International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 07, July 2017
www.ijarse.com

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

Potential Technology of Precision Agriculture: A review

Jaya Sinha[1], S.K. Maurya[2]

[1,2]Division of Agricultural Engineering, Indian Agricultural Research Institute, New Delhi, (India)

Population explosion and its need to provide food for humankind and to increase the quality and quantity of food products in order to ensure food security with regard to its managerial, environmental, and developmental aspects has led to the use of new agriculture methods and technologies. Using modern technologies under the title of precision agriculture have been proposed as ways to achieve food security. Precision agriculture is a strategy of managing small areas within fields instead of managing whole fields as a single unit. Precision farming is for site specific management of inputs with variable rate technology for optimization of profit, sustainability and reduces the environmental effect. Precision agriculture defined as information and technology based farm management system to identify, analyze and manage variability within fields for optimum profitability, sustainability and protection of the land resource. The goal is not to obtain the same yield everywhere, but rather to manage and distribute inputs on a site specific basis to maximize long term cost/benefit. Tools of precision agriculture are GIS, GPS, Yield monitoring, VRA and remote sensing.GPS provides continuous position information in real time, while in motion. Having precise location information at any time allows soil and crop measurements to be mapped. Global positioning systems are widely available in the agricultural community. Farm uses include: mapping yields, variable rate planting, variable rate lime and fertilizer application, field mapping for records and insurance purposes and parallel swathing. Geographic information systems (GIS) are computer hardware and software that use feature attributes and location data to produce maps. An important function of an agricultural GIS is to store layers of information, such as yields, yield maps, soil survey maps, remotely sensed data, crop scouting reports and soil nutrient levels. Remote sensing technology is a very useful tool for gathering much information simultaneously. Data sensors can simply be hand-held devices, mounted on aircraft or satellite-based. Plant stress related to moisture, nutrients, compaction, crop diseases and other plant health concerns are often easily detected in overhead images. Remote sensing can reveal in-season variability that affects crop yield, and can be timely enough to make management decisions that improve profitability for the current crop. Variable rate application of cropping inputs such as seed, fertilizers and pesticides etc. is one management strategy to address the variability that exists within agricultural fields. Precision agriculture gives farmers the ability to use crop inputs more effectively including fertilizers, pesticides, tillage and irrigation water. More effective use of inputs means greater crop yield and/or quality, without polluting the environment. Ultimately, Precision agriculture can address both economic and environmental issues that surround production agriculture today.

Keywords: Precision agriculture, remote sensing, GIS, GPS.

I. INTRODUCTION

Population explosion and the need to provide food for humankind and to increase the quality and quantity of food products in order to ensure food security with regard to its managerial, environmental, and developmental aspects has led to the use of new agriculture methods and technologies The phenomenal increase in population of both man and animal in the last century and fast growing industrialization and urbanization in last few decades have overstrained the natural resource base, which are getting degraded much faster than ever before. Thus the need to innovate agriculture and produce enough to meet the needs of burgeoning population. To meet the forthcoming demand and challenge we have to divert towards new technologies, for revolutionizing our agricultural productivity. To enhance growth rate in productivity, site specific management or precision farming technology has to be developed. Precision Farming is generally defined as information and technology based farm management system to identify, analyze and manage variability within fields for optimum profitability, sustainability and protection of the land resource. In this mode of farming, new information technologies can be used to make better decisions about many aspects of crop production. Precision farming involves looking at the increased efficiencies that can be realized by understanding and dealing with the natural variability found within a field. The goal is not to obtain the same yield everywhere, but rather to manage and distribute inputs on a site specific basis to maximize long term cost/benefit. Applying the same inputs across the entire field may no longer be the best choice. Precision farming is helping many farmers worldwide to maximize the effectiveness of crop inputs. Precision agriculture often has been defined by the technologies that enable it and is often referred to as GPS (Global Positioning System) agriculture or variable-rate farming. Precision farming distinguishes itself from traditional agriculture by its level of management wherein instead of managing whole fields as a single unit, management is customized for small areas *within* fields. This increased level of management emphasizes the need for sound agronomic practices. Before shifting to precision agriculture management, it is essential to have a good farm management system in place. Precision agriculture is a systems approach to farming. To be viable, both economic and environmental benefits must be considered, as well as the practical questions of field-level management and technologies needed

II. THE NEED FOR PRECISION FARMING

The potential of precision farming for economical and environmental benefits could be visualized through reduced use of water, fertilizers, herbicides and pesticides besides the farm equipments. Instead of managing an entire field based upon some hypothetical average conditions, which may not exist anywhere in the field, precision farming approaches recognizes site specific differences within fields and adjust management action accordingly. Farmers usually are aware that their fields have variable yields across the landscape. These variations can be traced to management practices, soil properties and/or environmental characteristics. Soil characteristics that affect yields include texture, structure, moisture, organic matter, nutrient status and landscape position. Environmental characteristics include weather, weeds, insects and diseases.

III. TECHNOLOGY FOR PRECISION FARMING

Spatially variable crop production to a large extent is technology-driven The new tools applicable to this PF are the advances in electronics and computers such as RS, GPS and GIS. Technologies used in PF cover three aspects such as data collection, analysis or processing of recorded information and recommendations based on available information.

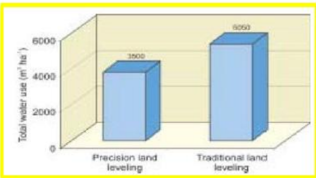
International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 07, July 2017
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

III. GLOBAL POSITIONING SYSTEM (GPS)

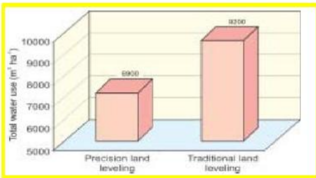
The generation of maps for crop and soil properties is the most important and first step in PF. These maps will measure spatial variability and provide the basis for controlling spatial variability. Data collection occurs both before and during crop production and is enhanced by collecting precise location coordinates using the GPS. The data collection technologies are grid soil sampling, yield monitoring, RS and crop scouting (Heimlich, 1998). During crop production, the data are collected through sensing instruments such as soil probes, electrical conductivity and soil nutrient status.

Optical scanners are used to detect soil organic matter and to recognize weeds9. Then these data generated through mapping are recorded and stored in a computer system for future action and generated maps used for acquisition of information and for making strategic decisions to control variability. Mapping can be done by RS, GIS and manually during field operations. Laser levelling of agricultural land is a recent resource conservation technology in India. Its results are quite encouraging. Precision land levelling may increase the water application efficiency and consequently increase the yield of crops .

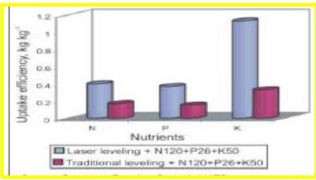
Kaur et.al had studied on Enhancing Water Productivity through On-farm Resource Conservation Technology in Punjab Agriculture. In this paper, economic and environmental benefits have been estimated from the adoption of laser level technology using farm-level information from the Moga district of Punjab. The results have shown that with laser levelling farmers could save irrigation water and energy by 24 percent and obtained 4.25 per cent higher yields. The irrigation cost reduced by 44 per cent over the conventional practice, and water productivity improved by 39 per cent. The returns over variable cost were higher by 1000 per hectare with application of this technology.



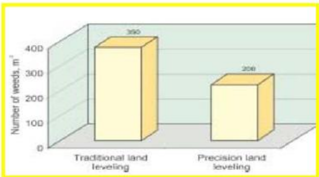
Total water use (m^3ha^{-1}) in wheat under precision and traditional land leveling



Effect of land leveling on water use (m^3ha^{-1}) of rice in a sandy loam soil



Effect of precision land leveling on uptake efficiency of N, P and K in rice



Total no. of weeds (m^2) in wheat at 30 days after sowing under precision leveled and traditionally level field

Global positioning systems (GPS) are widely available in the agricultural community. Farm uses include:

• Mapping yields (GPS + combine yield monitor)

• Variable rate planting (GPS + variable rate planting system),

• Variable rate lime and fertilizer application (GPS + variable rate controller),

• Field mapping for records and insurance purposes (GPS + mapping software), and

• Parallel swathing (GPS + navigation tool).

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

GPS and associated navigation systems are used in many types of agricultural operations. These systems are useful particularly in applying pesticides, lime, and fertilizers and in tracking wide planters/drills or large grain-harvesting platforms. GPS navigation tools can replace foam for sprayers and planter/drill-disk markers for making parallel swaths across a field. Navigation systems help operators reduce skips and overlaps, especially when using methods that rely on visual estimation of swath distance and/or counting rows. This technology reduces the chance of misapplication of agrochemicals and has the potential to safeguard water quality. Also, GPS navigation can be used to keep implements in the same traffic pattern year-to-year (controlled traffic), thus minimizing adverse effects of implement traffic.

A sloped terrain makes control of vehicle dynamics challenging. Roll (tilt from side-to-side), pitch (movement from front-to-rear), and yaw (rotation around the vertical axis) alter the GPS antenna location with the projected center of the vehicle . For example, when driving across a slope, the horizontal position of the GPS antenna is downhill with respect of the center of the vehicle, and the guidance will be in error down the slope

IV. ADVANTAGE

- GPS is more reliable and more accurate
- GPS provides effective guidance over growing crops and allows operation when visibility is poor
- Less affected by weather
- Reduces operator fatigue and eye strain
- Reduces pesticide use by reducing overlaps

V. GEOGRAPHIC INFORMATION SYSTEM (GIS)

In the recent times, use of GIS in agriculture has increased because of misuse of resources like land, water, etc. GIS is the principal technology used to integrate spatial data coming from various sources in a computer. GIS techniques deal with the management of spatial information of soil properties, cropping systems, pest infestations and weather conditions. This is primarily an intermediate step because it combines the data collected at different times based on sampling regimes, to develop the subsequent decision technologies such as process models, expert systems, etc. The manipulation of spatial information had begun in the 1960s, but has grown rapidly with the development of computer-aided techniques. In the new millennium, GIS-aided techniques are indeed needed for sustainable food production and resource utilization, without further depletion of the environment.GIS technology will help the farmers and scientists in decision making, as precise information on field will be readily available. GIS techniques make weed control, pest control and fertilizer application site-specific, precise and effective; it would also be very useful for drought monitoring, yield estimation, pest infestation monitoring and forecasting. GIS coupled with GPS, microcomputers, RS and sensors is used for soil mapping, crop stress, yield mapping, estimation of soil organic matter and available nutrients. In combination these technologies have brought out rapid changes in data collection, storing, processing, analysis and developing models for input parameters.

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

VI. YIELD MONITORING AND MAPPING

In highly mechanized systems, grain yield monitors continuously measure and record the flow of grain in the clean-grain elevator of a combine. When linked with a GPS receiver, yield monitors can provide data necessary for yield maps.Yield measurements are essential for making sound management decisions. However, soil,landscape and other environmental factors should also be weighed when interpreting a yield map. Used properly, yield information provides important feedback in determining theeffects of managed inputs such as fertilizer amendments, seed, pesticides and cultural practices including tillage and irrigation. Since yield measurements from a single year may be heavily influenced by weather, it is always advisable to examine yield data of several years including data from extreme weather years that helps in pinpointing whether theobserved yields are due to management or climate-induced.

VII. REMOTE SENSING AND GIS IN WATER RESOURCES

Remote sensing is an excellent tool for hydrologists and geologists in understanding the "perplexing" problems of groundwater exploration. In recent years, Satellite remote sensing data has been widely used in locating groundwater potential zones. Satellite remote sensing data is not only costeffective, reliable and timely but also meets the essential requirements of data in the geographical Information System (GIS) domain, which are "current, sufficiently accurate, comprehensive and available to a uniform standard". Integration of the information on the controlling parameters is best achieved through GIS which is an effective tool for storage, management and retrieval of spatial and non-spatial data as well as for integration and analysis of this information for meaningful solutions. The technique of integration of remote sensing and GIS has proved to be extremely useful for groundwater studies.

Satellite remote sensing provides an opportunity for better observation and more systematic analysis of various geomorphic units/landforms/lineaments due to the synoptic and multi-spectral coverage of a terrain. Investigation of remotely sensed data for d rainage map, geological, geomorphological and lineament characteristics of terrain in an integrated way facilities effective evaluation of ground water potential zones. Similar attempts have been made in the generation of different thematic maps for the delineation of groundwater potential zones in different parts of the country. Analysis of remotely sensed data along with Survey of India Topographical and collateral information with necessary ground check helps in generating the base line information for ground water targeting.

VIII. ROLE OF REMOTE SENSING AND GIS

- Spatial, spectral and temporal availability of data coverage.
- Inaccessible areas can be covered.
- Efficient and economic technology for broad range.
- Assessing, monitoring and conserving groundwater resources.
- Consistent, routine and global measurement.
- GIS is powerful environment for real time database development.

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

IX. REMOTE SENSING AND GIS FOR GROUNDWATER ZONING

- Different hydrogeological themes can be used to identify the groundwater potential zone.
- Geology, geomorphology, soil, lineament density, rainfall and land use/land cover maps are used to indicate the occurrence of groundwater.
- High resolution satellite imageries are widely used.
- RS data with topographical sheets and collateral information with ground truth verifications help in generating baseline information for groundwater targeting.
- Overlay analysis by GIS technique is used to delineate the groundwater potential zone.

X. MATERIAL AND METHODS

a) Data Required

- Topographic maps
- Land use and land cover map
- Lineament map
- Drainage map
- Soil information
- Slope
- Rainfall data

b) Data Collection

- Landsat TM data, IRS-IC, LISS-III Digital data images and SRTM (DEM) have been.
- Survey of India (SOI) Toposheet at 1:50,000 scales have also been used.
- Secondary data on hydrology and ground water well data have been collected from Central
- Ground Water Board and from the field to support mapping.
- Geographic Information System and Image Processing (ARC VIEW, ARC GIS and ERDAS IMAGINE software) have been used for analysis and mapping of the individual layers as described in the flow chart.

c) Satellite Data Analysis

The main task in this stage was to carry out analysis and interpretation of satellite data, in order to produce thematic maps, such as lithology, structural and land use maps. Initially, all the images were rectified using the SOI Toposheet. This was followed by processing the digital images using the various processing techniques, viz., enhancement, filtering, classification and other GIS processes. Subsequently, selective field checking was carried out.

d) Spatial Database Building

The main task was to bring all the appropriate data and other collateral data together into a GIS database. All the available spatial data was assembled in the digital form and properly registered to make sure the spatial component overlaps correctly. Digitizing of all the maps and collateral data, followed by transformation and conversion from raster to vector, gridding, buffer analysis, box calculation, interpolation and other GIS processes were undertaken. This stage produced derived layers such as Geomorphology, Drainage, Drainage density, Lithology, Lineament density, Surface water body, Slope etc.

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

e) Spatial Data Analysis

In this stage, the entire input layers derived from stage 2 and 3 were processed to extract the spatial features which are relevant to the groundwater zone. This stage includes various analyses such as table analysis and classification, polygon classification and weight calculation. Polygons in each of the thematic layers were categorized depending on the recharge characteristics, and suitable weightage have been assigned to them (table 1). The values of the weightage are based on.

XI. COMPONENTS OF YIELD MONITOR

The yield monitoring system was based on the principle of volumetric flow measurement for which an optical sensor was used. The other components of yield monitor system were moisture sensor, GPS (for position and speed), field computer with touch screen monitor and data-logging system. GPS was set up in cabin of the combine and used to indicate location of harvested patch in terms of longitude, latitude and altitude of the field. Field computer and junction box were installed in the front of driver seat. Optical sensor was fitted on the upper part of the clean grain conveyor, just before the grain was dropped in grain tank. Moisture sensor was installed for sensing the grain moisture from lower side of the grain conveyer

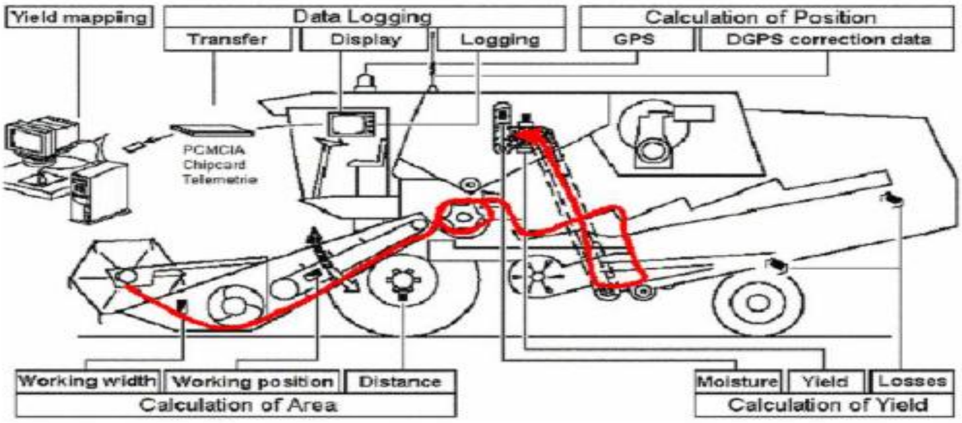
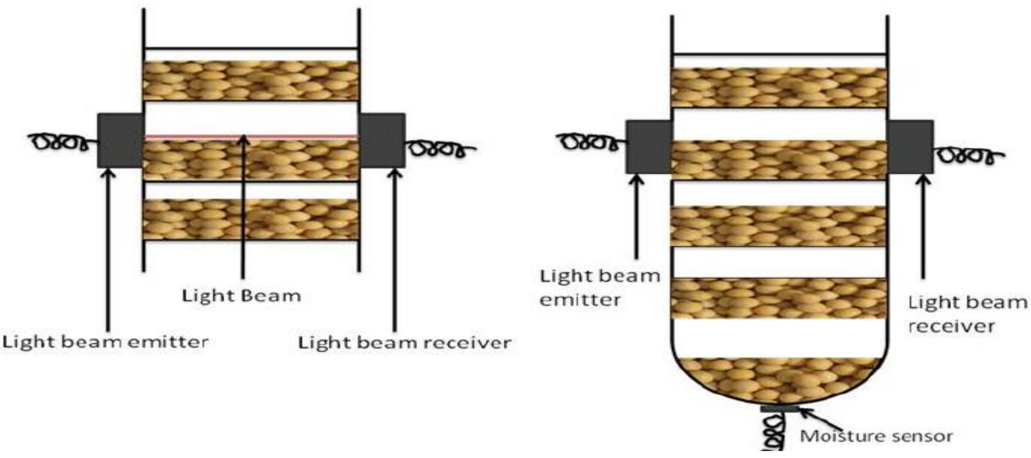


Fig. 2: Yield Monitors on Grain Combines



IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

Fig. 3: Position of Yield sensor and Moisture sensor on grain elevator

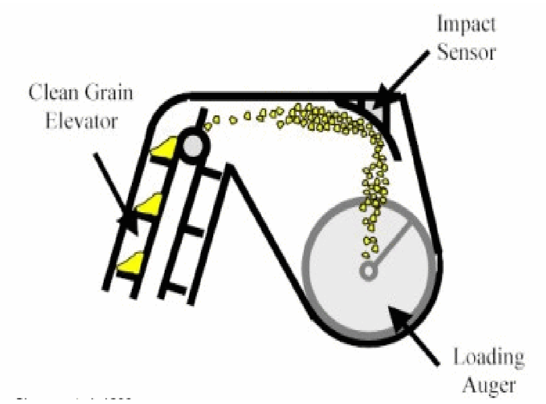


Fig. 4: Mass Flow Sensor on yield monitoring system

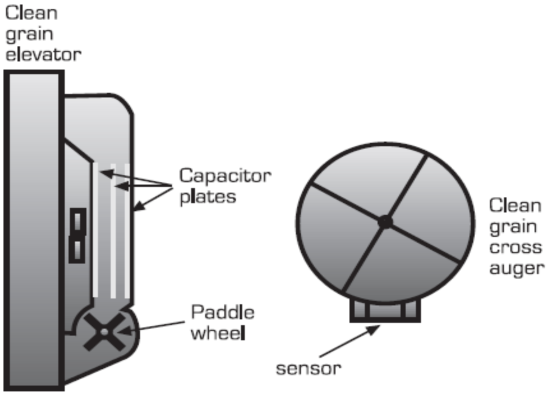


Fig. 5: Moisture Sensor on yield monitoring system

XII. GRAIN YIELD SENSOR

Grain yield was measured by an optical sensor (non contact type) installed near the top of the clean grain elevator (Figure 2). The transmitter and receiver together with lens and lens holders were each secured to a hinged mounting bracket which was riveted to the elevator housing. Sensor operation is indicated by a blinking of green colour LED light on the distal end of sensor. An infrared (non-visible) light beam transmitted across the elevator paddles from one side to the other. A receiver detects the light beam broken or intact. As each paddle passes the sensor the beam is broken. More the grain on the paddle, the longer time the beam is broken.

XIII. MOISTURE SENSOR

Measuring the moisture content of the grain is also an important element of yield monitoring. Moisture sensor is always mounted on the side of the clean grain elevator. Moisture sensor for yield monitor was installed on the lower side of grain elevator, as shown in Figure 2. Moisture content was determined by sensing the dielectric properties of the harvested grain. The level of moisture within the grain affects the grain's capacitance which is ability to store an electrical charge and it is sensed by confining a predetermined volume of grain between two conductive metal surfaces.

XIV. VARIABLE RATE APPLICATION

Method of applying varying rates of inputs in appropriate zones throughout a field .Application of variable rate technology in crop production can include fertilizer (Micro and Macro nutrients),pesticides (Herbicide, insecticides and fungicides) ,manure ,seeding tillage (vary depth based on level of compaction) ,Irrigation .

XV. COMPONENTS OF VARIABLE RATE APPLICATOR

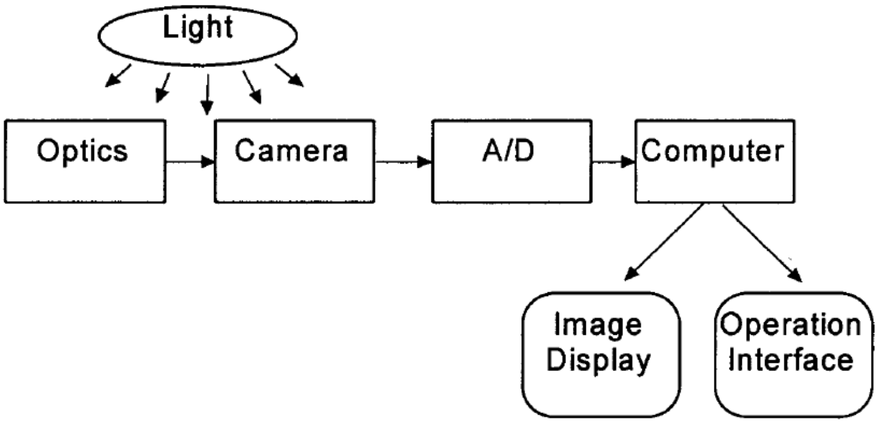


Fig. 6: Components of a machine vision system

15.1 Cameras

An imaging camera receives light from surface and converts the light into electrical signal using a charge-coupled device (CCD). The CCD Cameras are becoming smaller, lighter and less expensive. Images are sharper and more accurate, and the new dual output cameras produce images twice as fast as previous models. A new generation of CCD colour cameras adds another dimension to machine vision by enabling systems to better detect and discriminate between objects, remove backgrounds and perform spectral analysis.

15.2 Lighting system

The light range can be in the UV(200-400nm),VIS(400-700nm), or NIR (700-2500nm). When radiation from the lighting system illuminates an object it is transmitted through, absorbed and reflected. These phenomena are referred as optical properties. The importance of proper illumination for a machine vision system cannot be overstated. With well-chosen lighting system, the incident light will present the objects or scenes in the optimal way to be recognized or analyzed, thereby eliminating many tedious image processing procedures that would be needed

15.3 Frame grabber

The features of a frame grabber for machine vision applications include image acquisition, camera control, and image data pre-processing. The frame grabber can acquire either digital or analog images. These specialized A/D converters change video or still images into digital information. Most frame grabbers are printed circuit boards compatible with the most common types of bus structures, including peripheral component interconnect (PCI), PC-104, ISA, VME and Compact PCI.

15.4 Image processing

Digital image processing is performed with a computer to manipulate information within an image to make it useful. Image processing includes image enhancement, image feature extraction and image feature classification.

15.5 Advantages of using machine vision system

- High resolution vision system
- Real time processing and application

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

- Non destructive
- Rapid inspection rate

15.6 Variable rate application methods

There are a number of questions that must be answered before establishing a site-specific crop management (SSCM) programme. The variable rate application can be done with or without a GPS system. The two basic technologies for VRA are: map-based and sensor-based.

Map-based VRA adjusts the application rate based on an electronic map, also called a prescription map. Using the field position from a GPS receiver and a prescription map of desired rate, the concentration of input is changed as the applicator moves through the field. **Sensor-based VRA** requires no map or positioning system. Sensors on the applicator measure the soil properties and crop characteristics "on the go". Based on this continuous stream of information, a control system calculates the input needs of the soil or plants and transfers the information to a controller, which delivers the input to the location measured by the sensor.

BenefitsVariable rate technology can provide several benefits

15.7 Economics

- Increased input efficiency- apply only what is needed
- Could reduce overall amounts of inputs used
- Improved in-field equipment efficiency
- Improved crop yields through optimal use of inputs

15.8 Environmental

- Minimizing over-application of inputs thereby reducing the risk of pesticide and fertilizer runoff or leaching into water sources
- Reduce application in environmentally sensitive areas.

Sensor-based precision herbicide application system The concept design of the machine vision-controlled sprayer is shown in Fig.2. The system included a multiple-camera vision system, a ground speed sensor and a nozzle controller. The application rate for each nozzle on the spraying boom is controlled separately based on local weed infestation conditions.

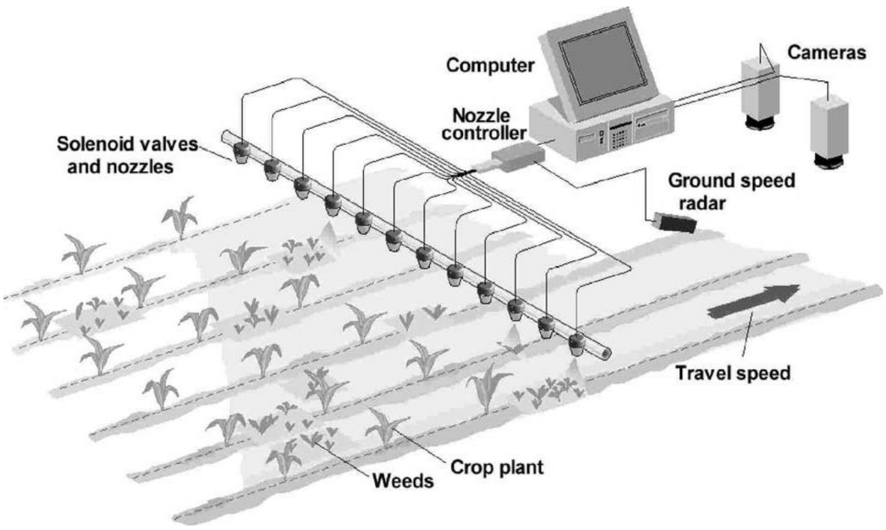


Fig7. : Machine vision controlled sprayer

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

XVI. SYSTEM COMPONENTS

- **Real time control:** To relate the FOV of the camera to the spraying area, a real-time/multi-task control system has to be used. Instead of using an expensive real-time modular for a multitasking operating system, a low-cost microcontroller (serve as system timer and nozzle controller) in conjunction with a PC running on a multitasking operating system were combined together to form a hybrid real-time system. The PC provided a standard interface between a video camera and a digital computer plus a high-level programming environment while the microcontroller provided an interface with the system to respond to real-time events.

The nozzle controller was built around a V-25-based embedded microcontroller. This controller received the commands from the main computer and a square-wave pulse train proportional to the ground speed of the vehicle from the ground speed sensing radar. To realize modulated spraying, Synchronic solenoid valves were mounted on the check valve ports of standard nozzle bodies on the spray boom, and the nozzle controller directed a modulated 12 V signal to the solenoid valves through solid state relays. A ground speed radar gun was used to measure the distance travelled.

- **Image processing:** The image processing software was developed using Microsoft Visual C and the Windows application program interface to create a graphical user interface, which made possible a graphical display of the image processing results and ease in changing the software settings. Each image was first segmented with an environmentally adaptive segmentation algorithm (EASA). The EASA specifies the boundaries of a region in HSI colour space, which corresponded to the colour of the objects in the outdoor scene through an interactive calibration window. To separate weeds from crop plants, additional information, such as field location (different zones), crop row spacing, crop plant size (age), etc. was used in the image-processing algorithm. The crop rows were identified and the inter-row area was used for weed infestation condition measurement. The hypothesis is that weed patches are normally distributed across the inter-row and crop row area and the weed density is similar in a relatively near neighbourhood (say within 1 m). So, the inter-row area weed density can be used to estimate the weed infestation condition in the crop row between plants. After all, herbicide can only be controlled and direct into unified grids (20×20 in.^{2}).

- **Decision-making algorithm:** In the decision-making algorithm, a four-level application-rate scheme was selected. Because the vision system has a resolution limitation (0.005×0.005 m^2/pixel), a 10% label rate was selected as the base-rate. This design eliminates the possibility of overlooking the infestation areas composed mainly of newly-germinated weeds. Based on the sensed weed infestation conditions, three other levels of chemical dosage were assigned—33, 66, and 100% of full application rate (from the label). The economic chemical application threshold was considered in the calculation of the application rate in the simulation tests, since information about weed numbers in each unit area and average weed size (age) was used to make the decision to skip some low weed density control zones or to decide between multiple application rates for different weed infestation levels.

- **Main system control program:** The main system control program loop started with the program waiting to receive a trigger signal from the nozzle controller. When a trigger was received, an image field was acquired by the main PC and the nozzle controller was strobe. The program then started processing the control zone rows starting with the first row closest to the spray boom .The image-processing algorithm calculated the weed density and weed size in each control zone. Based on image processing results, one of four specific dosages was

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

assigned to the corresponding control zone. Then an encoded nozzle command was set for the nozzle controller to adjust the corresponding nozzle to a certain duty cycle. When the entire control zone row was processed, the two-byte-long encoded nozzle control command was sent for that control zone row. Processing continued, row by row, until all the four rows were processed. Finally, the program returned to the beginning to wait for the trigger and another image would be acquired.

XVII. VARIABLE RATE HERBICIDE APPLICATOR USING MACHINE VISION FOR BETWEEN ROW WEEDING OF SUGARCANE FIELDS

A tractor mounted site-specific, real time herbicide applicator was developed for variable rate herbicide application between sugarcane rows. Using the software based machine vision system, the picture frames captured by the web camera were processed and the quantified greenness level due to weeds was used to actuate the controllers of a sprayer pump system. The pulse width modulation (PWM) drive motor speed control was correlated with the percentage of greenness to vary the application flow rate by adjusting the duty level of PWM motor.

XVIII. SYSTEM COMPONENTS

- **Image acquisition and processing system:** Picture frames captured by the web camera were sent to the data acquisition system through USB port, processed by Borland C++ builder program. The algorithm was to read a BMP format and to analyze all pixels, pixel by pixel starting from the first to the last. Each pixel was evaluated whether it is green or not. The decision was made by comparing R, G, and B with Rth,Gth, and Bth so the result to recognize greenness. After the analysis of all the pixels, the overall Green Pixel threshold level could be estimated based on the calibration. The processed output was in terms of percentage of greenness of weed in the capture frame area (84 cm x 62 cm) and it appeared on the active window. This processed information then activated the mechatronic system.
- **Mechatronic system:** PWM circuit and output signal; an 8-bit signal passed through parallel port is acquired and processed for the percentage of greenness, and sending signals to control the speed of 12-volt DC electric motor of the pump to apply set level of herbicide application.
- **Ground speed monitoring system:** As shown in Fig. 4, a free rolling strake wheel was arranged near one of the front wheels of the tractor as such it rotated with tractor wheel. The proximity sensor could pick up pulse signals (6 per revolution) and feed to the application software. The application software incorporated the speed changes and compensated the position and rate inaccuracies in the system.

International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 07, July 2017
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

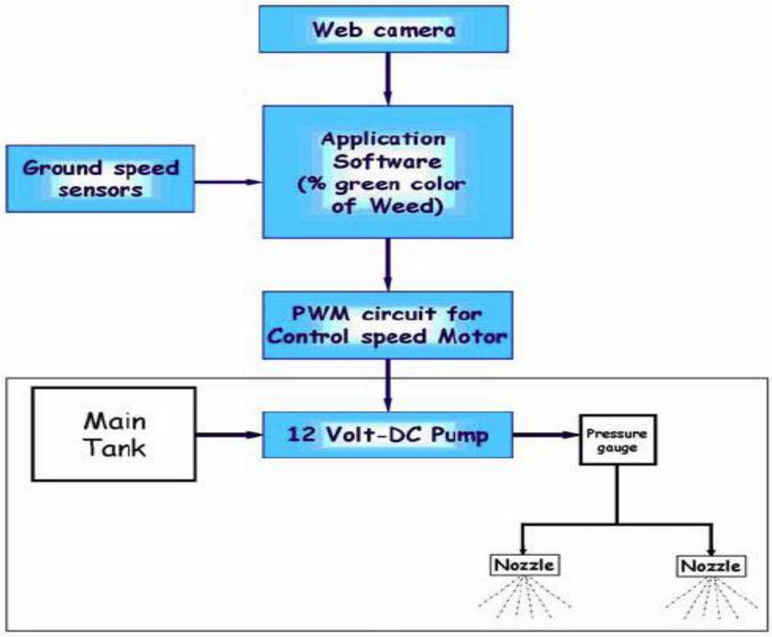


Fig. 8: System block diagram of the site specific herbicide applicator

- **Mounting frames and accessories, and the tractor:** A 21 kW 4-wheel, 2-wheel-drive tractor of 1.10-meter track-width was used to mount the variable rate sprayer designed for herbicide application in sugarcane fields.The user has an option to adjust the four green colour percentage levels for operation. Changing percentage level of green colour and PWM duty cycle (%) can manoeuvre the threshold.

0 - 5%	no weed	no spray
5.1 - 20%	minimum amount of weed	low application rate
20.1 - 40%	medium amount of weed	medium application rate
40.1 -100%	high amount of weed	high application rate

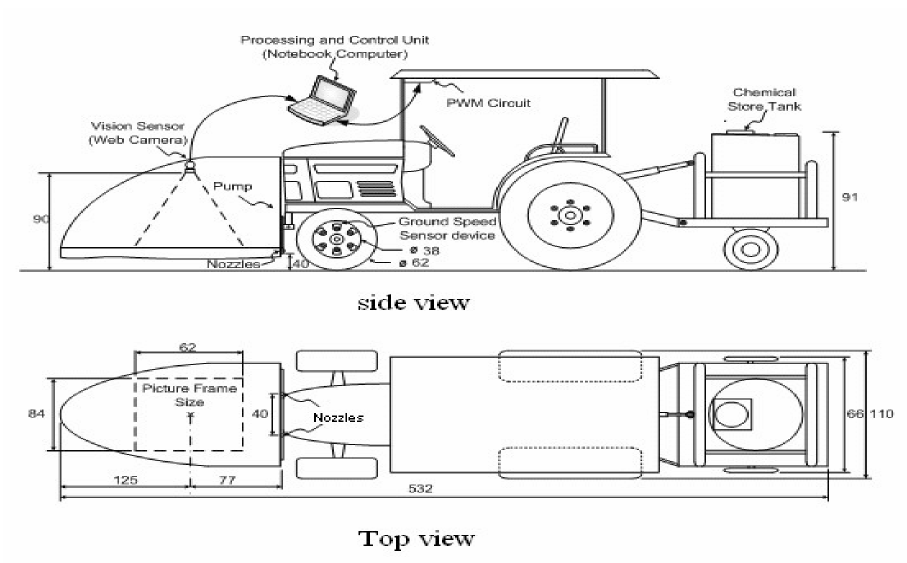


Fig 9 : Schematic of a variable rate applicator system

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

Accuracy in percentage green colour output was confirmed by comparing the percentage green level obtained from image processing of the captured image by the software and the value estimated from the graphical analysis .The output was calibrated using 100 x 75 grids of a 62 cm x 84 cm picture frame size. The error was found to be around 0.31% with standard deviation of +0.25.

The prototype was further tested for application flow accuracy, in which the flow rate was analyzed from quantity of liquid collected in distance marked grooves of the plastic container. In addition corresponding application positions on captured pictures were recorded during test runs. The results were then compared with the PWM duty cycle settings. The application flow rate accuracy was found to be 91.7%.

XIX. CONCLUSIONS

- Precision Agriculture' aims at increasing productivity, decreasing production costs and minimizing the environmental impact of farming
- Laser-assisted precision land leveling offers a great potential for water nutrients and agro-chemicals saving. It also enhances environmental quality and crop yields
- Integration of GIS and remote sensing techniques provides an excellent tool for delineation of potential ground water zones which can be undertaken with minimal time, high accuracy and lower costs
- GPS navigation system can increase the efficiency of the farm or agribusiness while minimizing adverse environmental impacts associated with overlapping applications field mapping and soil sampling. The system can also reduce operator fatigue and anxiety regarding fertilizer and pesticide application
- An automated yield monitoring system consisting of an optical yield sensor, a moisture sensor, a GPS, and a field computer with custom software mounted on a self propelled combine harvester for real-time crop yield mapping with good accuracy
- Variable-rate application of cropping inputs such as seed, lime, fertilizers, and pesticides is one management strategy to address the variability that exists within agricultural fields by adjusting the rate of input

Translation of remote sensing data, GIS techniques and precision farming database information in to implementable schemes at the field level and absorption of technology at the grass root level by the actual beneficiaries still remains a greater challenge. These technologies should infiltrate in to agricultural sector at micro level for greater and sustainable benefits. These technologies should be used to complement the traditional methods for enhancing productivity and quality.

REFERENCES

[1] Chandel, N.S., Agrawal, K. N., Tiwari, P. S., Golhani, K. and Tripathi, H. 2013. IDW interpolation of soybean yield data acquired by automated yield monitor International Journal for Science and Emerging Technologies with Latest Trends13(1): 36-45 .

[2] Chen,Y.R., Chao,K., and Kim,M.S. 2002. Machine vision technology for agricultural applications. *Computer and Electronics in Agriculture.* **36.** 173-191.

[3] Ghazali, K.H., Mustafa, M.M. and Hussain, A. 2008. Machine vision system for automatic weeding strategy in oil palm plantation using image filtering technique.

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

[4] Grisso, Robert, Alley, M., Thomason, W., Holshouser, D. and Roberson, G.T. 2011. Precision Farming Tools: Variable-Rate Application Virginia Tech. Publication 442-505.

[5] Kaur, B., Singh, S., Garg, B R., Singh, J.M. and Singh, J.2012. Enhancing water productivity through On-farm resource conservation technology in Punjab agriculture Agricultural Economics Research Review Vol. 25

[6] Maheswari, R., Ashok, K. and Prahadeeswaran, M.2008. Precision farming technology, adoption decisions and productivity of vegetables in resource-poor environments. Agricultural Economics Research Review Vol. 21. pp 415-424.

[7] Mondal, P.,Basu,M. and Bhadoria, P.B.S. 2011. Critical review of precisio agriculture technologies and its scope of adoption in India. *American journal of experimental agriculture.***1**(3): 49-68.

[8] Tangwongkit, R., Salokhe, V.M. and Jayasuriya, H.P.W. 2006. Development of a Real time, Variable rate herbicide applicator using machine vision for between- row weeding of sugarcane fields. *Agricultural Engineering International : the CIGR Ejournal* .vol. VIII. June .

[9] Tian, Lei. 2002. Development of a sensor-based precision herbicide application system used a machine vision system for application of herbicide. *Computer and Electronics in Agriculture* . **36.** 133-149 .

[10] Yeh, H.F., Lee C.H., Hsu K. C. and Chang, P.H.2009. GIS for the assessment of the groundwater recharge potential zone Environ Geol 58:185–195.