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- (71) Applicant: BAYER CROPSCIENCE LP [US/US]; 2 T.W. Alexander Drive, Research Triangle Park, North Carolina 27709 (US).
- (72) Inventor: KOOB, Jim; 4113 Les Arbres Drive, Apex, North Carolina 27539 (US).
- (74) Agent: HARRIS, Ryan; 2 T.W. Alexander Drive, Research Triangle Park, North Carolina 27709 (US).
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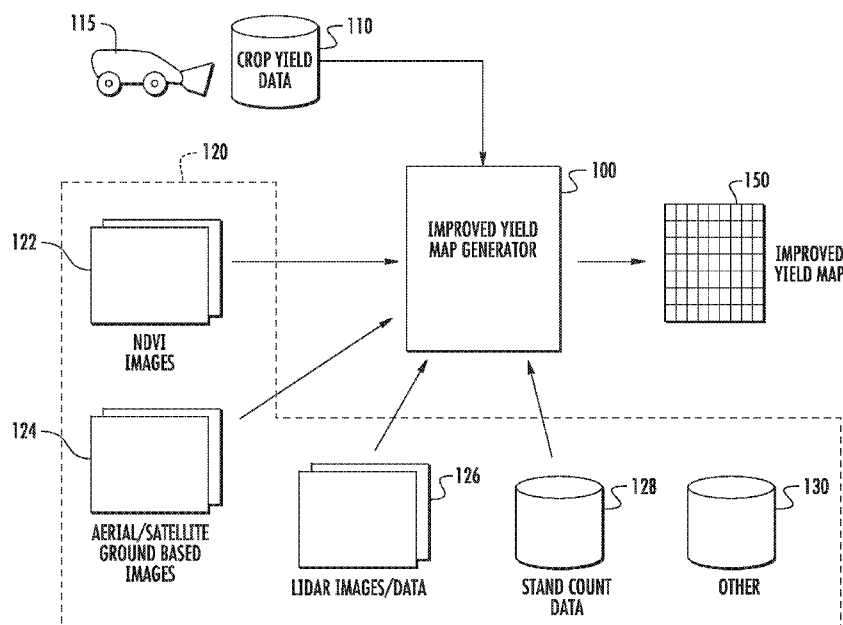


FIG. 1

(57) Abstract: Systems and methods for generating crop yield maps are provided, in one example embodiment, a method can include accessing, by one or more processors, data indicative of crop yield for a field area; and accessing, by the one or more processors, one or more data types associated with the field area. Each of the data types can provide a geospatial distribution of data associated with vegetation across the field area. The method can further include determining, by the one or more processors, a crop yield distribution for the field area based at least in part on the data indicative of crop yield and the one or more data types; and generating, by the one or more processors, a yield map for the field area based at least in part on the crop yield distribution.



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METHOD FOR MAPPING CROP YIELDS

FIELD

[0001] The present disclosure relates generally to crop yield mapping.

BACKGROUND

[0002] Crop mapping can be used to analyze variables such as crop yield in a field. More particularly, a yield map can be used to assess a distribution of crop yield across a field or other space. Yield maps can be used, for instance, to analyze the variability of crop yield at particular locations in response to various inputs (e.g., moisture content, use of fungicide, stand count, etc.). A link between crop yield and a specific geographic point in a field or other space can be important in the accuracy of such analysis.

[0003] Harvest equipment, such as a harvester, can include systems used to generate yield maps as the harvest equipment ingests crops in a field during harvesting. However, a primary purpose of harvest equipment is the efficient harvesting of crops from the field. As a result, most harvesters are configured to harvest multiple rows of crops at the same time as the harvest equipment moves through the field. Accordingly, the harvest equipment may only be able approximate the data for a yield map with numerous plants growing, for instance in a ten to fifteen meter area. Additionally, the ingest rate of the harvest equipment may change when the harvest equipment moves up hill, down hill, turns, speeds up, or slows down. The change in ingest rate can lead to difficulties in associating crop yield with a specific area.

SUMMARY

[0004] Aspects and advantages of embodiments of the present disclosure will be set forth in part in the following description, or may be learned from the description, or may be learned through practice of the embodiments.

[0005] One example aspect of the present disclosure is directed to a method for generating a yield map for a field area. The method can include accessing, by one or more processors, data indicative of a crop yield for a field area. The method can further include accessing, by one or more processors, one or more data types associated with the field area. Each of the data types can provide a geospatial distribution of data associated with vegetation across the field area. The method can further include determining, by the one or more processors, a crop yield distribution for the field area based at least in part on the data indicative of crop yield and the one or more data types and generating, by the one or more processors, a yield map for the field area based at least in part on the crop yield distribution.

[0006] Other example aspects of the present disclosure are directed to systems, devices, methods, processes, and non-transitory computer-readable media for generating a yield map for a field area.

[0007] These and other features, aspects and advantages of various embodiments 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 present disclosure and, together with the description, serve to explain the related principles.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Detailed discussions of embodiments directed to one of ordinary skill in the art are set forth in the specification, which makes reference to the appended figures, in which:

[0009] FIG. 1 depicts an overview of improved crop yield mapping according to example embodiments of the present disclosure;

[0010] FIG. 2 depicts an example crop yield map generated by harvest equipment;

[0011] FIG. 3 depicts a representation of an improved crop yield map according to example embodiments of the present disclosure;

[0012] FIG. 4 depicts the example determination of a crop yield distribution from a VI image according to example embodiments of the present disclosure;

[0013] FIG. 5 depicts a flow diagram of an example method according to example embodiments of the present disclosure; and

[0014] FIG. 6 depicts an example system for generating a crop yield map according to example embodiments of the present disclosure.

DETAILED DESCRIPTION

[0015] Reference now will be made in detail to embodiments, one or more examples of which are illustrated in the drawings. Each example is provided by way of explanation of the embodiments, not limitation of the present disclosure. In fact, it will be apparent to those skilled in the art that various modifications and variations can be made to the embodiments without departing from the scope or spirit of the present disclosure. For instance, features illustrated or described as part of one embodiment can be used with another embodiment to yield a still further embodiment. Thus, it is intended that aspects of the present disclosure cover such modifications and variations.

[0016] Example aspects of the present disclosure are directed to systems and methods for generating improved crop yield maps. More particularly, a crop yield distribution for a field area can be determined using data taken from, for instance, harvest equipment. Improved crop yield values can be allocated geospatially across the field area using one or more data types associated with the field area. The data types can include data associated with vegetation that is geospatially distributed across the field area. For instance, the data types can include imagery depicting or otherwise representing vegetation (e.g., vegetation index (VI) imagery, LIDAR imagery, photographic imagery, satellite imagery, aerial imagery, ground based imagery, etc.). The data types can also include data such as stand count data, as-planted values, etc. Once determined, the crop yield distribution can be used to generate an improved crop yield map with increased accuracy and/or resolution relative to yield maps normally generated by harvest equipment.

[0017] For example, in one embodiment, data indicative of crop yield for a field area can be accessed (e.g., total crop yield, crop yield distribution generated by harvester equipment, etc.). The crop yield can be more accurately allocated across the field area using one or more VI images. In particular embodiments, a model can analyze pixel value (e.g., pixel color and/or intensity) distribution patterns in one or more VI images and allocate a crop yield value to different geospatial positions in the field area based on the pixel value distribution. As one example, a crop yield value can be determined for discrete subsections of the field area based at least in part on the pixel value for each pixel in the VI image corresponding to the discrete subsections of the field area.

[0018] Additional refinements or adjustments to the crop yield distribution generated from the harvester can be determined by adapting the model to account for data from other data sources. For instance, the initial crop yield distribution can be adjusted based on as planted values collected from planting equipment to centralize on probable target crop points on the field. As another example, multiple VI images collected at different times during the growing season can be used to create a more robust model that takes into account growth trends across a growing season. Stand count data can be used to distinguish between target crop and weed locations. LIDAR maps can provide information on crop height to provide additional information relevant to crop vigor in order to refine the accuracy of the model.

[0019] Once the crop yield distribution has been determined based on the model, the crop yield distribution can be used to generate an improved crop yield map. The improved crop yield map can similarly include a plurality of pixels. Each pixel includes a pixel value corresponding to the crop yield value determined for the discrete subset of the field area corresponding to the pixel.

[0020] In this way, example embodiments of the present disclosure can provide for generation of improved crop yield maps based on crop yield data collected by any harvest equipment. In some embodiments, the improved crop yield maps can be generated to compensate for variations in elevation, slope, soil conditions and harvest equipment variability. As a result, the improved crop yield maps generated according to certain example embodiments of the present disclosure can have a higher degree of accuracy in assessing crop yield distribution. In addition, the improved crop yield maps can lead to more accurate management of the field area, can provide a better understanding of the soil conditions, and can provide a better linkage of crop input application efficacy to specific areas of a field.

[0021] As used herein, crop yield can refer to a measure of yield of a crop (e.g., amount of crop harvested) per a unit of area or to a measure of yield of a crop (e.g., amount of crop harvested) for each seed, or other measure of crop yield or to another suitable measure of crop yield. Field area can refer to a space where crops are planted and/or harvested. Data types can include a set of data (e.g., an image, table, or other data set) that provides data points (e.g., pixel values, stand count measurements, etc.) that are geospatially allocated across the field area. A crop yield map can refer to a data set that provides crop yield values that are geospatially allocated over a space. A vegetation index can include any of one or more vegetation indices, including, for instance, a normalized difference vegetation index NDVI, a leaf area index (LAI), a green ratio vegetation index (GRVI), an enhanced vegetation index (EVI), a difference vegetation index (DVI), a simple ratio index (SR), or other index. The term "about" when used in conjunction with a numerical value refers to within 35% of the stated numerical value.

[0022] FIG. 1 depicts an overview of generation of an example improved crop yield map according to example embodiments of the present disclosure. More particularly, an improved yield map generator 100 can be implemented by one or more processors to generate an improved crop yield map 150 based on various data sources, such as data indicative of crop yield 110 (e.g. yield maps generated from the harvest equipment 115) for a field area and one or more data types 120. Referring to FIG. 1, the improved crop yield map 150 can be analyzed to determine best field management practices for various growing inputs (e.g., moisture, pesticide, stand count, etc.) to obtain improved crop yield for the field area.

[0023] In some embodiments, the improved yield map generator 100 can include computer logic used to generate a crop yield map according to example aspects of the present disclosure. The improved yield map generator 100 can be implemented in hardware, application specific circuits, firmware and/or software controlling a general purpose processor. In one embodiment, the improved yield map generator 100 can include program code files stored on one or more memory devices and executed by

one or more processors or can be provided from computer program products, for example computer executable instructions, that are stored in a tangible computer-readable storage medium such as RAM, ROM, hard disk or optical or magnetic media. When software is used, any suitable programming language or platform can be used to implement the improved yield map generator 100. A flow diagram of an example method implemented by an improved yield map generator 100 is depicted in FIG. 5.

[0024] The improved yield map generator 100 can access data indicative of crop yield for the field area 110. The crop yield data 110 obtained from the harvest equipment 115 can be the total volume of crops ingested by harvest equipment from the field area, a crop yield distribution generated by the harvest equipment 115, or any other crop yield data obtained from the harvest equipment 115 or other source. For instance, harvest equipment 115 can ingest crops from the field area. Crop yield data 110 for the field area can be determined, for instance, by the harvest equipment 115 or other equipment. The crop yield data 110 can be stored in one or more memory devices for access by the improved yield map generator 100.

[0025] FIG. 2 depicts one example of crop yield data 110 that can be generated by the harvest equipment 115. Crop yield data 110 can be a crop yield map that includes a plurality of pixels. Each pixel represents a discrete subsection of the crop yield map. In addition, each pixel corresponds to a discrete subsection of the field area represented by the crop yield map. Each pixel can have a pixel value associated with the color and/or intensity of the pixel. The pixel value of a pixel can be indicative of the crop yield value for the discrete subsection of the field area represented by the pixel.

[0026] Referring back to FIG. 1, the improved yield map generator 100 can also access data associated with one or more data types 120. The data types 120 can include data collected during the growing season that is geospatially allocated across the field area. As will be discussed in more detail below, the data types 120 can be used by the improved crop yield map generator 100 to more accurately geospatially allocate data indicative of crop yield across the field area.

[0027] The one or more data types 120 can include, for instance, one or more VI images 122 associated with the field area. Each of the one or more VI images 122 can include a plurality of pixels. Each pixel can have a pixel value (e.g., color and/or intensity) associated with the amount of vegetation in a discrete subsection of the field area corresponding to the pixel. More particularly, each pixel in the VI images can correspond to a discrete subsection of the field area (e.g., depicts the discrete subsection of the field area). The pixel value associated with the pixel is indicative of the amount of live vegetation in the discrete subsection.

[0028] The VI images 122 can be accessed or obtained from any suitable source. For instance, in some embodiments, the VI images 122 can be VI images captured, for instance, from a satellite based on spectral reflectance measurements. In some embodiments, the VI images 122 can be captured at different times during the growing season. For instance, a first VI image can be captured at a first time during the growing season. A second VI image can be captured at a second time that is different from the first time during the growing season.

[0029] The one or more data types 120 can include photographic imagery 124, such as aerial imagery, satellite imagery, or ground based imagery captured of the field area, for instance, from an image capture device. Aerial imagery can include images (e.g. photos) captured of the field area from an aerial perspective, for instance, from manned or unmanned aerial aircraft. Satellite imagery can include images (e.g. photos) of the field area captured from one or more satellites. Ground-based images can be images captured of the field area from a perspective at or near ground level. The photographic imagery 124 can include digital images captured of the field area. The photographic imagery 124 can depict vegetation at various stages of the growing season to assist with geospatial allocation of crop yield across the field area by the improved yield map generator 100.

[0030] The one or more data types 120 can include LIDAR data 126 (e.g., LIDAR images) associated with the field area. The LIDAR data 126 can provide depth information associated with different geospatial points in the field area based on laser range sensing measurements. The depth information can be indicative of crop height, which can provide a measure of crop vigor and other crop health. The LIDAR data 126 can be used to determine a geospatial allocation of crop yield across the field area by the improved yield map generator 100 by providing a metric indicative of crop growth height.

[0031] The one or more data types 120 can include stand count data 128. Stand count data 128 can provide a measure of the number of plants that emerge from seeds in a given area. The stand count data 128 can provide stand count values for different geospatial areas of the field area. The stand count data 128 can be used to determine a geospatial allocation of crop yield across the field area by the improved yield map generator 100 based on actual number of plants that grow from planted seeds.

[0032] The one or more data types 120 can include other data 130 associated with vegetation that is geospatially allocated across the field area. As one example, the one or more data types 120 can include as-planted data indicative of the number of crop planted in discrete geospatial subsections of the field area. The as-planted data can be obtained from, for instance, planting equipment. As another example, the one or more data types 120 can include hyperspectral imagery captured of the field area. Other data further includes, but is not limited to, other agronomic field observations (e.g. disease ratings, arthropod damage ratings, etc.), physical properties of the field (e.g. soil data such as moisture

data, electrical conductivity, soil type, soil chemistry, ground elevation, etc.), and climatological elements (e.g., weather station data, forecasting data, etc.).

[0033] The improved yield map generator 100 can be configured to process the crop yield data 110 and the one or more data types 120 to generate the improved crop yield map 150 for the field area. More particularly, the improved yield map generator 100 can generate a crop yield distribution that provides more accurate crop yield values for discrete subsections of the field area. The crop yield distribution can be used to generate the improved crop yield map 150. The improved crop yield map 150 can be stored in one or more memory devices and/or provided for display on one or more display devices to provide graphical representation of the crop yield distribution.

[0034] FIG. 3 depicts an example improved crop yield map 150 generated according to example embodiments of the present disclosure. The improved crop yield map 150 is illustrated as displayed on a display device 325. The display device 325 can be a display associated with a computing device, such as a desktop, laptop, tablet, mobile phone, wearable device, display with one or more processors, special purpose computing device, or other device.

[0035] The improved crop yield map 150 includes a plurality of pixels 155. Each pixel 155 represents a discrete subsection of the improved crop yield map 150. In addition, each pixel 155 corresponds to a discrete subsection of the field area represented by the crop yield map. Each pixel 155 can have a pixel value associated with the color and/or intensity of the pixel. The pixel value of a pixel can be indicative of the crop yield value for the discrete subsection of the field area represented by the pixel.

[0036] Referring to FIG. 1, the yield map generator 100 can be configured to generate the improved crop yield map 150 using a model defining crop yield values for discrete subsections of the field area as a function of the crop yield and data associated with the discrete subsections from the one or more data types. The model can be an algorithm (e.g., a non-linear algorithm), statistical model, lookup table, correlation, function, or other suitable relationship.

[0037] For example, in one embodiment, the improved yield map generator 100 can be configured to allocate crop yield geospatially across the field area based on the pixel values of a VI image 122 collected of the field area when the crops are in a peak vegetative state. More particularly, the model can correlate the pixel values of pixels in the VI image 122 with a crop yield values for the discrete subsections of the field area corresponding to the pixels to determine a crop yield distribution for the field area.

[0038] For instance, FIG. 4 depicts an example VI image 122. The VI image 120 has a plurality of pixels 125. Each pixel 125 corresponds to a discrete subsection of the field area. Each pixel 125 has a pixel value indicative of the amount of vegetation in the discrete subsection.

[0039] The pixel value of pixel125 can be provided to a model 140. The model 140 can correlate the pixel value of the VI image as well as yield data generated by harvest equipment with a crop yield value for the discrete subsection corresponding to the pixel 125. A pixel value for pixel 155 of the crop yield map 150 corresponding to the discrete subsection can be determined based at least in part on the crop yield value.

[0040] In some embodiments, the model 140 can determine the crop yield value for the discrete subsection based on other data types such as photographic imagery 124, LIDAR data 126, stand count data 128, and other data types 130. For example in some embodiments, an initial crop yield value can be determined based at least in part on crop yield data from the harvest equipment. The initial crop yield value can be adjusted and/or refined based on the other data types (e.g., VI images) as the other data sources become available. Depending on the availability of other data types, the initial crop yield value can be adjusted based on stand count data to differentiate between target crops and weeds, LIDAR data to account for crop height, VI imagery collected at different times to account for different stages of growth, etc.

[0041] Example aspects of the present disclosure are discussed with reference to adjusting an initial crop yield value generated by harvest equipment based on a VI image 122 for purposes of illustration and discussion. Those of ordinary skill in the art, using the disclosures provided herein, will understand that the initial crop yield value can be determined based on other data sources, such as photographic imagery, LIDAR imagery, hyperspectral imagery, stand count data, etc.

[0042] In some embodiments, the model 140 can be configured to determine the crop yield distribution as a function of multiple inputs. Each input can be allocated a weight in the model. More particularly, the model can have weights associated with each of the one or more data types or other data sources that are used determining the crop yield distribution for the field area. Higher weights can be provided to certain data types (e.g., VI images) relative to the other data types (e.g. photographic imagery). A model based on multiple inputs can provide a more robust and accurate determination of crop yield distribution based on numerous factors.

[0043] FIG. 5 depicts a flow diagram of an example method (200) of generating an improved crop yield map according to example embodiments of the present disclosure. The method (200) can be implemented by one or more processors, such as one or more processors implanting an improved crop

yield generator 100 according to example aspects of the present disclosure. In addition, FIG. 5 depicts steps performed in a particular order for purposes of illustration and discussion. Those of ordinary skill in the art, using the disclosures provided herein, will understand that various steps of any of the methods disclosed here can be adapted, modified, rearranged or omitted in various ways without deviating from the scope of the present disclosure.

[0044] At (202), the method includes accessing crop yield data for a field area generated by, for instance, harvest equipment or other source. The data indicative of crop yield can be based at least in part on, for instance, total crop ingested from the field area by harvest equipment during harvest, crop yield distribution generated by the harvest equipment, etc. The crop yield data from the harvest equipment can be accessed from a memory device or can be input by a user via a suitable user interface and/or input device.

[0045] At (204), one or more data types can be accessed. The one or more data types can organize data associated with vegetation such that it is geospatially distributed across the field area. Example data types can include VI images, hyperspectral images, photographic images (e.g., aerial, satellite, ground-based), LIDAR data, stand count data, as-planted data, other agronomic field observations (e.g. disease ratings, arthropod damage ratings, etc.), physical properties of the field (e.g. SSURGO soil data (SSURGO: (Soil Survey Geographic database), elevation, etc.), climatological elements (e.g., weather station data, forecasting data, etc.).

[0046] At (206), the method can include accessing a crop yield distribution model. The model can define crop yield values for discrete subsections of the field area as a function of the data indicative of crop yield and the one or more data types. For instance, the geospatial allocation of data in the data types can be used to inform the crop yield distribution of the crop yield data generated by the harvest equipment across the field area. The model can be an algorithm (e.g., a non-linear algorithm), statistical model, lookup table, correlation, function, or other suitable relationship.

[0047] For instance, as discussed above, the model can correlate crop yield distribution as a function of multiple inputs. Each input can be allocated a weight in the model. More particularly, the model can have weights associated with each of the one or more data types or other data sources that are used determining the crop yield distribution for the field area. Higher weights can be provided to certain data types (e.g., VI images) relative to the other data types (e.g. photographic imagery). A model based on multiple inputs can provide a more robust and accurate determination of crop yield distribution based on numerous factors.

[0048] At (208), a crop yield distribution for the field area can be determined using the model. For instance, crop yield values for discrete subsections of the field area can be determined based at least in part on the model. As one example, a crop yield value for a discrete geospatial area can be determined based on a data point (e.g., pixel value, depth data, stand count data) for the discrete geospatial area.

[0049] Once the crop yield distribution has been determined, an improved crop yield map can be generated (210). The improved crop yield map can include a plurality of pixels. Each of the plurality of pixels can have a pixel value corresponding to the crop yield value for the discrete subsection of the field area corresponding to the pixel.

[0050] At (212), the improved crop yield map can be provided for display on one or more display devices. A user can analyze the improved crop yield map to assess various conditions of the field area and growing inputs for their effect on crop yield. In some embodiments, crop growing inputs (e.g., amount of watering, application of fungicides, etc.) can be modified to provide for improved crop yield based at least in part on the yield map as shown at (214).

[0051] FIG. 6 depicts an example computing system 300 that can be used to implement the methods and systems according to example aspects of the present disclosure. The system 300 can include one or more computing devices 310. The computing device(s) 310 can have one or more processors 312 and one or more memory devices 314. The computing device(s) 310 also include a network interface used to communicate with one or more remote devices 330 over a communication link 340. The network interface can include any suitable components for interfacing with one more networks, including for example, transmitters, receivers, ports, controllers, antennas, or other suitable components.

[0052] The one or more processors 312 can include one or more suitable processing devices, such as a microprocessor, microcontroller, integrated circuit, logic device, or other suitable processing device. The memory devices 314 can include one or more computer-readable media, including, but not limited to, non-transitory computer-readable media, RAM, ROM, hard drives, flash drives, or other memory devices. The memory devices 314 can store information accessible by the one or more processors 312, including computer-readable instructions 316 that can be executed by the one or more processors 312. The instructions 316 can be any set of instructions that when executed by the one or more processors 312 cause the one or more processors 312 to perform operations. The instructions 316 can be implemented in hardware and/or software. In some embodiments, the instructions 316 can be executed by the one or more processors 312 to implement the yield map generator 100 and/or the method of FIG. 5 according to example embodiments of the present disclosure.

[0053] Referring to FIG. 6, memory devices 314 can also include data 318 that can be retrieved, manipulated, created, or stored by the one or more processors 312. The data 318 can include, for instance, yield maps, data types, crop yield data from the harvest equipment, and other data. The data 318 can be stored in one or more databases. The one or more databases can be connected to the computing device(s) 310 by a high bandwidth LAN or WAN, or can also be connected to computing device(s) 310 through network 340. The one or more databases can be split up so that they are located in multiple locales.

[0054] The computing device(s) 310 can exchange data with one or more remote devices 330 over the communication link 340. Similar to the computing device(s) 310, the remote device(s) 330 can include one or more processors and memory devices. The communication link 340 can include any combination of wired and or wireless communication links. In some embodiments, the communication link 340 can include any type of communications network, such as a local area network (e.g. intranet), wide area network (e.g. Internet), cellular network, or some combination thereof. The communication link 340 can also include a direct connection between the computing device(s) 310 and the remote device(s) 330.

[0055] The computing device(s) 310 can include various input/output devices for providing and receiving information from a user, such as a touch screen, touch pad, data entry keys, speakers, and/or a microphone suitable for voice recognition. For instance, the computing device(s) 310 can have a display device 330 for presenting a crop yield map to a user.

[0056] Further examples of the present invention are:

[0057] An apparatus according to one or more aspects of any embodiments disclosed herein, or variants thereof.

[0058] A system according to one or more aspects of any of the embodiments disclosed herein, or variants thereof.

[0059] A method according to one or more aspects of any of the embodiments disclosed herein, or variants thereof.

[0060] A method for generating a yield map for a field area, comprising:
accessing, by one or more processors, data indicative of crop yield for a field area;

accessing, by the one or more processors, one or more data types associated with the field area, each of the data types providing a geospatial distribution of data associated with vegetation across the field area;

determining, by the one or more processors, a crop yield distribution for the field area based at least in part on the data indicative of crop yield and the one or more data types;

generating, by the one or more processors, a yield map for the field area based at least in part on the crop yield distribution.

[0061] The method as defined in [0060], wherein the method further comprises providing the yield map for display on one or more display devices.

[0062] The method as defined in [0060], wherein determining, by the one or more processors, a crop yield distribution for the field area comprises:

accessing, by the one or more processors, a model defining crop yield values for discrete subsections of the field area as a function of at least the one or more data types;

and

determining, by the one or more processors, the crop yield distribution based at least in part on the model.

[0063] The method as defined in any of [0060] to [0062], wherein the yield map comprises a plurality of pixels, the pixel value of each pixel being determined based at least in part on a crop yield value for the discrete subsections of the field area corresponding to the pixel.

[0064] The method as defined in any of [0060] to [0063], wherein the one or more data types comprise a vegetation index (VI) image of the field area.

[0065] The method as defined in any of [0060] to [0064], wherein determining, by the one or more processors, a crop yield distribution for the field area comprises determining, by the one or more processors, a crop yield value for discrete subsections of the field area based at least in part on a pixel value of a pixel corresponding to the discrete subsections in the VI image.

[0066] The method as defined in any of [0060] to [0065], wherein the one or more data types comprise a plurality of VI images, each of the VI images captured at a different time.

[0067] The method as defined in any of [0060] to [0066], wherein the one or more data types comprise stand count data for the field area.

[0068] The method as defined in any of [0060] to [0067], wherein the one or more data types comprise one or more LID AR images for the field area.

[0069] The method as defined in any of [0060] to [0068], wherein the one or more data types comprise one or more satellite images, aerial images, or ground based images of the field area.

[0070] The method as defined in any of [0060] to [0069], wherein the one or more data types comprise as-planted values obtained from planting equipment.

[0071] The method as defined in any of [0060] to [0070], wherein the one or more data types comprise one or more hyperspectral images obtained of the field area.

[0072] The method as defined in any of [0060] to [0070], wherein the data indicative of crop yield is generated by harvesting equipment for the field area.

[0073] A method for generating a yield map for a field area, comprising:

accessing, by one or more processors, data indicative of crop yield for a field area;

accessing, by the one or more processors, a vegetation index (VI) image of the field area, the VI image comprising a plurality of pixels, each pixel in the VI image having a pixel value associated with an amount of vegetation in a discrete subsections of the field area corresponding to the pixel;

determining, by the one or more processors, a crop yield distribution for the field area, the crop yield distribution comprising a crop yield value for each of a plurality of discrete subsections of the field area determined based at least in part on the data indicative of crop yield and the pixel value of the pixel in the VI image corresponding to the discrete subsections in the field area;

generating, by the one or more processors, a yield map for the area based at least in part on the crop yield distribution, the yield map comprising a plurality of pixels, the pixel value of each pixel in the yield map being determined based at least in part on a crop yield value for the discrete subsections of the field area corresponding to the pixel.

[0074] The method as defined in any of [0060] to [0073], wherein the method further comprises:

refining, by the one or more processors, the crop yield distribution based at least in part on one or more data types.

[0074] The method as defined in any of [0060] to [0073], wherein the one or more data types comprise one or more VI images captured at different time periods, one or more LIDAR images, one

or more satellite images, aerial images, or ground based images of the field area, stand count data, as planted values obtained from planting equipment, or one or more hyperspectral images.

[0075] A system comprising:

one or more display devices;

one or more processors; and

one or more memory devices, the one or more memory devices storing computer-readable instruction that when executed by the one or more processors cause the one or more processors to perform operations, the operations comprising one or more aspects of any of the methods of the preceding claims.

[0076] One or more tangible, non-transitory computer-readable media storing computer-readable instructions that when executed by one or more processors cause the one or more processors to perform operations, the operations comprising one or more aspects of any of the methods of the preceding claims.

[0077] The technology discussed herein makes reference to computing devices, databases, software applications, and other computer-based systems, as well as actions taken and information sent to and from such systems. One of ordinary skill in the art will recognize that the inherent flexibility of computer-based systems allows for a great variety of possible configurations, combinations, and divisions of tasks and functionality between and among components. For instance, processes discussed herein may be implemented using a single computing device or multiple computing devices working in combination. Databases and applications may be implemented on a single system or distributed across multiple systems. Distributed components may operate sequentially or in parallel.

[0078] While the present subject matter has been described in detail with respect to specific example embodiments thereof, it will be appreciated that those skilled in the art, upon attaining an understanding of the foregoing may readily produce alterations to, variations of, and equivalents to such embodiments. Accordingly, the scope of the present disclosure is by way of example rather than by way of limitation, and the subject disclosure does not preclude inclusion of such modifications, variations and/or additions to the present subject matter as would be readily apparent to one of ordinary skill in the art.

CLAIMS

1. A system (300) for generating a yield map (150) for a field area, the system (300) comprising:
 - one or more display devices (325);
 - one or more processors (312); and
 - one or more memory devices (314), the one or more memory devices (314) storing computer-readable instructions (316) that when executed by the one or more processors (312) cause the one or more processors (312) to perform operations, the operations comprising:
 - accessing, by one or more processors (312), data indicative of crop yield (110) for a field area;
 - accessing, by the one or more processors (312), a vegetation index (VI) image (122) of the field area, the VI image (122) comprising a plurality of pixels (125), each pixel (125) in the VI image (122) having a pixel value associated with an amount of vegetation in a discrete subsection of the field area corresponding to the pixel (125);
 - determining, by the one or more processors (312), a crop yield distribution for the field area, the crop yield distribution comprising a crop yield value for each of a plurality of discrete subsections of the field area determined based at least in part on the data indicative of crop yield (310) and the pixel value of the pixel (125) in the VI image (122) corresponding to the discrete subsections in the field area;
 - generating, by the one or more processors (312), a yield map (150) for the area based at least in part on the crop yield distribution, the yield map (150) comprising a plurality of pixels (155), the pixel value of each pixel (155) in the yield map (150) being determined based at least in part on a crop yield value for the discrete subsections of the field area corresponding to the pixel (155).
2. The system (300) of claim 1, wherein the operations further comprise refining, by the one or more processors (312), the crop yield distribution based at least in part on one or more data types (120).
3. The system (300) of claim 1 or 2, wherein the operations further comprise providing, by the one or more processors (312), the yield map (150) for display on the one or more display devices (325).
4. The system (300) of claim 2 or 3, wherein the one or more data types (120) comprise one or more VI images (122) captured at different time periods, one or more LIDAR images (126), one or more satellite images (124), aerial images (124), or ground based images (124) of the field

area, stand count data (128), as-planted values obtained from planting equipment (130), or one or more hyperspectral images (130).

5. A method (200) for generating a yield map (150) for a field area, comprising:
(202) accessing, by one or more processors (312), data indicative of crop yield (110) for a field area;
(204) accessing, by the one or more processors (312), one or more data types (120) associated with the field area, each of the data types (120) providing a geospatial distribution of data associated with vegetation across the field area;
(208) determining, by the one or more processors (312), a crop yield distribution for the field area based at least in part on the data indicative of crop yield (110) and the one or more data types (120);
(210) generating, by the one or more processors (312), a yield map (150) for the field area based at least in part on the crop yield distribution.

6. The method (200) of claim 5, further comprising:
(212) providing, by the one or more processors (312), the yield map (150) for display on one or more display devices (325).

7. The method (200) of claim 5 or 6, wherein (208) determining, by the one or more processors (312), a crop yield distribution for the field area comprises:
(206) accessing, by the one or more processors (312), a model (140) defining crop yield values for discrete subsections of the field area as a function of at least the one or more data types (120); and
(208) determining, by the one or more processors (312), the crop yield distribution based at least in part on the model (140).

8. The method (200) of any one of claims 5 to 7, wherein the yield map (150) comprises a plurality of pixels (155), the pixel value of each pixel (155) being determined based at least in part on a crop yield value for the discrete subsections of the field area corresponding to the pixel (155).

9. The method (200) of any one of claims 5 to 8, wherein the one or more data types (120) comprise a vegetation index (VI) image (122) of the field area.

10. The method (200) of claim 9, wherein (208) determining, by the one or more processors (312), a crop yield distribution for the field area comprises determining, by the one or

more processors (312), a crop yield value for discrete subsections of the field area based at least in part on a pixel value of a pixel (125) corresponding to the discrete subsections in the VI image (122).

11. The method (200) of any one of claims 5 to 10, wherein the one or more data types (120) comprise a plurality of VI images (122), each of the VI images (122) captured at a different time.

12. The method (200) of any one of claims 5 to 11, wherein the one or more data types (120) comprise as-planted values (130) obtained from planting equipment and/or stand count data (128) for the field area.

13. The method (200) of any one of claims 5 to , wherein the one or more data types (120) comprise one or more LIDAR images (126) associated with the field area and/or one or more hyperspectral images (130) obtained of the field area..

14. The method (200) of any one of claims 5 to 13, wherein the one or more data types (120) comprise one or more satellite images (124), aerial images (124), or ground based images (124) of the field area.

15. A computer program element for controlling a system according to any of claims 1 to 4, which when executed by a processor is configured to carry out the method of any of claims 5 to 14.

16. A computer readable medium having stored the program element of claim 15.

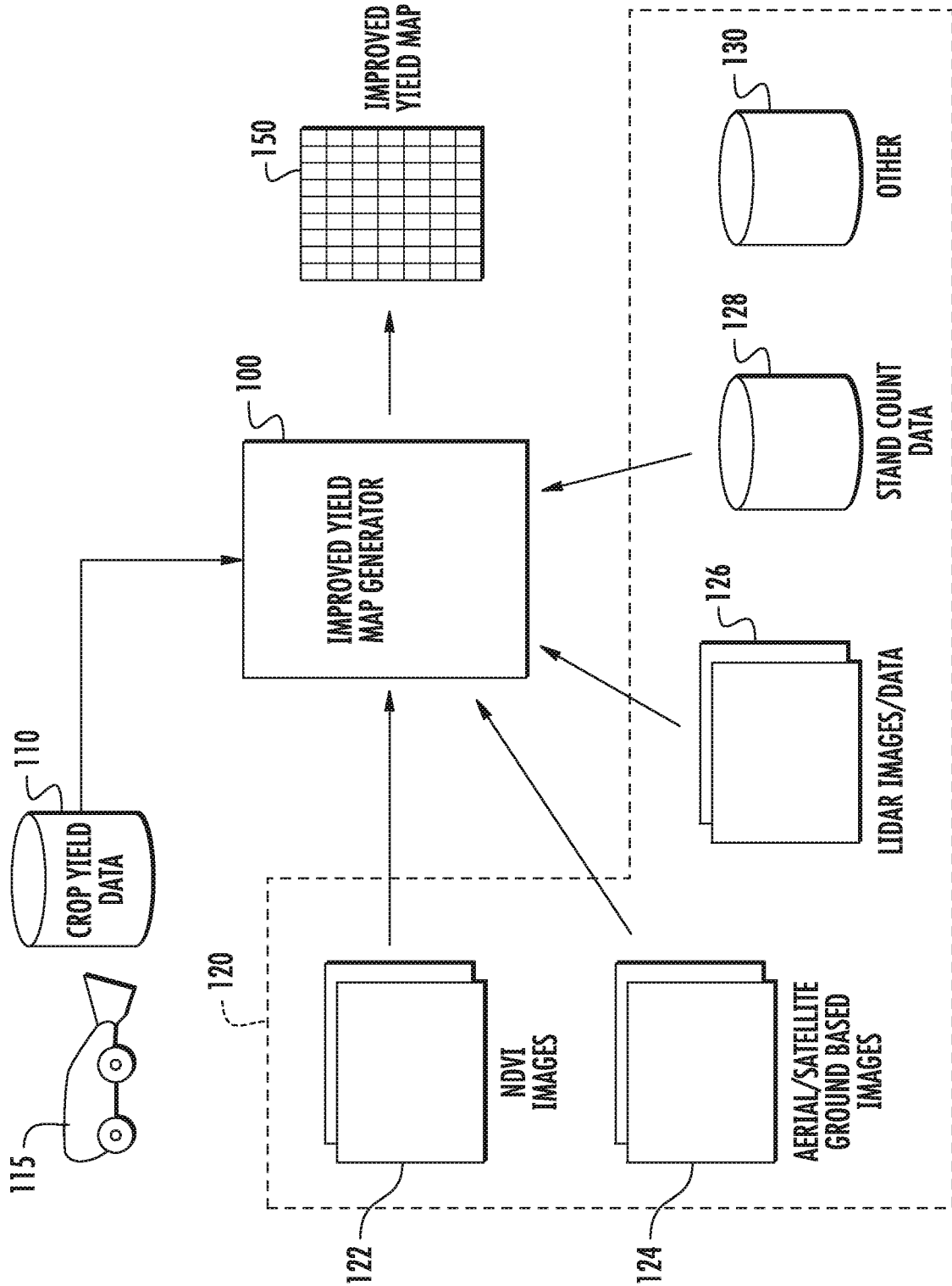


FIG. 1

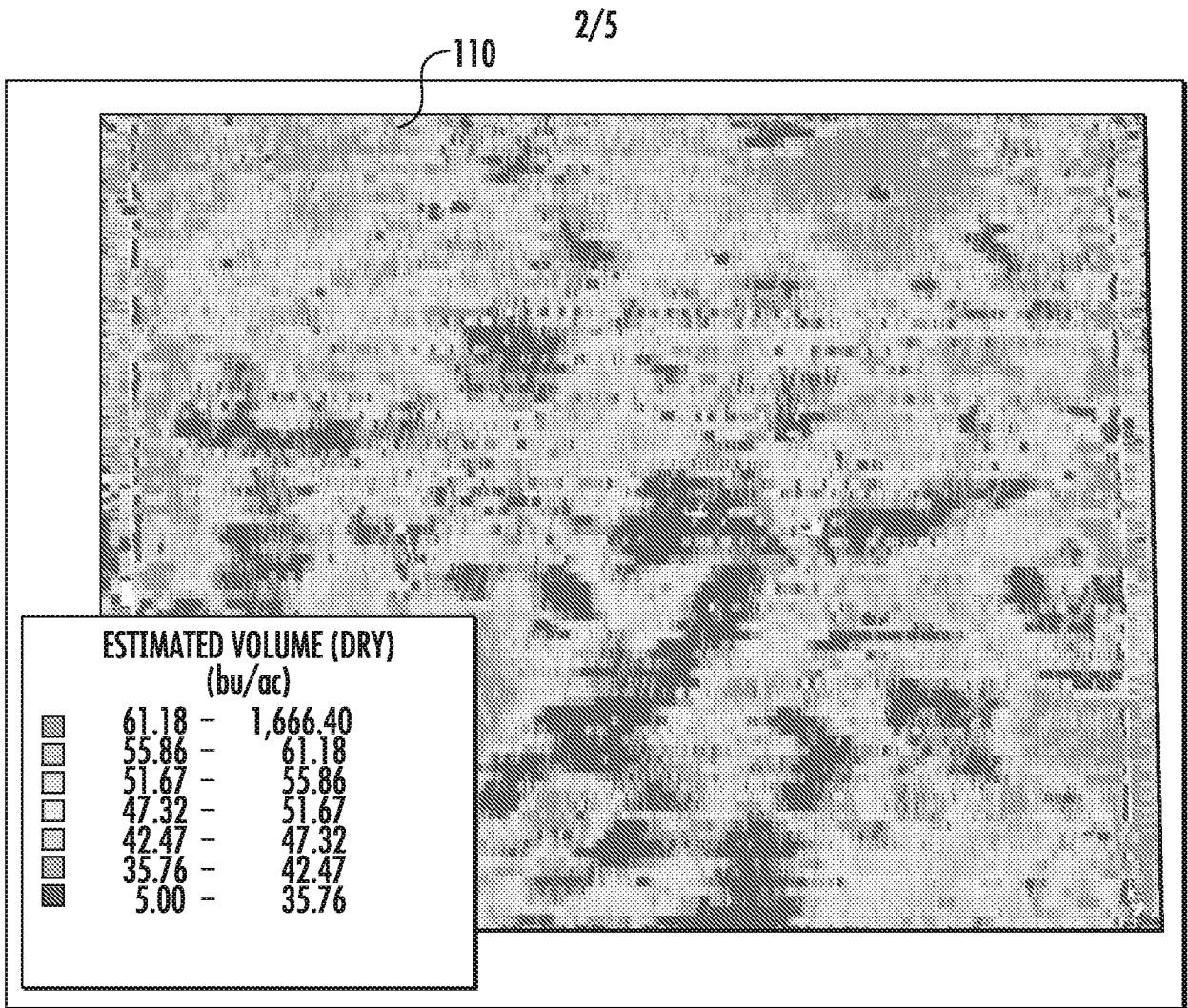
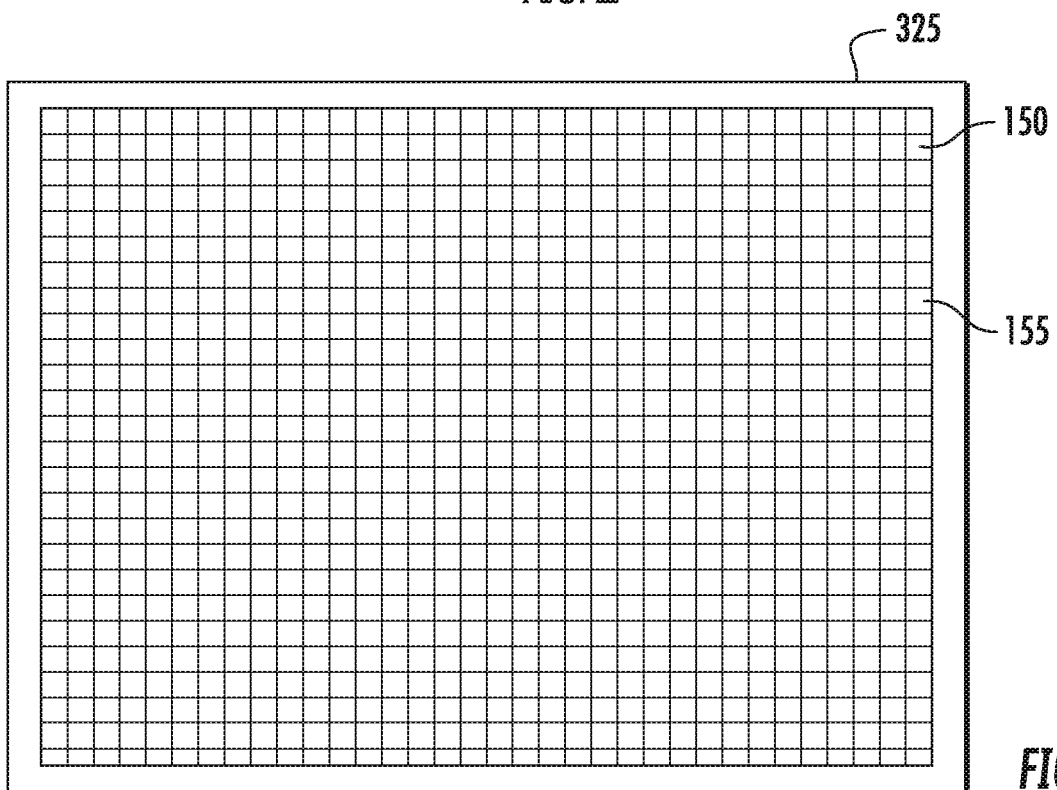


FIG. 2



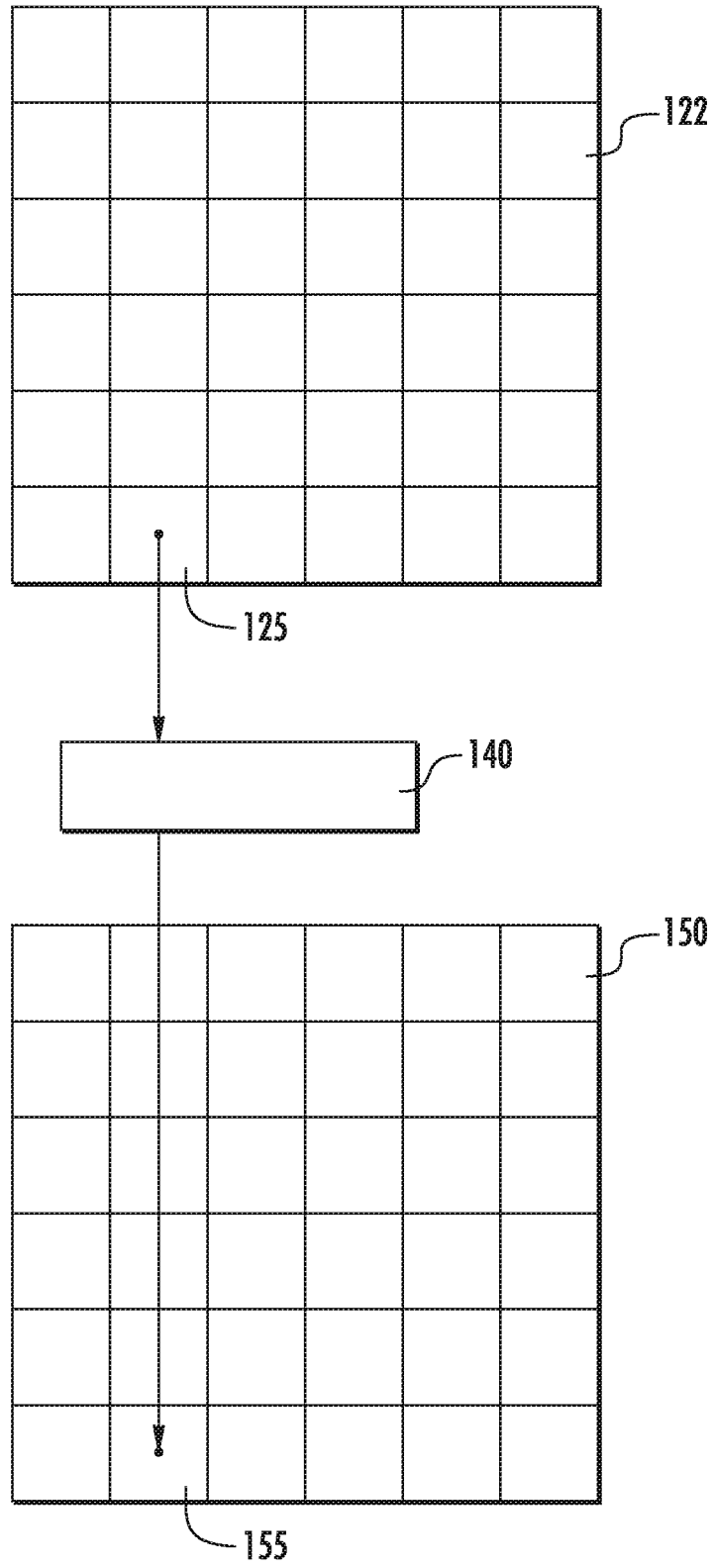


FIG. 4

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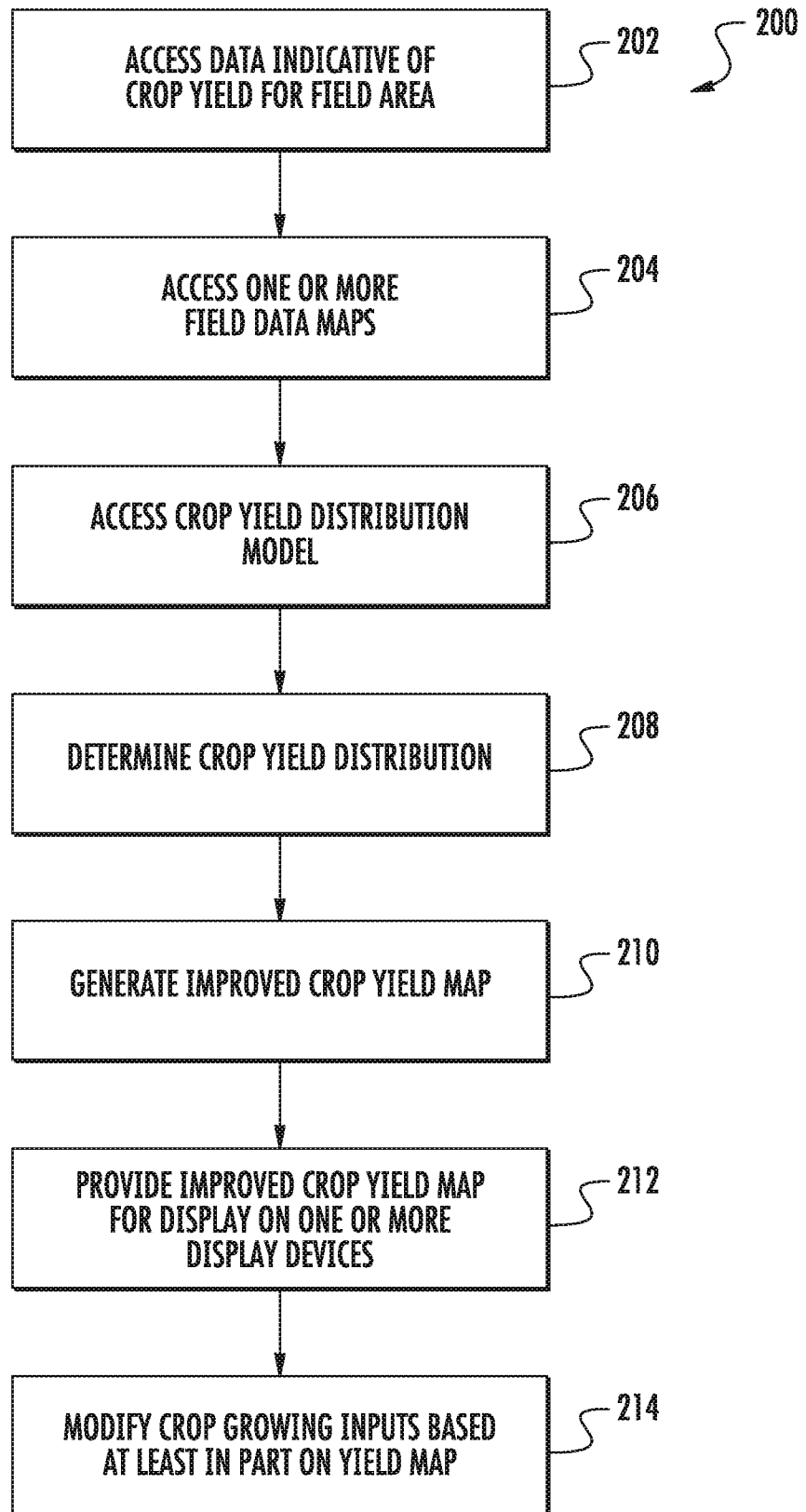


FIG. 5

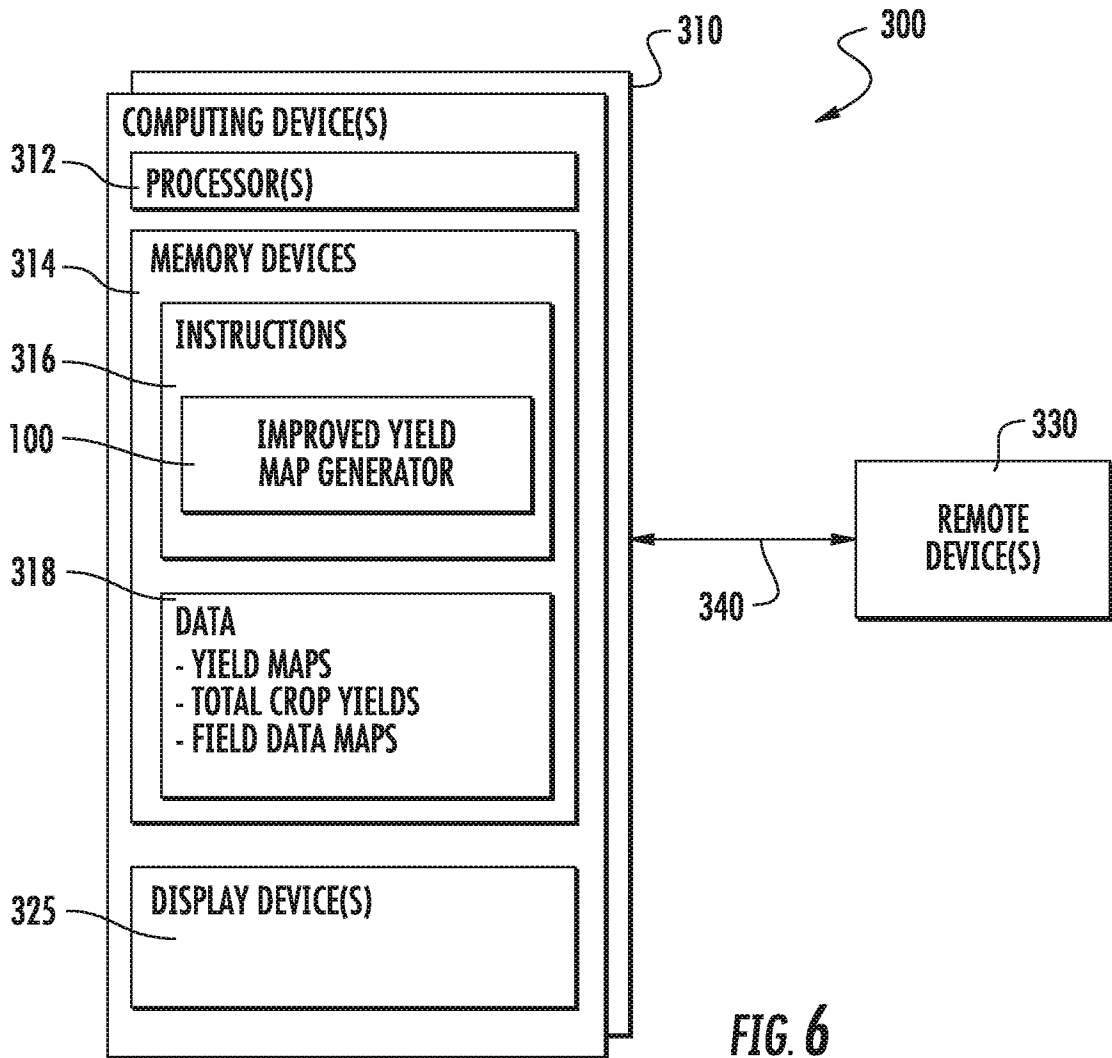


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2017/059146

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06Q10/04 G06Q50/02
ADD.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
G06Q
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2016/073573 A1 (ETHINGTON JAMES [US] ET AL) 17 March 2016 (2016-03-17) paragraph [0028] - paragraph [0029] paragraph [0086] - paragraph [0090]; figures 1,12,15 abstract	1-16
X	US 2016/180473 A1 (GROENEVELD DAVID P [US]) 23 June 2016 (2016-06-23) abstract paragraph [0065] - paragraph [0066]; figures 1,2 paragraph [0151] - paragraph [0154] ----- -/--	1-16

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 21 December 2017	Date of mailing of the international search report 19/01/2018
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Anastasov, Yuliyana

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2017/059146

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2015/116330 A1 (CHIOCCO GREGORY D [US] ET AL) 30 April 2015 (2015-04-30) abstract paragraph [0021] - paragraph [0024]; figure 1 paragraph [0031] - paragraph [0040]; figures 5-8 -----	1-16

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2017/059146

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		AR 103494 A1	17-05-2017
		AU 2015315001 A1	27-04-2017
		CA 2960424 A1	17-03-2016
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		EP 3192021 A1	19-07-2017
		US 2016073573 A1	17-03-2016
		WO 2016040678 A1	17-03-2016

US 2016180473	A1	23-06-2016	NONE

US 2015116330	A1	30-04-2015	NONE
