IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 7, June 2022
Impact Factor: 6.252

Evaluation of Map-Based Control System for Application of Fertilizer

Ajay V. Raipure[1], Mrs. N. V. Hippalgaonkar[2], Mrs. V. S. Kharote-Chavan[3], Mrs. S. V. Naik[4], Mrs. Archana Gaikwad[5]
Department of E&TC Engineering[1,2,3,4,5]
Pimpri Chinchwad Polytechnic, Nigdi, Pune, Maharashtra, India

Abstract: *Preserving environment in farming is now becoming main concern since use of inputs like fertilizers & pesticides has been widely employed. Site–specific application of agricultural chemicals is an effective way of resource saving and environmental protection. Precise farming implementation is now gaining popularity and widely accepted as one of smart solutions to sustain agriculture production without ignoring environment. This paper isbased on results of map analysis, where map of soil can be developed based on (1) soil type (chemical composition of soil) (2) soil colour and texture (3) topography (high ground, low ground) (4) crop yield.As per results of chemical analysis, system is developed for controlling opening of outlet of valve for delivery of proper chemical composition (i.e., fertilizer) in same soil by controlling D.C.motor. Through this system, it is possible to improve agricultural production without ignoring environment, [1]*

Keywords: Precision Farming, Map Based Technique, Variable Rate Applicator, etc.

I. INTRODUCTION

Main concern in developed countries is to preserve environment while focusing on high yielding with intensive use of inputs such as fertilizers and pesticides. Beside maintaining high yield performance, conscious efforts are made in preserving environment through concept of soil specific crop management or as precision farming.[2]Soil fertility varies from place to place, even it differs from foot to foot in the same field. Therefore, application of fertilizers should be done keeping this fact in mind. It is possible to develop the map-based design for application of particular fertilizer in a particular field as follows:

- Perform soil sampling (lab analysis) for the field, Laboratory test often check for plant nutrients in three categories:
  1. Major Nutrients: nitrogen(N), phosphorus (P), and potassium (K)
  2. Secondary Nutrients: sulfur, calcium, magnesium.
  3. Minor Nutrients: iron, manganese, copper, zinc, boron, chlorine.
- Generate site- specific map of soil nutrient s properties.
- Algorithm to develop site specific fertilizers map.
- Use map to control fertilizers application.

II. MAP BASED TECHNIQUE

Site specific farming utilize the map-based method of sampling, map generation, and variable rate application. This method is more suitable sensors are difficult to rapidly monitor soil and crop conditions.

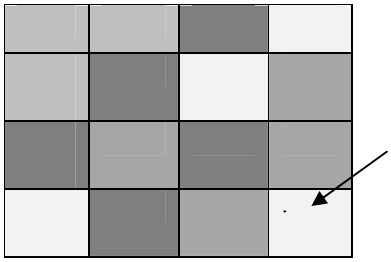


Figure 1: Grid map of Soil Sampling Data

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 7, June 2022
Impact Factor: 6.252

Maps are good for collecting and interpreting data for soil properties that do not fluctuate greatly from year to year. Properties such as organic matter content and soil texture tend to change slowly. Soil fertility may change more quickly.[4] Particular nutrients such as phosphorus and potassium may change from year to year, Concentration of nitrogen in the soil are greatly affected by temperature and moisture conditions and can fluctuate rapidly.Nitrogen is most important soil fertility factor .

III. PROPOSED SYSTEM

The application system mainly includes four parts: crop nutrition monitoring system based on interface module, variable fertilization controller and variable fertilizer applicator.Crop nutrition monitoring system installed in front of the tractor,foracquisition crop growth state and nutritional status, the sensors were connected to interface module, and the collected data transmission to interface module. The interface module has serial and power connections. The interface module connected with variable fertilization controller by serial. The variable fertilization controller combined with fertilization model to make the best use of fertilizers decision, this decision information can transmit fertilization information to variable applicator by the fertilization controller, the fertilizer applicator control system through the control hydraulic valve opening size which scatter the needed fertilization in the surface of the soil. Variable rate fertilization system is designed to achieve demand of fertilization application.

The paper is based on a variableinput signal to output the electric signal to control hydraulic valve opening size.The flow rate of valve can be controlled by adjusting the opening position of hydraulic valve. And the flow rate can be controlled by changing hydraulic motor rotation speed as feedback-based tractor speed. The input signals of controller include crop nutrient information by optical sensor, per-axis fertilizer amount, fertilizer applicator parameters and pre-set fertilizer amount; the feedback of sensors; tractor speed; and GPS / GIS / PC input signals, etc. Output signal is mainly hydraulic valve opening size which used to control flow rate, the pulse-width modulation (PWM) used to control the hydraulic control valve and the serial data which output to the LCD screen. In addition, the controller has a serial data interface to allow for the extended application (to connect some testing equipment, such as bin level sensor etc.).[5]

The system structure shows in Figure 2.

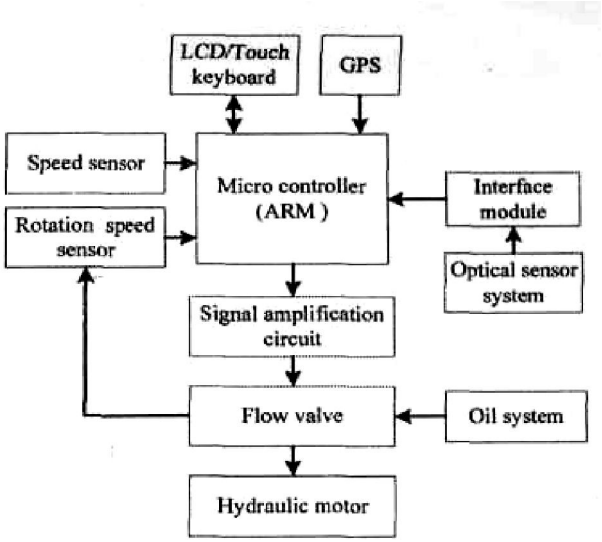
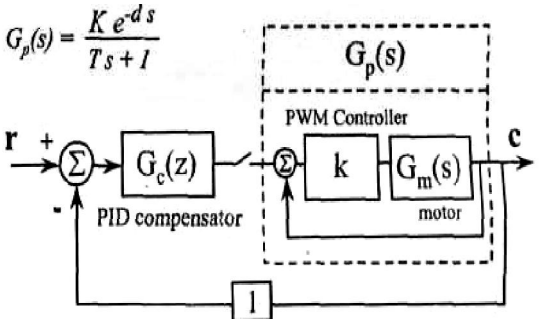


Figure 2: The System Structure

Digital PID Control: Digital control based on embedded system will be used in this research. A feedback control with a digital PID compensator, therefore, was adopted to improve the robustness of control. For this purpose, the rotor speed was monitored using an optical rotary encoder with resolution 30 pulses per rotation. A 16 bit counter was used to count the pulses every 20 ms.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 7, June 2022
Impact Factor: 6.252



Rotary Encoder

Figure 3: Schematic Diagram of Digital Control

IV. FERTILIZATION AMOUNT FEEDBACK CONTROL

The chip can calculate the output PWM duty cycle according to the pre-set fertilizer amount after collected the speed of tractor. The feedback control is to regulate the PWM signal duty cycle according the real revolution speed of hydraulic motor by the microcontroller chip collect the rotary encoder output signal which fixed on the hydraulic motor. The new PWM signal controls the oil flow of the hydraulic flow control valve to control hydraulic motor which achieved to adjust the hydraulic motor revolution speed. Software design flow chart shows in Fig. 4

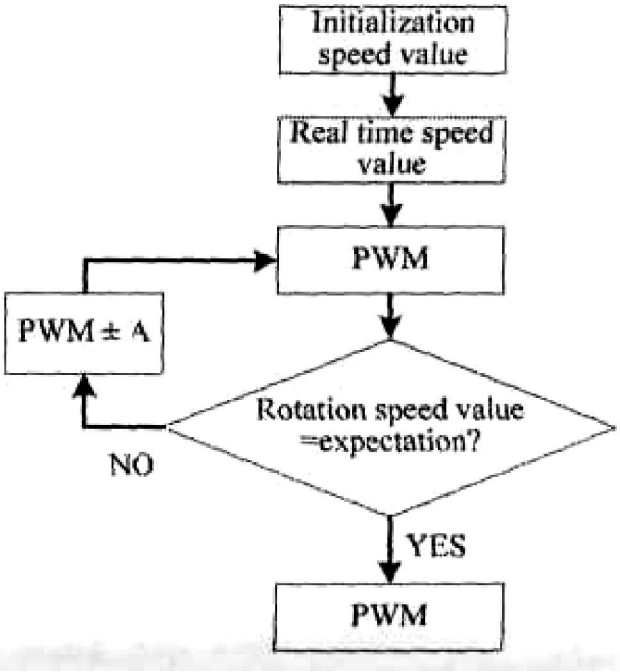


Figure 4: Feedback Control Design

V. SYSTEM TEST AND EXPERIMENT

In order to test the actual performance, carry out field trials and testing to the automatic controller of variable rate fertilizer applicator. Before the experiment, fix the controller, hydraulic motors, Hall switches and the other implementation units to these positions and connect the oil hydraulic circuit to the tractor.

The DC power is controller, sensors and hydraulic need provided by tractor battery and its specifications is +12V/240 A hr. Fertilizer uses the better mobility of chemical fertilizers - urea in the experiment. Check the corrects of the system, then power up, after initialization, the operator through the keyboard input the preset data, after

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 7, June 2022
Impact Factor: 6.252

controller calculate these collected signals output PWM signals to control the hydraulic motor, hydraulic motor driven gears through chains to achieve the precise variable rate fertilization. Table 1 showed the measured results of different preset fertilizer amount.

Table 1: Different Prese tFertilizer Amount Experiment

Number	Pre-set Amount (kg/hm^2)	Actual amount kg/hm^2	Relative Error (%)
1	75	75.50	0.50
2	100	103.1	3.1
3	125	128.7	3.7
4	150	154	4
5	175	173	2
6	200	204	4
7	255	252.42	1.01
8	300	302.44	0.81
9	345	341.20	1.10
10	375	365.17	2.62

In the actual measurement, the maximum relative error is 4 %, and it shows range is from 0.5 % to 4 %. So, it can well meet the purpose of variable rate fertilization and its standards. From Figure 5, we can see that the response is the rapid and timely in fertilization. The response time of fertilizer volume changes is less than 0.9s; this time is less than the desired time of the controller designed. The experiment has proved that fertilizer controller can meet the requirements of field fertilization.

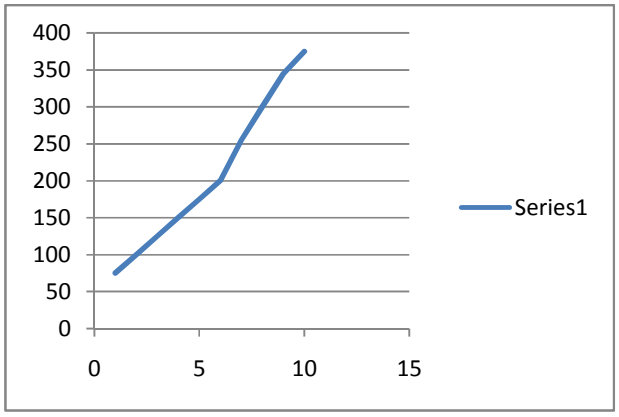


Fig. 5.1: Preset Amount of Distribution

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 7, June 2022
Impact Factor: 6.252

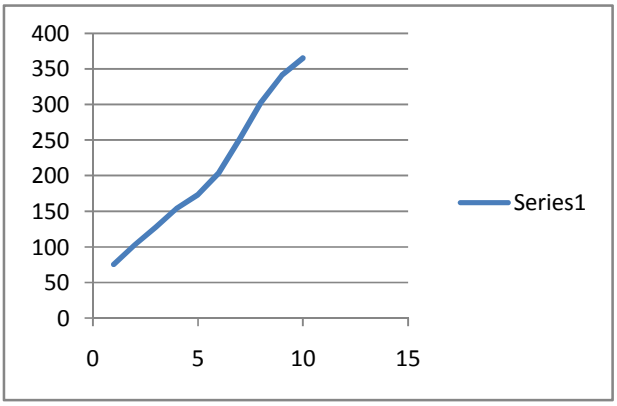


Figure 5.2: Actual Amount of Distribution

VI. CONCLUSIONS

Design of feedback control system for developing VR fertilizer applicator was successful. It was able to discharge fertilizer at target rate with acceptable delay and accuracy or, the paper analyzes the input and output conditions of control system, designed a hardware control system based on ARM chip, designed mainly software flow and designed a feedback control.

The system can automatically control flow amount by adjusting hydraulic valve size, and can change hydraulic motor rotation based on working speed at the same time. The system used the hydraulic motor as a drive mechanism is more reasonable than motor, which can overcome the small torque and start out-of-step phenomenon. And used control chip is faster, reliability well, and has a good real-time online display.

Carried out systematic laboratory testing, field testing and analyses experimental results of errors. Field experiment results show that fertilizer amount in fact is well to target fertilization amount, the maximum relative errors is 5. %, and it shown CV is from 0.35 % to 2. %. Experiment indicated that the variable rate fertilization control system to control fertilization, which achieves the aim of saving fertilizer and reasonable fertilization. The fertilizer response time of controller system is less than 0.9 *s*.

REFERENCES

[1] Rui Zhang, XiuWng, Jianhua Guo, Liping Chen, Jianjum Zhou, "Development of variable rate fertilizer system based on optical sensor" sensor & Transducers, Vol.26, March 2014, pp1-6.

[2] Kyle H. Holland, James. Schepers, use of virtual- reference concept to interpret active crop canopy sensor data, precision agriculture, 14-1-2013 pp 71-85.

[3] Chunling Lang, "Design and developmentof control system for deep fertilization variable liquid fertilizer applicator", ICDMA 2011 second international conference pp 369-372.

[4] Zidong Yang, "The Research on adaptive control modeling of a liquid fertilizer spreader" published online February 2010 (http://www.scrip.org/journaleng).

[5] Rui Zhang, Chunjiang Zhao. "Variable rate fertilizer control system for disc fertilizer spreaders" Intelligent automation and soft computing, Vol.18 No.5, pp.461-467, 2012.

[6] WengianHuanog, Zhijien Meng, "Ddesgn of CAN- based variable rate fertilizer control system" pp 1330-32.

[7] P.A.S. Radite, WawanHermawn "Development of variable rate fertilizer applicator module based on 8-bit embedded system."AFITA 2010 international conference pp-93-98.

[8] A.M. Mouazen, M.R. Maleki, "On-line measurement of some selected soil properties using a VIS-NIR sensor". Soil and Tillage research 2007, pp13-27.

[9] EhteshamForouzanmehr, Mohammad Loghavi, "Design, development and field evaluation of a map - based variable rate granular fertilizer control system", CIGR journal dec. 2012 Vol.14, No. 4 pp 255-261.