Monitoring Growth of Wheat Crop using Digital Image Processing

Anil Kakran Rita Mahajan
PG StudentAssistant Professor
PEC University of Technology, ChandigarhDepartment of E&EC, PEC

ABSTRACT
Automation is need of future and automation in farming is necessary as there is acute storage of both fertile land and skilled farmer. Judging the need of crop is quite difficult as the demand of nutrients changes with age of crop. The growth of a wheat plant is measured in stages. Understanding the stages of growth is important to help farmers optimize the yield. The optimum timing of fertilizer, irrigation, herbicide, insecticide, and fungicide applications are also best determined by crop growth stage rather than calendar date.This work provide a solution to finding the age of wheat crop, once the age of crop is found farmer can take precious and calculated step to enhance their production of wheat or other agricultural product. Colour processing feature of Digital Image Processing is used for finding the age of wheat crop. RGB and HSI colour models utilized in examining wheat crop.

Keywords
Digital Image Processing, Colour Processing, RGB, HIS

1. INTRODUCTION
Since the population of world is growing at rapid pace, and fulfilling the food requirement of these growing population is not so easy. So, there is utter need of modernisation of agricultural. This modernisation can certainly satisfy the food requirement of world. The advancement in agriculture is nourished by technology. The governments across the world is emphasising on increasing the production of main cereals includes Wheat, Rice and Maize and spending large amounts money to ensure the food stability of country. Rapidly growing countries, like India practising new and improved method of agricultural and fuelling money on research and development of new agriculture practises [1].

Wheat is most important cereal of India and it is being cultivated across the major part of country since ancient times. Wheat is a Rabi crop that is grown in the winter season. Sowing of wheat takesplace in October to December and harvesting is done during the months ofFebruary and May [2]. The wheat crop needs cool winters and hot summers.Cultivation of wheat crop is not a difficult task but judging the wheat crop on basis of quality and maturity is not so easy.The manual inspection is slow, labour intensive, tedious and error prone.The decision about the age of wheat crop requirestough analysationof wheat crop and it was done by skilled and experienced farmer. The right timing of fertilizer, irrigation, herbicide, insecticide, and fungicide applications are also best determined by crop growth stage rather than calendar date [3].The growth of a wheat plant is measured in stages. Understanding the stages of growth is important to help farmers optimize the yield[3].

Following are different stages of wheat crop [3][4].

Seedling and TilleringStage: it is first stage and start form the germination of seed into the soil tothe apprence first leaves.Tillering can occur before or after the winter beginning. Roots grips the soil as the plant rises during tillering.

Jointing Stage: jointing stage starts when the stalk forms its second node, a hard joint from which the plant rises upwards. The wheat plant appears maximum green during this stage.

Booting Stage: During this stage, the head of the wheat develops and becomes visible. This ends with the tips of the head, called awns, begin to grow.

Heading and Flowering Stage: Heading and flowering stage begins with the emergence of awns from the sheath. When the awns have emerged the flowering begins and pollination and fertilization occurs. After this stage green color start decreasing.

Maturity Stage: This stage is followed by fertilization, and includes several short stages. The first sub stage of maturing is milk stage it start when the kernel begins forming.Kenal is very mosit and contains 30% of water. During the ripening stage the kernel loses the rest of its moisture and it turns yellow and is ready to be harvested [5]

Several systems have been developed to provide numerical designations for growth and developmental wheat growth stages. Feekes, Zadoks, and Haun scales are most frequently used scales in monitoring wheat crop. The Haun scale manly examine thedevelopment of the main shoot. In the first stages, each new leaf is realted to previous leaf that was produced [6]. The Feekes scale was developed on eleven major growth stages starting with seedling emergence and ending with grain ripening. The Feekes scale is most frequently used to identify optimum stages for chemical treatments, such as fungicide and pesticide applications. Freeks scale manily focussed on the plant development period from the start of stem elongation to the completion of flowering [7].Whereas, the Zadoks scale gives the most complete description of wheat plant growth stages. Zadoks uses code based on ten major stages that can be subdivided, making it particularly suited for computerization [8].
In this work, the decision of age of the wheat crop is done by taking the digital image of the wheat crop time to time. After taking the image of wheat crop using the digital camera the image is transferred to the computer. MATLAB is used for the feature extraction of that digital image. The green pigment of wheat crop decrease with its age [9]. The wheat crop is having the maximum green pigment during early stages and the matured wheat crop have minimum green pigment [3]. Therefore, age of the wheat crop is analysed by measuring the

content of green colour present in the wheat crop. Measurement of green colour in the image of wheat is done by digital image processing.

2. DIGITAL IMAGE PROCESSING

Digital image processing has a history going back over 35 years and colour has been part of that history for at least 25 years [10]. In Digital image processing imagesare captured, transmitted, and processed in digital form.

Digital image processing is one of division in electronic area where image being modified to pixels, stored in a digital storage and processed by computer. In effect, it reduces cost increasing computational speed, and flexibility [11]. The core task of digital image processing is storing images and enhances them to the new information structures, so as to provide a better basis for obtaining and analysis of related activities [12]**.** In addition, digital image processing leads to enhancement of image features' interest and therefore useful information about the scene from enhanced image could be computed [11].

Digital image processing, extract information of an image for processing and analysis task. After taking the digital image from the digital camera, the system transferred to a computer for processing and storage by using different processes such as image capturing, image digitization, noise filtering and feature identification [13].

Now a day, Digital Image processing has been applied to medical diagnosis [14], weather forecasting [15], food quality control [16] and galaxy monitoring [17]. Among the famous technology that applies image processing technique is Face Recognition [18]

3. COLOUR PROCESSING

Colour of an organic material gives vital information about that material. Colour Features Colour analysis in this project is based on the RGB Colour Space and HSI colour spaces.

3.1 RGB Colour Space:

This colour space is commonly used and human eye can also perceive it. The colour of any object is made from three primary colours these are Red, Green and Blue. Other colours are made from primary colours that is, the mixture of 2 or more primary colour gives the full colour spectrum. RGB colour space based on the primary spectral components of red (R), green (G) and blue (B).

3.2 HSI Colour Space:

HSI that is hue (H), saturation (S) and intensity (I)gives the colour description in terms that are practical for human interpretation. Hue, Saturation and Intensity of the colour objects are perceived and described by human eye. Hue gives the measure of distinct colour of the spectrum such as red, green, yellow etc. Saturation is a measure of the degree to which pure colour is diluted by white light that is richness of pure colour. Intensity is the brightness subjective descriptor and impossible to measure. The Intensity of HSI model decouples the intensity component from the colour carrying information (hue and saturation) in a colour image [19].

HSI is the gives the best results and compared to RGB colour system because in RGB colour system provide three separate coordinates RED, GREEN and BLUE which is not efficient for colour perception and image processing than compared to HSI mode.Whereas in HIS modal only hue (h) can give the colour perception. As a result HIS model is known as the most ideal tool for developing image processing algorithms [19].

Hence it is proved that HSI is efficient in examining of organic products and other coloured objects because

- HIS models can separate intensity from the colour information which gives chromatic purity of the coloured object
- Hue and Saturation components are intimately related to the way in which human being perceive colour.
- Hue of the colour does not depends upon the light intensity.

4. FEATURE EXTRACTION AND FORMULA USED FOR CALCULATIONS

Here we are extracting the Red, Green and Blue colour from the wheat crop image and predicting the age of wheat crop. As mentioned above the percentage of green colour in the wheat crop vanishes with its age. Firstly, we are calculating the percentage of green colour in the image of wheat crop. After calculating the percentage of green colour present in the image in RGB colour system, we are converting the RGB colour system into HSI that is, Hue, and Saturation and Intensity foe better prediction.

RGB data is first converted into HSI data. With image representation in the HSI domain,the colour analysis was based on primarily the Hue value. Hue is a colour attribute that describes

a pure colour, whereas saturation gives a measure of the degree to which a pure colour is

Diluted by white light and finally intensity gives the effectiveness of the colour. The three

Dimensional RGB space is reduced to a one-dimensional 'H' Space for colour analysis. For a

Digitized colour image, the Hue histogram represented the colour components and the amountof that Hue in the image.

In this paper we are taking three images (Image1, Image2, Image3) or wheat crop at different instances of time. The Image1 is taken after 6 weak of sowing wheat. Image2 is taken after 14 months of sowing and the Image3 is taken after 18months older. The wheat crop requirement changes with the time and at the age 6, 14 and 18 weeks the crop show maximum transition in the requirement[20][21][22][3]. So, by knowing this development phase of wheat crop farmer can cultivate better yield.

Fig1:Image1 (6 weak older wheat crop)

Fig2:Image2 (14 weak older wheat crop)

Fig3:Imgae3(18 weak older wheat crop)

Mean of Red, Green and Blue colour components obtained by using Digital image processing in MATLAB. Mean of Red, Mean of Green and Mean of Blue colour components is represented as R, G and B respectively. This computation helps to comprehend the most dominant primary colour of the image

4.1 Formula used for calculations

Percentage of Green colour in RGB modal,

$$\mathbf{g} = \frac{\mathbf{G} \times \mathbf{100}}{\mathbf{R + G + B}}$$

RGB colour system is converted to HSI colour system by using following formulas. Given an image in RGB format, the Hue component of each RGB pixel is given by

Hue**, H**

$$\mathbf{tan(H)} = \frac{\sqrt{\mathbf{3}}}{\mathbf{2R - G - B}}(\mathbf{G - B})$$

Saturation,$\mathbf{S = 1 - \frac{3}{R+G+B}[min(R, B, G)]}$

Intensity $\mathbf{I = \frac{1}{3}(R+G+B)}$

5. RESULT AND DISCUSSION

The green colour present in the three images of wheat crop is separated using Digital image processing. Following images show the content of green colour present in 3 images of wheat crop taken at different instances in grey scale.

Fig4: Green content in Image1

Fig4: Green content in Image2

Fig6: Green content of Image3

It is difficult to comment on the content of green colour in above three images. Therefore, weseparated the Red, Green and Blue colour and calculated the mean of the three colours present. Mean of Red, Green and Blue is represented my R, G and B.

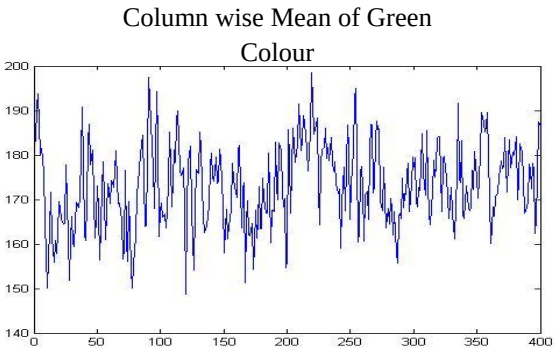

Fig 7: Mean of Green colour of Image1

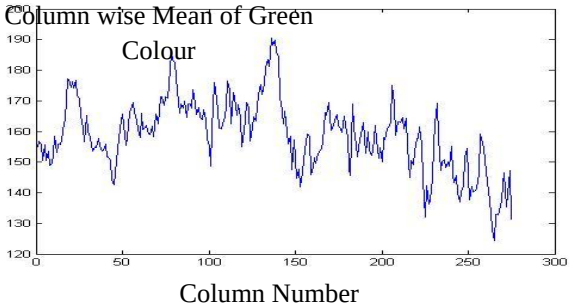

Fig 8: Mean of Green colour of Image2

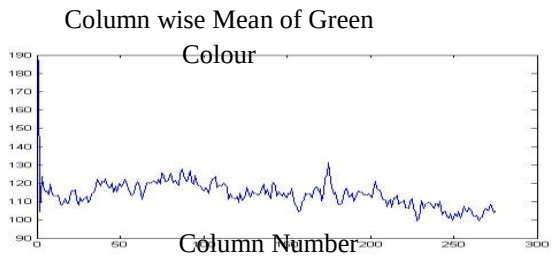

Figure 9: Mean of Green colour of Image3

In the above three figures mean of green colour is plotted for Image1, Image2, Image3 of wheat crop. It is clearly visible from observing 3 figures that range of mean of green colour is maximum in first image, moderate in second image and least in third image. This range can be used in aging the wheat crop. Using R, G and B and the formulas' mentioned above, further calculation of Percentages of Green colour, Hue, Saturation and Intensity were done for the three images of wheat crop.

Table 1

From RGB model, it is clear by observingthe percentage of green colour that the percentage of green colour is decreasing from first image to the third image that is, Image1 have maximum green colour and Image3 have least green colour. Above percentage of green colour can be used in aging the wheat crop.So the Image1 is younger then the Images2 and Images3. And their nutrition requirements can be decided according to their needs for better yield.

	Mean of Red colour present, R	Mean of Blue colour present, B	Mean of Green colour present, G	Percentage of green colour, g	Hue, H	Saturation, S	Intensity, I
Image 1	131.93	69.56	173.22	46.22 %	65.6	0.37	133.91
Image 2	159.56	83.45	158.73	39.51 %	83.1	0.44	124.90
Image 3	168.98	57.23	113.99	33.50 %	89.4	0.49	113.40

HIS components for the 3 images are also calculated and all three images give distinctive values hue (H), saturation(S) and intensity (I). Hue is maximum for the Images1 and it decreases as the crop ages similarly saturation level also decreases with the age of crop. But the intensity is maximum in Image1 and decreased with age of crop.

Automation in farming is need of future and digital image processing can play very vital role in examining the crop cover. Colour processing in digital image processing can be utilized for precious farming [22]. As the colour of the crop changes when it is not getting enough of vital nutrients and other required products .Colour of the plant crop is an important aspect in monitoring health of crop and by examining the colour of the crop, the health of the crop can be predicted [23].Digital image processing can also be used in monitoring the health of crop and checking disease spread in the farms and timely action can ensure better yield [24].

6. CONCLUSION

Good yield of a crop species is dependent upon critical growth stages so that the plant can capitalize on favourable weather periods during the growing season. An understanding of how crops respond to environmental stresses at different stages of growth can assist in the assessment of crop condition and production potential throughout the clutivating season. In this paper we have taken three different image of wheat crop during different intervals. Certainly images were taken when the crop's nutrition demand changes that is, Demand of fertilizer and other nutrients changes with growth of crop. Supply of fertilizers and nutrients on the basis of crop age can lead higher yield. Using Colour processing of Digital image processing the age of wheat crop is found and necessary action can be taken according to age of crop. Judging the maturity of wheat crop can be done

7. REFRENCES

[1] A. K. Joshi, B. Mishra, R. Chatrath, G. Ortiz Ferrara and Ravi P. Singh, Wheat improvement in India: present status, emerging challenges and future prospects "Improving Yield Potential in Wheat"

[2] DWR.IN - Directorate of Wheat Research, karnal

[3] D. Brian Fowler,Crop Development Centre, University of Saskatchewan, Saskatoon, Canada.

[4] Nelson, J.E., K.D. Kephart, A. Bauer, and J.E. Connor. 1988. Growth staging of wheat, barley, and wild oat. Montana State Univ. Coop. Exten. Service, Bozeman, and Univ. Idaho Coop Exten. Service, Moscow.

[5] The Agricultural and Processed Food Products Export Development Authority (APEDA), New Delhi, www.apeda.gov.in/

[6] Haun, J.R. 1973. Visual quantification of wheat development.Agron. J. 65: 116-119

[7] Large, E.G. 1954. Growth stages in cereals: Illustration of the Feeke's scale. Pl. Path. 3: 128-129.

[8] Zadoks, J.C., T.T. Chang, and C.F. Konzak. 1974. A decimal code for growth stages of cereals. Weed Res. 14: 415-421.

[9] Cook, R.J. and R.J. Veseth, 1991. Wheat health management. Amer. Phytopath. Soc., St. Paul, Minn.

[10] S. J. Sangwine, Colour in image processing

[11] B. Silver, "An Introduction to Digital Image Processing"2000, fetch from http://www.machinevisiononline.org/public/articles/cognex1.PDF on January 2010.

[12] W. Osten, "Digital Image Processing for Optical Metrology," Springer Handbook of Experimental Solid Mechanics, 2008.

[13] H.C. Chung, J. Liang, S. Kushiyama and M. Shinozuka, Digital image processing for non-linear system identification, 2004, pp. 691-707.

[14] V. Lakshmanan, T. Smith, G. J. Stumpf and K. Hondl, "The warning decision support system-integrated information," Weather and Forecasting, Vol. 22(3), 2007, pp. 596-612.

[15] A.A. Gowen, C.P. O'Donnell, P.J. Cullen, G. Downey, J.M. Frias, "Hyperspectral imaging an emerging process analytical tool for food quality and safety control," Trends Food Sci. Technol. 2007, pp. 590-598.

[16] G. Dougherty, "Digital Image Processing for Medical Applications". Cambridge University Press, 2009.

[17] B. Hyde, "Galaxy image processing and morphological modeling: Applications to understanding galaxy formation and evolution," January 1, 2009

[18] J. Lu, K.N. Plataniotis, and A.N. Venetsanopoulos, "Regularization studies of linear discriminant analysis in small sample size scenarios with application to face

recognition," Pattern Recognition Letters, Volume 26, Issue 2, January 2005.

[19] R. C. Gonzalez and R. E. Woods, Digital Image Processing. Prentice Hall, 2nd ed., 2002.

[20] D. S. Jayas, J. Paliwal, and N. S. Visen, "Multi-layer neural networks for image analysis of agricultural products," J. Agric. Eng. Res., vol. 77, no. 2, pp. 119 - 128,2000.

[21] Paliwal, N. S. Visen, D. S. Jayas, and N. D. G. White, "Cereal grain and dockage identification using machine vision," Biosystems Engineering, vol. 85, no. I, pp. 51 - 57, 2003.

[22] H. Luijten, "Basics of color based computer vision implemented in matlab," traineeship report, TechnischeUniversiteit Eindhoven, June 2005.

[23] Xia, Xu; Fan, Chao; Lu, Shu-Jie; Hou, Li-Long, The Analysis of Wheat Appearance Quality Based on Digital Image Processing, 2010 2nd Conference on Environmental Science and Information Application Technology.

[24] Jinghui Li, LingwangGao , ZuoruiShen,Extraction and analysis of digital images feature of three kinds of wheat diseases, 2010 3rd International Congress on Image and Signal Processing (CISP2010).