount or volume of the non-harvest material **20**. In several

embodiments, the crop material sensors **88** may be installed or otherwise positioned on or within any component of the harvester **10**. For instance, the one or more crop material sensors **88** may be installed on an exterior portion of the harvester **10** and configured to capture data forwardly, rearwardly, and/or laterally outward of the harvester **10**. Additionally or alternatively, the one or more crop material sensors **88** may be installed within the vehicle. For example, the one or more crop material sensors **88** may be operably coupled with the feeder housing **30**, the threshing and separation system **34**, the cleaning system **36**, the grain tank **38**, the unloading conveyance **40**, the residue management system **70**, the chopper **72**, the spreader assembly **74**, and/or any other system of the harvester **10**.

(36) In various embodiments, the one or more crop material sensors **88** are object detecting/identifying imaging devices, where the data captured by the one or more crop material sensors **88** may be indicative of the type of plants (e.g., harvest material **18** and/or non-harvest material **20**) and/or other objects.

(37) The agricultural harvester **10** may include any suitable number of the crop material sensors **88** and should not be construed as being limited to the number of crop material sensors **88** shown in FIG. **1**. Additionally, the crop material sensors **88** may generally correspond to any suitable sensing devices. For example, each crop material sensor **88** may correspond to any suitable camera, such as single-spectrum camera or a multi-spectrum camera configured to capture images, for example, in the visible light range and/or infrared spectral range. Additionally, in various embodiments, the camera may correspond to a single lens camera configured to capture two-dimensional images or a stereo camera having two or more lenses with a separate image imaging device for each lens to allow the camera to capture stereographic or three-dimensional images. Alternatively, the crop material sensors **88** may correspond to any other suitable image capture devices and/or other imaging devices capable of capturing “images” or other image-like data. For example, the crop material sensors **88** may correspond to or include radio detection and ranging (RADAR) sensors, light detection and ranging (LIDAR) sensors, and/or any other practicable device.

(38) Referring to FIG. **2**, a second vehicle configured as an agricultural sprayer **100** capable of performing a spraying operation based at least partially on the data provided from the first vehicle and/or the one or more crop material sensors **88** (FIG. **1**) is generally illustrated. In some embodiments, such as the one illustrated in FIG. **2**, the agricultural sprayer **100** may include a chassis **102** configured to support or couple to a plurality of components. For example, front and rear wheels **104**, **106** may be coupled to the chassis **102**. The wheels **104**, **106** may be configured to support the work vehicle **10** relative to the field **14** and move the work vehicle **10** in a direction of travel (e.g., as indicated by arrow **42** in FIG. **2**) across a field **14** or a ground surface.

(39) The chassis **102** may also support a cab **108**, or any other form of operator's station, that houses various control or input devices (e.g., levers, pedals, control panels, buttons, and/or the like) for permitting an operator to control the operation of the sprayer **100**. For instance, as shown in FIG. **2**, the agricultural sprayer **100** may include a user interface **110**, such as a human-vehicle interface (HMI), for providing messages and/or alerts to the operator and/or for allowing the operator to interface with the vehicle's controller through one or more user-input devices **112** (e.g., levers, pedals, control panels, buttons, and/or the like) within the cab **108** and/or in any other practicable location.

(40) The chassis **102** may also support a product system **112**. The product system **112** can include one or more tanks **116**, such as a product tank and/or a rinse tank, and a boom assembly **118**. The product tank is generally configured to store or hold an agricultural product, such as pesticides (e.g., herbicides, insecticides, rodenticides, etc.) and/or nutrients. The agricultural product is conveyed from the product tank and/or the rinse tank through a product circuit including numerous plumbing components, such as interconnected pieces of tubing, for release onto the underlying field **14** (e.g., plants and/or soil) through one or more nozzle assemblies **120** mounted on the boom assembly **118** (or the sprayer **100**).

(41) As shown in FIG. **2**, the boom assembly **118** can include a frame **122** that supports first and second boom arms **124**, **126**, which may be orientated in a cantilevered nature. The first and second boom arms **124**, **126** are generally movable between an operative or unfolded position and an inoperative or folded position. When distributing an agricultural product, the first and/or second boom arm **124**, **126** extend laterally outward from the work vehicle **10** to cover wide swaths of the underlying ground surface, as illustrated in FIG. **2**. However, to facilitate transport, each boom arm **124**, **126** of the boom assembly **118** may be independently folded forwardly or rearwardly into the inoperative position, thereby reducing the overall width of the vehicle **10**, or in some examples, the overall width of a towable implement when the applicator is configured to be towed behind the work vehicle **10**.
(42) The boom assembly **118** may be configured to support a plurality of nozzles **230**. Each nozzle **230** may, in turn, be configured to dispense the agricultural product stored within the tank **26** onto the underlying field **14**. In several embodiments, the nozzles **230** may be mounted on and/or coupled to the first and/or second boom arms **124**, **126** of the boom assembly **118**, with the nozzles **230** being spaced apart from each other along a lateral direction **44**. Furthermore, fluid conduits **128** may fluidly couple the nozzles **230** to the tanks. In this respect, as the sprayer **100** travels across the field **14** in the direction of travel **42** to perform a spraying operation thereon, the agricultural product moves from the tank **26** through the fluid conduit(s) **58** to each of the nozzles **230**. The nozzles **230** may, in turn, dispense or otherwise spray a fan of the agricultural product. For example, in one embodiment, the nozzles **230** may correspond to flat fan nozzles configured to dispense a flat fan of the agricultural product. However, in alternative embodiments, the nozzles **230** may correspond to any other suitable types of nozzles, such as dual pattern nozzles and/or hollow cone nozzles.
(43) Referring to FIGS. **3** and **4**, in several embodiments, a system **200** may include a first vehicle **202**, such as the harvester **10** (FIG. **1**), that may collect crop material data related to the crop material **16** within a field **14**. The data may be analyzed for a subsequent spraying operation, which may be performed by a second vehicle **204**, such as the sprayer **100** (FIG. **1**).
(44) Referring further to FIG. **3**, a schematic view of a system **200** for operating various agricultural vehicles is illustrated in accordance with aspects of the present subject matter. In general, the system **200** will be described with reference to the harvester **10** of FIG. **1** and the sprayer **100** of FIG. **2**. However, the disclosed system **200** may generally be utilized with agricultural vehicles having any other suitable vehicle configuration. For purposes of illustration, communicative links, or electrical couplings of the system **200** shown in FIG. **3** are indicated by dashed lines. The one or more communicative links or interfaces may be one or more of various wired or wireless communication mechanisms, including any combination of wired (e.g., cable and fiber) and/or wireless (e.g., cellular, wireless, satellite, microwave, and radio frequency) communication mechanisms and any desired network topology (or topologies when multiple communication mechanisms are utilized). Exemplary wireless communication networks include a wireless transceiver (e.g., a BLUETOOTH module, a ZIGBEE transceiver, a Wi-Fi transceiver, an IrDA transceiver, an RFID transceiver, etc.), local area networks (LAN), and/or wide area networks (WAN), including the Internet, providing data communication services.
(45) In several embodiments, the first vehicle **202** can include a first computing system **106**. In general, the first computing system **106** may comprise any suitable processor-based device, such as a computing device or any suitable combination of computing devices. Thus, in several embodiments, the first computing system **106** may include one or more processors **208** and associated memory **210** configured to perform a variety of computer-implemented functions. As used herein, the term “processor” refers not only to integrated circuits referred to in the art as being included in a computer, but also refers to a controller, a microcontroller, a microcomputer, a programmable logic controller (PLC), an application-specific integrated circuit, and other programmable circuits. Additionally, the memory **210** of the first computing system **106** may

generally comprise memory elements including, but not limited to, a computer-readable medium (e.g., random access memory (RAM)), a computer-readable non-volatile medium (e.g., a flash memory), a floppy disk, a compact disc-read only memory (CD-ROM), a magneto-optical disk (MOD), a digital versatile disc (DVD) and/or other suitable memory elements. Such memory **210** may generally be configured to store information accessible to the processor **208**, including data **212** that can be retrieved, manipulated, created, and/or stored by the processor **208** and instructions **214** that can be executed by the processor **208**, when implemented by the processor **208**, configure the first computing system **106** to perform various computer-implemented functions, such as one or more aspects of the image processing algorithms and/or related methods described herein. In addition, the first computing system **106** may also include various other suitable components, such as a communications circuit or module, one or more input/output channels, a data/control bus, and/or the like.
(46) In several embodiments, the first computing system **106** may correspond to an existing controller of the harvester **10**, or the first computing system **106** may correspond to a separate processing device. For instance, in some embodiments, the first computing system **106** may form all or part of a separate plug-in module or computing device that is installed relative to the harvester **10** to allow for the disclosed system **200** and method to be implemented without requiring additional software to be uploaded onto existing control devices of the harvester **10**.
(47) In several embodiments, the data **212** may be information received and/or generated by the first computing system **106** that is stored in one or more databases. For instance, as shown in FIG. **3**, the memory **210** may include crop material data **216** received from the crop material sensor **88**. For instance, the crop material sensor **88** may be configured to continuously, periodically, or otherwise capture crop material data **216** associated with the crop material **16**. In such embodiments, the crop material data **216** transmitted to the computing system **106** from the crop material sensor **88** may be stored within the crop material database **216** for subsequent processing and/or analysis.
(48) Additionally or alternatively, as shown in FIG. **3**, the memory **210** may also include a location database **218**, which may be configured to store location data **218** generated by a positioning device **224** that is received in conjunction with the crop material data **216** from the crop material sensor **88** and stored in association with such crop material data **216** for later use in geo-locating the crop material data **216** relative to the field **14**. In some instances, the system **200** may store areas of the field **14** as distinct regions. In such instances, the system **200** may correlate the crop material data **216** to each geolocated regions. In several examples, the first computing system **106** may store a harvest volume of the harvest material **18** within one or more regions of the field **14** a non-harvest volume of the non-harvest material **20** within the one or more regions of the field **14**.
(49) In several embodiments, the instructions **214** stored within the memory **210** of the first computing system **106** may be executed by the processor **208** to implement a crop material analysis module **220**. In general, the crop material analysis module **220** may be configured to assess the crop material data **216** and associated location data **218** to geolocate the crop material data **216** within the field **14**. As such, in various embodiments, as the harvester **10** travels across the field **14**, the first computing system **106** may be configured to receive sensor data (e.g., image data) associated with crop material within the harvester **10** from the crop material sensor **88** (e.g., crop material-identifying sensors).
(50) The first computing system **106** may be configured to analyze/process the crop material data **216** to detect/identify the type and location of crop material within the field **14**. In this regard, the first computing system **106** may include any suitable image processing algorithms stored within its memory **210** or may otherwise use any suitable image processing techniques to determine, for example, the amount or volume of the harvest material **18** and/or an amount or volume of the non-harvest material **20** within the crop material **16** based on the received crop material data **216**. For instance, the first computing system **106** may be configured to distinguish between various types of

objects, such as harvest material **18**, which may be a grain or other material to be harvested, and non-harvest material **20**, which may be any material other than the material to be harvested. In some instances, the first computing system **106** may further determine one or more objects within the non-harvest material **20**. For example, the first computing system **106** may classify whether objects within the non-harvest material **20** are weeds (e.g., any plant other than harvest material **18**), dirt, rocks, stalk, straw, harvested crop from a previous season, etc.

(51) The instructions **214** stored within the memory **210** of the first computing system **106** may further be executed by the processor **208** to implement a field module **222**. The field module **222** may operate in conjunction with the crop material analysis module **220** and the location data **218** to generate one or more maps or any other type of information as field data **246**. The field data **246** may be provided to the second vehicle **204** and/or any other remote location.

(52) In some embodiments, the positioning device **224** may be configured as a satellite navigation positioning device (e.g. a GPS, a Galileo positioning system, a Global Navigation satellite system (GLONASS), a BeiDou Satellite Navigation and Positioning system, a dead reckoning device, and/or the like) to determine the location of the harvester **10**.

(53) Further, as shown in FIG. **3**, the first computing system **106** may also include a transceiver **226** to allow for the first computing system **106** to communicate with any of the various other system components described herein. For instance, one or more communicative links or interfaces (e.g., one or more data buses) may be provided between the transceiver **226** and the crop material sensor **88** and/or the positioning device **224**. Similarly, one or more communicative links or interfaces may be provided between the transceiver **226** and the second vehicle **204**.

(54) In several embodiments, the second vehicle **204** may additionally or alternatively be configured to receive the field data **246**, the crop material data **216**, and/or any other information from the first vehicle **202**. In turn, the second vehicle **204** may utilize one or more nozzle assemblies **120** to selectively apply an agricultural product to the field **14**. In some embodiments, the one or more nozzle assemblies **120** may be positioned along the boom assembly **118**. The one or more nozzle assemblies **120** can include a valve **228** operably coupled with a nozzle **230** and configured to control a flow of agricultural product through the nozzle **230**. The one or more nozzle assemblies **120** each define a respective orifice **232** that may dispense a fan pattern of the agricultural product. In various embodiments, the valve **228** may be configured as electronically controlled valves that are controlled by a Pulse Width Modulation (PWM) signal for altering the application rate of the agricultural product.

(55) In several embodiments, the second vehicle **204** includes a second computing system **234**. In general, the second computing system **234** may comprise any suitable processor-based device, such as a computing device or any suitable combination of computing devices. Thus, in several embodiments, the second computing system **234** may include one or more processors **236** and associated memory **238** configured to perform a variety of computer-implemented functions. As used herein, the term “processor” refers not only to integrated circuits referred to in the art as being included in a computer, but also refers to a controller, a microcontroller, a microcomputer, a programmable logic controller (PLC), an application-specific integrated circuit, and other programmable circuits. Additionally, the memory **238** of the second computing system **234** may generally comprise memory elements including, but not limited to, a computer-readable medium (e.g., random access memory (RAM)), a computer-readable non-volatile medium (e.g., a flash memory), a floppy disk, a compact disc-read only memory (CD-ROM), a magneto-optical disk (MOD), a digital versatile disc (DVD) and/or other suitable memory elements. Such memory **238** may generally be configured to store information accessible to the processor **236**, including data **240** that can be retrieved, manipulated, created, and/or stored by the processor **236** and instructions **242** that can be executed by the processor **236**, when implemented by the processor **236**, configure the second computing system **234** to perform various computer-implemented functions. In addition, the second computing system **234** may also include various other suitable components, such as a

communications circuit or module, one or more input/output channels, a data/control bus, and/or the like.

(56) In several embodiments, the second computing system **234** may correspond to an existing controller of the agricultural second vehicle **204**, or the second computing system **234** may correspond to a separate processing device. For instance, in some embodiments, the second computing system **234** may form all or part of a separate plug-in module or computing device that is installed relative to the second vehicle **204** or boom assembly **118** to allow for the disclosed system **202** and method to be implemented without requiring additional software to be uploaded onto existing control devices of the second vehicle **204** or the boom assembly **118**.

(57) In several embodiments, the data **240** may be data received and/or generated by the first vehicle **202** that is stored in one or more databases. Additionally or alternatively, the data **240** may be data and/or information received and/or generated by the second computing system **234** that is stored in one or more databases. For instance, as shown in FIG. **3**, the memory may include the crop material data **244** generated by the first vehicle **202** and/or any processed data **244** that may be generated from the crop material data **216** generated by the first vehicle **202**.

(58) The memory may also include location database **248**, which may be configured to store data from a positioning system **250** associated with the second vehicle **204**. In some embodiments, the positioning system **250** may be configured as a satellite navigation positioning device (e.g. a GPS, a Galileo positioning system, a Global Navigation satellite system (GLONASS), a BeiDou Satellite Navigation and Positioning system, a dead reckoning device, and/or the like) to determine the location of the second vehicle **204**.

(59) In several embodiments, the instructions **242** stored within the memory **238** of the second computing system **234** may be executed by the processor **236** to implement a crop material analysis module **252**. In general, the crop material analysis module **220** may be configured to assess the crop material data **244** and associated location data **218** from the first vehicle **202** to generate field data **246**. The field data **246** generated by the first computing system **206** may be similar and/or different from the field data **246** that may be generated by the second computing system **234**.

(60) In various embodiments, the instructions **242** stored within the memory **238** of the second computing system **234** may be executed by the processor **236** to implement a path analysis module **254**. In general, the path analysis module **254** may be configured to receive the field data **246** from the crop material analysis module **252** and/or the field data **246** from the first computing system **206**. In addition, the instructions **242** may receive location data **248** from a positioning system **250** of the second vehicle **204**. In turn, the second computing system **234** may determine whether the second vehicle **204** is within a defined location of the field **14**.

(61) Referring still to FIG. **3**, in some embodiments, the instructions **242** stored within the memory **238** of the second computing system **234** may also be executed by the processor **236** to implement a control module **256**. In general, the control module **256** may be configured to electronically control the operation of one or more components of the agricultural second vehicle **204**. For instance, the second vehicle **204** may be configured to selectively spray the agricultural product when the second vehicle **204** is within a defined region of the field **14**. For example, when the second vehicle **204** is within a region portion of the field **14**, the control module **256** may selectively dispense agricultural product onto the field **14** at a first flow rate. When the second vehicle **204** is within a second region of the field **14**, the control module **256** may selectively dispense agricultural product onto the field **14** at a second flow rate, which may be varied from the first flow rate.

(62) Further, as shown in FIG. **3**, the second computing system **234** may also include a transceiver **258** to allow for the second computing system **234** to communicate with any of the various other system components described herein. For instance, one or more communicative links or interfaces (e.g., one or more data buses) may be provided between the transceiver **258** and the one or more nozzle assemblies **120** positioned along a boom assembly **118**.

(63) As illustrated, the transceiver **226** of the first computing system **206** and/or the transceiver **258** of the second computing system **234** may be operably coupled with a remote electronic device **260**. The electronic device **260** may include a display for displaying information to a user. For instance, the electronic device **260** may display one or more user interfaces and may be capable of receiving remote user inputs. In addition, the electronic device **260** may provide feedback information, such as visual, audible, and tactile alerts, and/or allow the operator to alter or adjust one or more components of the harvester **10** through the usage of the remote electronic device **260**. The electronic device **260** may include a variety of computing systems **262** including a processor and memory. For example, the electronic device **260** may be a cell phone, mobile communication device, key fob, wearable device (e.g., fitness band, watch, glasses, jewelry, wallet), apparel (e.g., a tee shirt, gloves, shoes, or other accessories), personal digital assistant, headphones and/or other devices that include capabilities for wireless communications and/or any wired communications protocols.

(64) Referring to FIG. **4**, in some examples, the first vehicle **202** (e.g., the harvester **10**), the second vehicle **204** (e.g., the sprayer **100**), and/or the electronic device **260** may be communicatively coupled with one another and/or one or more remote sites, such as a remote server **264** via a network/cloud **266** to provide data and/or other information therebetween. The network/cloud **266** represents one or more systems by which the first vehicle **202**, the second vehicle **204**, and/or the electronic device **260** may communicate with the remote server **264**. The network/cloud **266** may be one or more of various wired or wireless communication mechanisms, including any desired combination of wired and/or wireless communication mechanisms and any desired network topology (or topologies when multiple communication mechanisms are utilized). Exemplary communication networks **266** include wireless communication networks (e.g., using Bluetooth, IEEE 802.11, etc.), local area networks (LAN) and/or wide area networks (WAN), including the Internet and the Web, which may provide data communication services and/or cloud computing services. The Internet is generally a global data communications system. It is a hardware and software infrastructure that provides connectivity between computers. In contrast, the Web is generally one of the services communicated via the Internet. The Web is generally a collection of interconnected documents and other resources, linked by hyperlinks and URLs. In many technical illustrations when the precise location or interrelation of Internet resources are generally illustrated, extended networks such as the Internet are often depicted as a cloud (e.g. **266** in FIG. **4**). The verbal image has been formalized in the newer concept of cloud computing. The National Institute of Standards and Technology (NIST) defines cloud computing as “a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.” Although the Internet, the Web, and cloud computing are not the same, these terms are generally used interchangeably herein, and they may be referred to collectively as the network/cloud **266**.

(65) The server **264** may be one or more computer servers, each of which may include a computing system **268** including at least one processor and at least one memory, the memory storing instructions executable by the processor, including instructions for carrying out various steps and processes. The server **264** may include or be communicatively coupled to a data store **270** for storing collected data as well as instructions and/or data for the first vehicle **202**, the second vehicle **204**, and/or the electronic device **260** with or without intervention from a user, the first vehicle **202**, the second vehicle **204**, and/or the electronic device **260**. Moreover, the server **264** may be capable of analyzing initial or raw sensor data received from the first vehicle **202**, the second vehicle **204**, and final or post-processing data (as well as any intermediate data created during data processing). Accordingly, the instructions and/or data provided to any one or more of the first vehicle **202**, the second vehicle **204**, and/or the electronic device **260** may be determined and generated by the server **264** and/or one or more cloud-based applications **272**. In such instances, the user interface

250 of the first vehicle **202**, the second vehicle **204**, and/or the electronic device **260** may be a dummy device that provides various instructions and/or data based on instructions from the network/cloud **266**.

(66) With further reference to FIG. **4**, the server **264** also generally implements features that may enable the first vehicle **202**, the second vehicle **204**, and/or the electronic device **260** to communicate with cloud-based applications **272**. Communications from the electronic device **260** can be directed through the network/cloud **266** to the server **264** and/or cloud-based applications **272** with or without a networking device, such as a router and/or modem. Additionally, communications from the cloud-based applications **272**, even though these communications may indicate one the first vehicle **202**, the second vehicle **204**, and/or the electronic device **260** as an intended recipient, can also be directed to the server **264**. The cloud-based applications **272** are generally any appropriate services or applications **272** that are accessible through any part of the network/cloud **266** and may be capable of interacting with the electronic device **260**.

(67) In various examples, the first vehicle **202**, the second vehicle **204**, and/or the electronic device **260** can be feature-rich with respect to communication capabilities, i.e. have built-in capabilities to access the network/cloud **266** and any of the cloud-based applications **272** or can be loaded with, or programmed to have, such capabilities. The first vehicle **202**, the second vehicle **204**, and/or the electronic device **260** can also access any part of the network/cloud **266** through industry-standard wired or wireless access points, cell phone cells, or network nodes. In some examples, users can register to use the remote server **264** through the first vehicle **202**, the second vehicle **204**, and/or the electronic device **260**, which may provide access to the first vehicle **202**, the second vehicle **204**, and/or the electronic device **260** and/or thereby allow the server **264** to communicate directly or indirectly with the first vehicle **202**, the second vehicle **204**, and/or the electronic device **260**. In various instances, the first vehicle **202**, the second vehicle **204**, and/or the electronic device **260** may also communicate directly, or indirectly, with the first vehicle **202**, the second vehicle **204**, and/or the electronic device **260** or one of the cloud-based applications **272** in addition to communicating with or through the server **264**. According to some examples, the first vehicle **202**, the second vehicle **204**, and/or the electronic device **260** can be preconfigured at the time of manufacture with a communication address (e.g. a URL, an IP address, etc.) for communicating with the server **264** and may or may not have the ability to upgrade or change or add to the preconfigured communication address.

(68) Referring still to FIG. **4**, when a new cloud-based application **272** is developed and introduced, the server **264** can be upgraded to be able to receive communications for the new cloud-based application **272** and to translate communications between the new protocol and the protocol used by the first vehicle **202**, the second vehicle **204**, and/or the electronic device **260**. The flexibility, scalability, and upgradeability of current server technology render the task of adding new cloud-based application protocols to the server **264** relatively quick and easy.

(69) In several embodiments, an application interface **274** may be operably coupled with the cloud **266** and/or the application **272**. The application interface **274** may be configured to receive data related to the first vehicle **202**, the second vehicle **204**, and/or the electronic device **260**. In various embodiments, one or more inputs related to the field data **246** (FIG. **3**) may be provided to the application interface **274**. For example, a farmer, a vehicle user, a company, or other persons may access the application interface **274** to enter the inputs related to the field data **246**. Additionally or alternatively, the inputs related to the field data **246** may be received from a remote server **264**. For example, the inputs related to the field data **246** may be received in the form of software that can include one or more objects, agents, lines of code, threads, subroutines, databases, application programming interfaces (APIs), or other suitable data structures, source code (human-readable), object code (vehicle-readable). In response, the system **200** may update any input/output based on the received inputs. The application interface **274** can be implemented in hardware, software, or a suitable combination of hardware and software, and which can be one or more software systems

operating on a general-purpose processor platform, a digital signal processor platform, or other suitable processors.

(70) In some examples, at various predefined periods and/or times, the first vehicle **202**, the second vehicle **204**, and/or the electronic device **260** may communicate with the server **264** through the network/cloud **266** to obtain the stored instructions and/or data, if any exist. Upon receiving the stored instructions and/or data, the first vehicle **202**, the second vehicle **204**, and/or the electronic device **260** may implement the instructions and/or data. In some instances, the first vehicle **202**, the second vehicle **204**, and/or the electronic device **260** can send event-related data to the server **264** for storage in the data store **270**. This collection of event-related data can be accessed by any number of users, the first vehicle **202**, the second vehicle **204**, and/or the electronic device **260** to assist with application processes.

(71) In various embodiments, the data used by the first vehicle **202**, the second vehicle **204**, the electronic device **260**, the remote server **264**, the data store **270**, the application **272**, the application interface **274**, and/or any other component described herein for any purpose may be based on data provided by the one or more crop material sensors **88** and/or the positioning device **224** operably coupled with the first vehicle **202**, the positioning system **250** operably coupled with the second vehicle **204**, and/or third-party data that may be converted into comparable data that may be used independently or in conjunction with data collected from the one or more crop material sensors **88**.

(72) In various embodiments, based on the data collected during the first operation, the system **200** may be configured to generate a harvest material yield map **280**, a predicted weed concentration map **282**, a prescription map **284** that generally illustrates one or more regions for which an agricultural product is to be applied, and/or any other information. The system **200** may include the first computing system **106** associated with the first vehicle **202**, the second computing system **234** associated with the second vehicle **204**, the computing system **262** of the electronic device **260**, a computing system **268** of the remote server **264**, a computing system associated with the data store **270**, a computing system associated with the application **272**, and/or a computing system associated with the application interface **274**. As such, in various embodiments, the information that may be produced by a computing system is remote from the first vehicle **202** and/or the second vehicle **204**.

(73) In various examples, the server **264** may implement machine learning engine methods and algorithms that utilize one or several machine learning techniques including, for example, decision tree learning, including, for example, random forest or conditional inference trees methods, neural networks, support vector vehicles, clustering, and Bayesian networks. These algorithms can include computer-executable code that can be retrieved by the server **264** through the network/cloud **266** and may be used to generate a predictive evaluation of the field **14**. In some instances, the machine learning engine may allow for changes to a harvest yield map **280**, a projected weed concentration map **282**, and/or a prescription map **284** to be performed without human intervention.

(74) With respect to FIGS. **5-12**, various example embodiments of the system **200** during various operations are illustrated according to the present subject matter will be described below. Particularly, FIGS. **5-7** generally illustrate a first vehicle **202** performing a first agricultural operation in a working area **286** of a field **14** in accordance with various examples of the present disclosure. Additionally, FIG. **8** generally illustrates an exemplary harvest yield map **280** in accordance with various examples of the present disclosure. FIG. **9** generally illustrates an exemplary projected weed concentration map **282** in accordance with various examples of the present disclosure. FIG. **10** generally illustrates an exemplary prescription map **284** in accordance with various examples of the present disclosure. FIGS. **11** and **12** generally illustrate projected paths for a second vehicle **204** to selectively apply an agricultural product to one or more regions of a field **14** detected by the first vehicle **202** in accordance with various examples of the present disclosure.

(75) Referring further to FIGS. **5-7**, the working area **286** of the field **14** extends in an operating

direction **288** between a first end portion **290** and a second end portion **292**. In addition, a plurality of swath lines **294** may extend in the operating direction **288** between the first and second end portions **406**, **408** of the working area **286**. In general, the swath lines **294** may correspond to predetermined or pre-generated guidance lines representing anticipated or desired paths or passes across the field **14** for performing a first agricultural operation (e.g., a planting operation, a seeding operation, a tilling operation, a harvesting operation, a spraying operation, and/or any other operation). While the embodiments of FIGS. **5-7** generally illustrate and describe the first vehicle **202** being configured as a harvester **10**, it will be appreciated that the first vehicle **202** may be configured as tractor, harvester **10**, self-propelled windrower, self-propelled sprayer, drone, and/or the like. In addition, it will be appreciated that the first vehicle **202** may be human-controlled, autonomously controlled, and/or semi-autonomously controlled without departing the scope of the present disclosure.

(76) With further reference to FIGS. **5-7**, while the first operation is performed by moving the first vehicle **202** through each swath line **294**, the one or more crop material sensors **88** may monitor the crop material **16** as the crops **12** are severed by the first vehicle **202**. Data captured by the one or more crop material sensors **88** may be provided to the first computing system **106** (FIG. **3**). Additionally, a positioning device **224** may be configured to provide data to the first computing system **106** related to a position of the first vehicle **202**, which may be correlated to the crop material data **244** generated by the one or more crop material sensors **88**. In some embodiments, the crop material data **244** and the location data may be utilized by the first computing system **106** to generate field data **246**.

(77) The field data **246** may include defined objects within the crop material data **244**. For example, the system **200** may determine whether an object is harvest material **18** or non-harvest material **20**. In addition, the system **200** may be configured to determine a concentration or ratio of harvest material **18** and/or non-harvest material **20** within the field **14**. Still further, the system **200** may determine various objects within the non-harvest material **20**, which may include weeds **296**A, **296**B including a previous harvest season crop that is different than a current crop, etc.

(78) In some instances, the system **200** may store areas of the field **14** as distinct regions. In such instances, the system **200** may geolocate various data to each region based on data from the positioning device **224**. For example, the stored field data may include a harvest volume of the harvest material **18** within one or more regions of the field **14** and/or a non-harvest volume of the non-harvest material **20** within the one or more regions of the field **14**.

(79) Referring to FIG. **8**, based on the field data **246** of the first vehicle **202**, and the location data **218** of the first vehicle **202**, the system **200** may generate a harvest yield map **280**, which generally illustrates harvest material **18** outputs for each of the one or more regions within the field **14**. For example, the yield map **280** may illustrate regions **298**A, **298**B **298**C of the field **14** that produced greater than a defined range of harvest material **18**, the defined range of harvest material **18**, and/or less than the defined range of harvest material **18**. Based on the various regions, the system **200** may project that regions **298**A that produced greater than the defined range of harvest material **18** may also have a higher concentration of weeds **296**A, **296**B as well. As such, a volume of the agricultural product above a defined volume or application rate may be applied to the regions **298**A having the higher concentration of weeds **296**A, **296**B. Likewise, the system **200** may project that regions **298**B that produced less than the defined range of harvest material **18** may also have a lesser concentration of weeds **296**A, **296**B as well. As such, an amount of the agricultural product less than a defined volume or application rate may be applied to the regions **298**B having the lesser concentration of weeds **296**A, **296**B. Further, the system **200** may project that regions **298**C that produced the defined range of harvest material **18** may also have an average concentration of weeds **296**A, **296**B as well. As such, an amount of the agricultural product at the defined volume or application rate may be applied to the regions **298**C having the lesser concentration of weeds **296**A, **296**B.

(80) Referring to FIG. **9**, the system **200** may additionally or alternatively generate a weed concentration map **282** based on the field data **246** of the first vehicle **202**, and the location data **218** of the first vehicle **202**. The weed concentration map **282** may illustrate regions **300**A, **300**B, **300**C of the field **14** that have a varied concentration and/or a number of weeds **296**A, **296**B from a defined range, which may be determined through the crop material sensors **88** detecting various objects within the crop material **16** and/or the non-harvest material **20** during the first operation. For instance, a first region **300**A may have a higher concentration of weeds **296**A, **296**B from the defined range, a second region **300**B may have a lower concentration of weeds **296**A, **296**B from the defined range, and remaining regions **300**C may have a concentration of weeds **296**A, **296**B within the defined range.

(81) The projected weed concentration map **282** may be used by the second vehicle **204** to apply various quantities of agricultural product to defined regions of the field **14**. Additionally or alternatively, based on the harvest material **18** and/or non-harvest material **20** outputted from the harvester **10**, the first computing system **206** may provide a sprayer operator with a suggested product to apply to the field **14**.

(82) The projected weed concentration map **282** may be used by the second vehicle **204** to apply various volumes or application rates of agricultural product to defined portions of the field **14**. For example, if a region **300**A of the field **14** contains a higher projected concentration of weeds **296**A, **296**B than a defined concentration range, a greater volume or application rate of the agricultural product or a different agricultural product may be applied to the higher projected concentration regions **300**A. Further, if a region **300**B of the field **14** contains a lower projected concentration of weeds **296**A, **296**B than the defined concentration range, a lesser volume or application rate of the agricultural product or a different agricultural product may be applied to the higher projected concentration regions **300**B.

(83) Referring to FIGS. **10-12**, the system **200** may additionally or alternatively generate a prescription map **284** that illustrates various regions **302**A, **302**B of the field **14** that may have one or more agricultural products applied thereto based on the field data **246** of the first vehicle **202**, and the location data **218** of the first vehicle **202**. For example, the prescription map **284** may include a first region **302**A that is indicative of an area for which a first weed type **296**A that is to have a first agricultural product applied thereto and/or a second region **302**B that is indicative of an area for which a second weed type **296**B that is to have a second agricultural product applied thereto by the second vehicle **204**. In various instances, the first agricultural product may be applied at a first application rate while the second agricultural product may be applied at a second application rate.

(84) In various examples, the system **200** may further generate one or more suggested paths **304**, **306** for the second vehicle **204** to apply an agricultural product to the first regions **302**A and/or the second regions **302**B of the field **14**. The paths **304**, **306** may be generated based on one or more user defined settings and/or field characteristics. The user defined settings may include any factor of a spray operation that may be altered by the user while the field characteristics may include one or more features of the field **14**. For example, the features may include whether the crop material **16** is in a pre-emergence stage or a post emergence stage. In such instances, as illustrated in FIG. **11**, a first path **304** may be generated to the second regions **320**B of the field **14** in which the sprayer **100** travels a first distance and may be utilized when the crop material **16** is in a pre-emergence stage. Additionally or alternatively, as illustrated in FIG. **12**, a second path **306** may be generated to the second regions **302**B of the field **14** in which the sprayer **100** travels a second distance and may be utilized when the crop material **16** is in a post-emergence stage. In some instances, the second distance may be less than the first distance.

(85) Referring now to FIG. **13**, a flow diagram of some embodiments of a method **400** for selectively applying an agricultural product is illustrated in accordance with aspects of the present subject matter. In general, the method **400** will be described herein with reference to the system **200**

described herein. However, it will be appreciated by those of ordinary skill in the art that the disclosed method **400** may generally be utilized with any suitable agricultural sprayer **100** and/or may be utilized in connection with a system having any other suitable system configuration. In addition, although FIG. **13** depicts steps performed in a particular order for purposes of illustration and discussion, the methods discussed herein are not limited to any particular order or arrangement. One skilled in the art, using the disclosures provided herein, will appreciate that various steps of the methods disclosed herein can be omitted, rearranged, combined, and/or adapted in various ways without deviating from the scope of the present disclosure.

(86) As shown in FIG. **13**, at (**402**), the method **400** can include capturing crop material data while processing crop material through a harvester from a crop material sensor. In general, the harvester is configured to sever crops from a field and direct the crop material into the harvester. Within the harvester, the crop material may be separated into harvest material (e.g., grain) and non-harvest material (e.g., material other than grain (MOG), straw, previous harvest season crop, etc.). The harvester may further include one or more crop material sensors that may be configured to capture data indicative of a makeup of the crop material.

(87) At (**404**), the method **400** can include classifying objects within the crop material data as harvest material or non-harvest material. In some instances, the crop material sensor can be configured to capture image data and/or image-like data. In such instances, the system provided herein can utilize one or more image processing algorithms to classify the objects within the crop material data as the harvest material or the non-harvest material.

(88) At (**406**), the method **400** can include determining a harvest volume of the harvest material within one or more regions of a field based on the data provided from the one or more crop material sensors. Additionally or alternatively, at (**408**), the method **400** can include determining a non-harvest volume of the non-harvest material within the one or more regions of the field. As provided herein, in some instances, the system may store areas of the field as distinct regions. In such instances, the system may correlate various data to each region. In addition, each region may be geolocated based on data from the positioning device.

(89) At (**410**), the method **400** can include determining the one or more regions of the field having the harvest volume exceeding a defined range. For example, regions of the field that produced greater than a defined range of harvest material, the defined range of harvest material, and/or less than the defined range of harvest material. Based on the various regions, the system may project that regions that produced greater than the defined range of harvest material may also have a higher concentration of weeds as well. As such, a volume of the agricultural product above a defined volume or application rate may be applied to the regions having the higher concentration of weeds. Likewise, the system may project that regions that produced less than the defined range of harvest material may also have a lesser concentration of weeds as well. As such, an amount of the agricultural product less than a defined volume or application rate may be applied to the regions having the lesser concentration of weeds. Further, the system may project that regions that produced the defined range of harvest material may also have an average concentration of weeds as well. As such, an amount of the agricultural product at the defined volume or application rate may be applied to the regions having the lesser concentration of weeds.

(90) At (**412**), the method **400** can include identifying one or more of the objects within the non-harvest material as weeds. For example, the system may classify whether objects within the non-harvest material are weeds (e.g., any plant other than harvest material), dirt, rocks, stalk, straw, harvested crop from a previous season, etc.

(91) At (**414**), the method **400** can include generating a map based on the detected harvest material and the non-harvest material. As provided herein, the map may be at least one of a harvest material yield map, a projected weed concentration map, or a prescription map.

(92) At (**416**), the method **400** can include generating one or more suggested paths for a sprayer based on the prescription map to apply an agricultural product to a first region and/or a second

region of the field. The one or more suggested paths may be generated based on one or more user defined settings and/or field characteristics. The user defined settings may include any factor of a spray operation that may be altered by the user while the field characteristics may include one or more features of the field. For example, the features may include whether the cop material is in a pre-emergence stage or a post emergence stage. For instance, a first path may be generated to the second regions of the field in which the sprayer travels a first distance and may be utilized when the crop material is in a pre-emergence stage. Additionally or alternatively, a second path may be generated to the second regions of the field in which the sprayer travels a second distance and may be utilized when the crop material is in a post-emergence stage. In some instances, the second distance may be varied from the first distance.

(93) In various examples, the method may implement machine learning methods and algorithms that utilize one or several machine learning techniques including, for example, decision tree learning, including, for example, random forest or conditional inference trees methods, neural networks, support vector vehicles, clustering, and Bayesian networks. These algorithms can include computer-executable code that can be retrieved by the computing system and/or through a network/cloud and may be used to evaluate and update the boom deflection model. In some instances, the machine learning engine may allow for changes to the boom deflection model to be performed without human intervention.

(94) It is to be understood that the steps of any method disclosed herein may be performed by a computing system upon loading and executing software code or instructions which are tangibly stored on a tangible computer-readable medium, such as on a magnetic medium, e.g., a computer hard drive, an optical medium, e.g., an optical disc, solid-state memory, e.g., flash memory, or other storage media known in the art. Thus, any of the functionality performed by the computing system described herein, such as any of the disclosed methods, may be implemented in software code or instructions which are tangibly stored on a tangible computer-readable medium. The computing system loads the software code or instructions via a direct interface with the computer-readable medium or via a wired and/or wireless network. Upon loading and executing such software code or instructions by the controller, the computing system may perform any of the functionality of the computing system described herein, including any steps of the disclosed methods.

(95) The term “software code” or “code” used herein refers to any instructions or set of instructions that influence the operation of a computer or controller. They may exist in a computer-executable form, such as vehicle code, which is the set of instructions and data directly executed by a computer's central processing unit or by a controller, a human-understandable form, such as source code, which may be compiled in order to be executed by a computer's central processing unit or by a controller, or an intermediate form, such as object code, which is produced by a compiler. As used herein, the term “software code” or “code” also includes any human-understandable computer instructions or set of instructions, e.g., a script, that may be executed on the fly with the aid of an interpreter executed by a computer's central processing unit or by a controller.

(96) This written description uses examples to disclose the technology, including the best mode, and also to enable any person skilled in the art to practice the technology, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the technology is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they include structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal language of the claims.

Claims

1. A system for an agricultural operation, the system comprising: a sprayer configured to selectively apply an agricultural product, the sprayer configured to communicatively couple with a harvester

configured to separate crop material into a harvest material and a non-harvest material, the harvester including a crop material sensor operably coupled with the harvester and configured to capture crop material data; and a positioning device configured to generate location data to geolocate the crop material data relative to a field; a nozzle assembly operably coupled with the sprayer; and a computing system communicatively coupled with the crop material sensor and the positioning device, the computing system configured to: classify objects within the crop material data as the harvest material or the non-harvest material; generate a map based on the harvest material and the non-harvest material; generate one or more suggested paths based on the crop material within the field being in a pre-emergence state or post-emergence state; and selectively apply the agricultural product from the nozzle assembly along the one or more suggested paths.
2. The system of claim 1, wherein the sprayer includes a boom assembly supporting the nozzle assembly.
3. The system of claim 2, wherein the computing system is remote from the harvester and the sprayer.
4. The system of claim 2, wherein the harvester and the sprayer are communicatively coupled through a communication network/cloud.
5. The system of claim 1, wherein the computing system is further configured to: store a harvest volume of the harvest material within one or more regions of the field; and store a non-harvest volume of the non-harvest material within the one or more regions of the field.
6. The system of claim 5, wherein the map is a harvest material yield map, the harvest material yield map configured to illustrate a yield of the harvest material from each of the one or more regions within the field.
7. The system of claim 1, wherein the crop material sensor is configured to capture image data, and wherein the computing system utilizes one or more image processing algorithms to classify the objects within the crop material data as the harvest material or the non-harvest material.
8. The system of claim 1, wherein the computing system is further configured to: identify one or more of the objects within the non-harvest material as weeds, wherein the map is a projected weed concentration map based on the weeds, the projected weed concentration map configured to illustrate a location of the weeds within the field.
9. The system of claim 8, wherein the computing system is further configured to: classify the weeds as a first set of weeds or a second set of weeds; and generate a prescription map based on the first set of weeds and the second set of weeds, wherein the prescription map includes a first region associated with the first set of weeds and a second region associated with the second set of weeds.
10. The system of claim 9, wherein the computing system is further configured to generate a first suggested path for the sprayer to the second region when the crop material within the field are in the pre-emergence state and a second suggested path for the sprayer to the second region when the crop material within the field are in the post-emergence state.
11. A method for operating an agricultural system, the method comprising: capturing, from a crop material sensor, crop material data while processing crop material through a harvester; classifying objects within the crop material data as harvest material or non-harvest material; generating a map based on the harvest material and the non-harvest material; generating a first suggested path for a second vehicle based on the crop material being in a pre-emergence state and a second suggested path based on the crop material being in a post-emergence state; and selectively applying an agricultural product along the first suggested path or the second suggested path through a sprayer.
12. The method of claim 11, wherein the method further comprises: determining a harvest volume of the harvest material within one or more regions of a field; and determining a non-harvest volume of the non-harvest material within the one or more regions of the field.
13. The method of claim 12, further comprising: determining the one or more regions of the field having the harvest volume exceeding a defined range.
14. The method of claim 11, further comprising: identifying one or more of the objects within the

non-harvest material as weeds.

15. The method of claim 11, wherein the map is at least one of a harvest material yield map, a projected weed concentration map, or a prescription map.

16. An agricultural system comprising: a harvester configured to separate crop material into a harvest material and a non-harvest material including a crop material sensor configured to capture crop material data of the crop material; a computing system communicatively coupled with the crop material sensor, the computing system configured to: classify objects within the crop material data as harvest material or non-harvest material; and generate one or more suggested paths based on the crop material within a field being in a pre-emergence state or post-emergence state; and a sprayer communicatively coupled with the harvester and configured to selectively apply an agricultural product to the field along the one or more suggested paths.

17. The system of claim 16, further comprising: a positioning device configured to generate location data to geolocate the crop material data relative to the field.

18. The system of claim 17, further comprising: a computing system communicatively coupled with the crop material sensor and the positioning device, the computing system configured to: generate a map based on the harvest material.

19. The system of claim 17, further comprising: a computing system communicatively coupled with the crop material sensor and the positioning device, the computing system configured to: generate a map based on the non-harvest material.