UNMANNED GROUND VEHICLE FOR PRECISION FARMING

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Abstract – *The objective of this idea is that it deals with detection of plant diseases at early stages before the farm/field gets ruined. With food being a major necessity for us, it is important that we address this concern before it becomes a major problem. This would help us increase productivity of food for an ever increasing population due to which the demand of food grain has been on the rise. The UGV device what we're using consists of a low cost IR camera which gets attached to the robotic arm at one end and the arm is then fixed onto the ground vehicle. The ground vehicle itself uses predefined track for traversing the terrain without any hindrance. The UGV then uses image processing software such as Open CV which is open source and processes the images to obtain the needed data. The mechanism it uses for processing these images is through the calculation of NDVI or also known as normalized difference vegetation index.*

This UGV can be detrimental in helping us find plant diseases beforehand which can help us eradicate them at an earlier stage and save crops from becoming ruined.

This can also help a great deal in reducing inputs such as water, pesticides, nutrients, etc. to crops and in turn increase efficiency.

***Key Words*: Unmanned ground vehicle, NDVI, Open CV, Robotic arm, IR camera**

1. INTRODUCTION

The scenario in urban agriculture has seen a shift in the recent years with substantial growth in the past few decades. This has meant that over the years, there has been an increase in the need for solutions which are low on cost and high on the efficiency scale. There have been two main factors which have been paramount to this idea when it comes to them affecting agriculture directly. The first one being is that investment into agriculture has been low and we are seeing more and more people leaving this particular field. Secondly it is that crop diseases have been the single largest contributor to yield loss on a large scale. This idea aims to address this by developing a low cost as well as an efficient way to combat crop loss. This system will be implemented primarily in agricultural research centres as well as urban and semi-urban commercial farms with our primary focus to be able to bridge the existing gap between the two using a combination of both hardware as well as software for this purpose keeping in mind the increase in urban as well as semi urban farming over the years.

The 2 key factors for this idea are illustrated below:

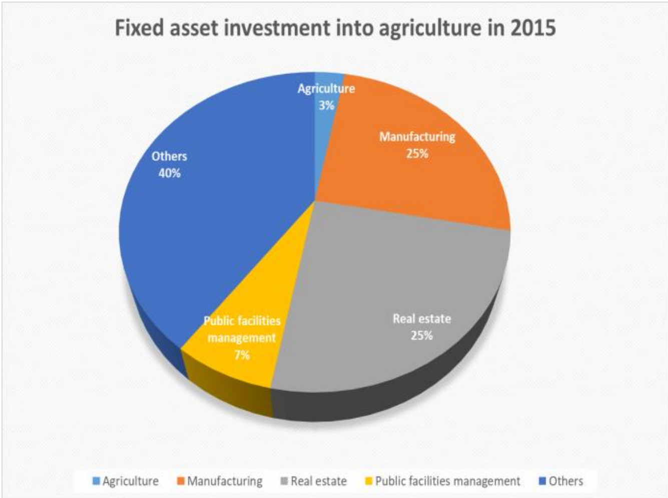

Fig 1: Fixed asset investment into agriculture in India stands at around 3 – 4 percent of our GDP.

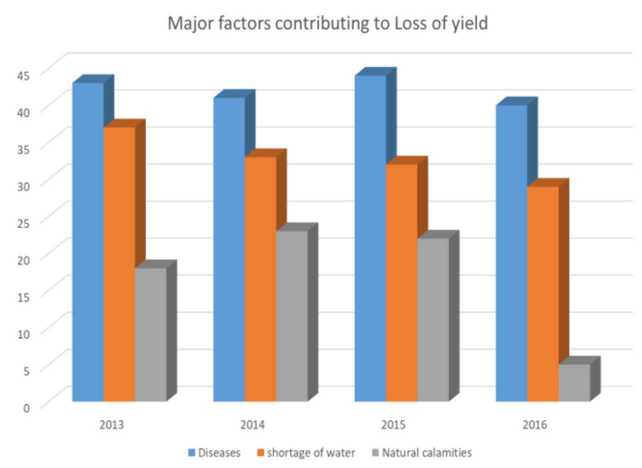

Fig 2: Diseases stand as the single biggest contributor to loss of yield to crops in India.

1.1 UNMANNED GROUND VEHICLE

The unmanned ground vehicle consists of a robotic arm attached to it at the top. The arm has the ability to extend up to a height of 3 feet. This robotic arm consists of an IR camera attached to it and is used for obtaining the pictures. The vehicle will move around the field on a predefined path and will use a line following mechanism for navigational purposes. It consists of an IR led and a photodiode which is controlled by switching the DC motor connected transistor on and off which results in the motor to start operating and move the vehicle. What makes this solution so unique is that the other current solutions in the market are ground based solutions or aerial drones and a couple of hand held devices as well which are either expensive or labor resource intensive.

1.2 WORKING

The main concept used here is NDVI which stands for normalized difference vegetation index. Its basic formula is

NDVI = (NIR — VIS)/ (NIR + VIS)

where

NIR = Reflectance in infrared spectrum,

VIS = Reflectance in visible red spectrum.

NDVI is calculated from the visible and near-infrared light reflected by vegetation. Healthy vegetation (left) absorbs most of the visible light that hits it, and reflects a large portion of the near-infrared light. Unhealthy or sparse vegetation (right) reflects more visible light and less near-infrared light. The numbers on the figure above are representative of actual values, but real vegetation is much more varied. Calculations of NDVI for a given pixel always result in a number that ranges from minus one (-1) to plus one (+1); however, no green leaves gives a value close to zero. A zero means no vegetation and close to +1 (0.8 - 0.9) indicates the highest possible density of green leaves.

Fig 3 shows what an image processed using this technique looks like.

Fig 3. NDVI imaging process.

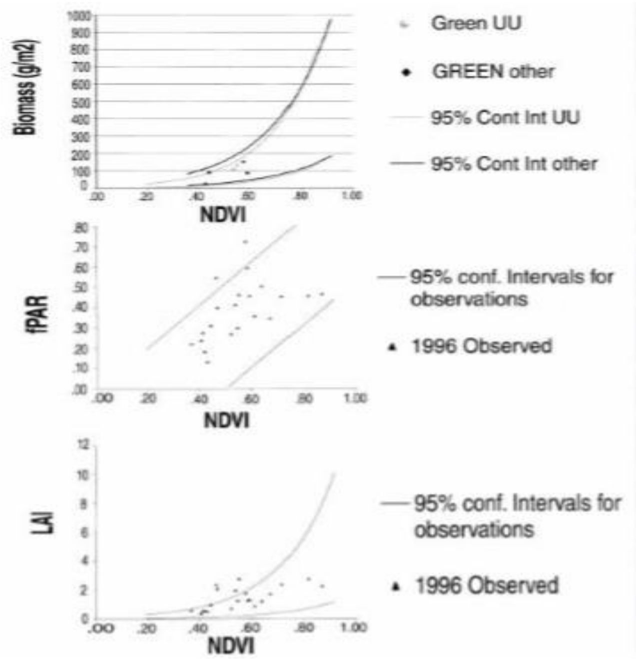

Fig 4: Three NDVI applications (Top) biomass and (Middle) fraction of absorbed photosynthetically active radiation (Fpar) ,(Bottom) leaf area index (LAI)

NDVI can be used for the following assessments:

•Stress assessment (droughts, fertilizing stripes (uneven) etc.)

•Species Delineation

•Leaf Area Index, biomass, chlorophyll concentration in leaves, plant productivity, fractional vegetation cover, accumulated rainfall, etc.

•Moisture problems detecting and measuring areas of crop stress caused by too much or too little precipitation or by inadequate drainage

•Fertilizer, insect, disease weed and herbicide problems

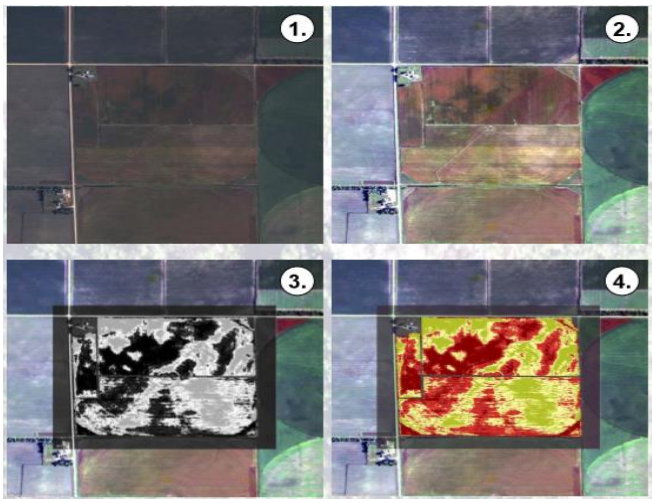

Fig 5: NDVI analysis

The way the process would be working is illustrated above:

- Raw image
- A simple equalization helps pull out contrast.
- An NDVI layer is calculated for the cotton field. Dark areas have low chlorophyll and light areas have more. The NDVI is an index ranging from -1.0 to 1.0.
- NDVI layer is color coded to better visualize vegetation coverage.

2. PROCESS FLOW

The entire process will have 2 simultaneous components to it. First step of the process would involve putting this system to work at local horticulture and agricultural departments where disease research takes place and creating an information database, which would be gradually upgraded on a timely basis with all the new pictures being taken and up to speed on the latest of information. The pictures that re then taken via the IR camera are then processed via a microprocessor for obtaining the NDVI value and are then uploaded to the cloud based database for correlation with the existing information and figuring out the specific disease. This information is then routed back to the user and the problem is specified. The first component of the process is described in the flowchart given below. Fig 6.

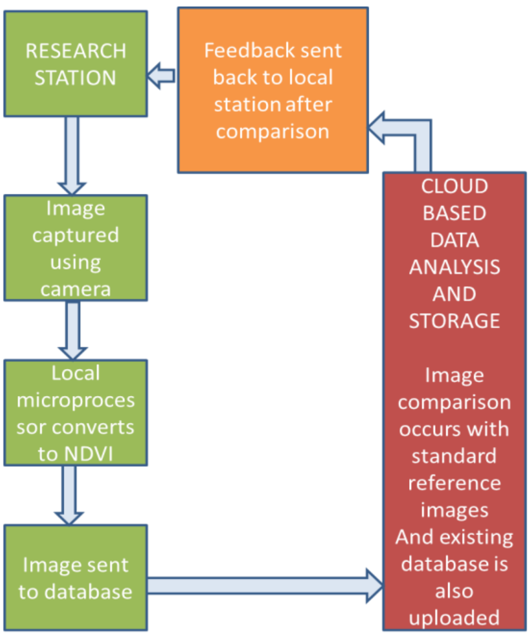

Fig 6: First component of the process.

The second component of this process consists of selling the setup to a consumer once a database has been setup with information about the various plants and their diseases. Some of the plants that this would be used for is tomatoes, roses, groundnuts, etc.

As detailed in the fig below Fig 7, once the image is taken by the IR camera on the vehicle, it is again processed by the microprocessor and the NDVI value is obtained after which it is sent to the cloud based database we have already setup where it is cross referenced with the information present in the database about various diseases and gives the output in the form of the particular disease and a solution as well to eradicate that particular disease. This information is directly sent to the farmer/client.

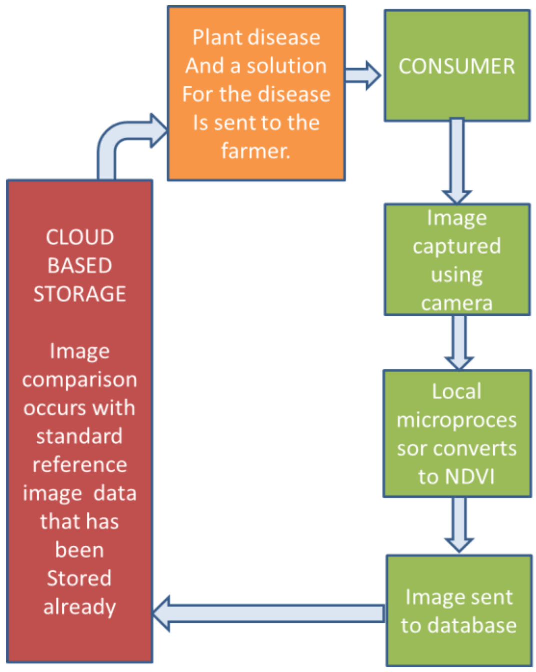

Fig 7: Second component of the process.

Both these processes occur simultaneously once the system is done setting up. The entire process occurring simultaneously looks like this Fig 8.

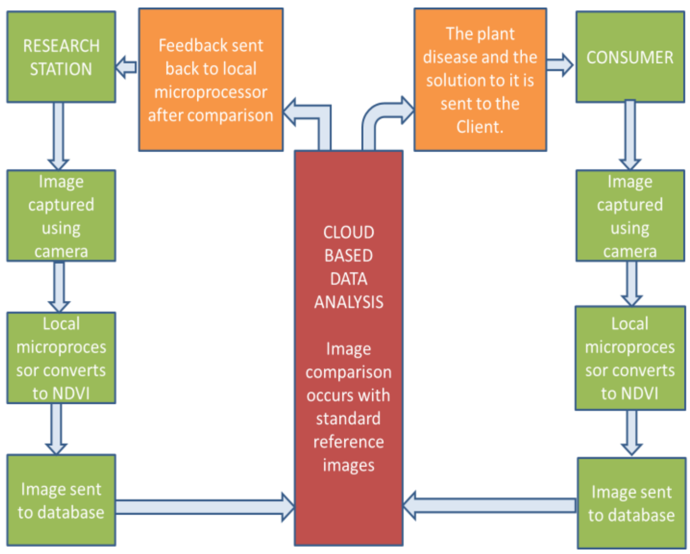

Fig 8: Complete process setup

3. NDVI based diagnosis

NDVI is used to widely examine the relationship between the growth rate of vegetation and spectral variability. It is also vital in detection of vegetation production and changes in vegetation. Given below, we have a study of a potato crop field with it being mapped Fig 8. and with the relevant areas of it sorted through depending on the health level of the crop.

Fig 9: Survey pattern of the field

Given below is the picture is that one in which the data has been analysed and the NDVI map has been generated. The red areas (circled below) show parts of the field that will not produce useable potatoes whereas the green and yellow areas should still produce (Fig. 10)

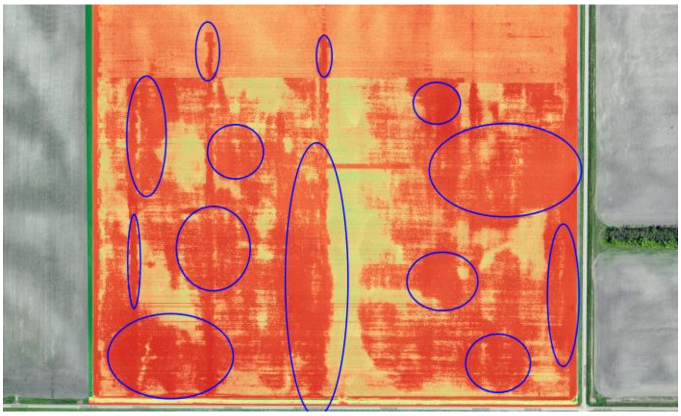

Fig 10: NDVI map

NDVI value	Description
0.3 – 0.8	Dense vegetation canopy
0.1 – 0.2	Soils, red soil, etc.
0.1 and below	Barren areas of rock, sand. Etc.
0.2 – 0.3	Shrubs and grasslands
0.6- 0.8	Temperate and tropical rainforests

Fig 11: NDVI values and their corresponding results

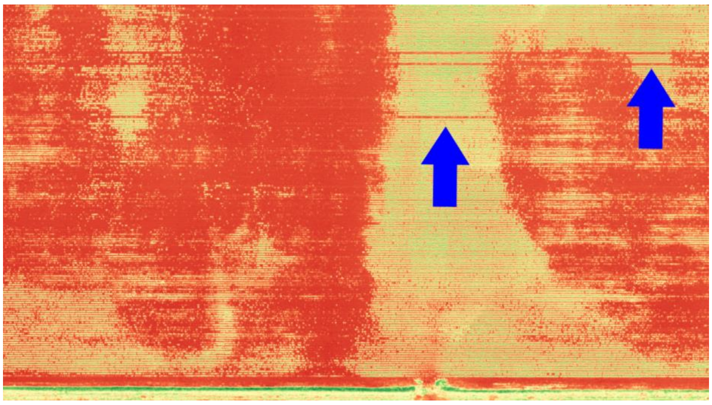

Fig 12: Lines depicting missing vegetation

In the diagram above (Fig. 12) we have a few line like artefacts that show up in the NDVI diagram when observed closely. This sort of analysis on such a deep level would otherwise be time consuming or would be most likely to go undetected.

This method of having fields surveyed is extremely fast and is able to weed out even the slightest of inconsistencies.

3. CONCLUSIONS

The conclusion that we got from this research is that this method has proven to be less resource intensive and more time efficient compared to the other existing methods with lower human capital required. This method has proven to be extremely cost effective as well compared to the others.

Future scope of the work include primary use in urban and semi urban farming scenarios since it is poised to grow exponentially in the coming years as well as being used extensively in the research domain of plant borne diseases.

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REFERENCES

[1] Mamata Swain, “Crop Insurance for Adaptation to Climate Change in India”, ASIA RESEARCH CENTRE WORKING PAPER 61, July (2014)

[2] Savita Kolhe, Harvinder S. Saini, Raj Kamal, G. K Gupta, ‖KMSCD: Knowledge Management System for Crop Diseases,‖ 978-1-4244-5612-3/09/$26.00 c_2009 IEEE (2015)

[3] E. W. Chappelle, S. K. Moon, and J. E. McMurtrey III, ―Ratio analysis of reflectance spectra (RARS): An algorithm for the remote estimation of the concentration

of chlorophyll a, chlorophyll b, and carotenoids in soybean leaves," Remote Sens. Environ., vol. 39, pp. 239–247, (1992).

[4] Gupta, G.K., Chauhan, G.S., Symptoms, identification and management of soybean diseases, technical bulletin, National Research Centre for Soybean (ICAR), Indore, India. 92. (2005)

[5] S. Prasad, P. Kumar and A. Jain, "Detection of Disease Using Block-Based Unsupervised Natural Plant Leaf Color Image Segmentation", Swarm, Evolutionary, and Memetic Computing, LNCS, Springer-Verlag Berlin Heidelberg, vol. 7076/2011, (2011), pp. 399-406.

[6] F. Mokhtarian and S. Abbasi, "Matching shapes with self-intersection: application to leaf classification", IEEE Transactions on Image Processing, vol. 13, (2004), pp. 653-661.

[7] S. Prasad, P. Kumar and R. C. Tripathi, "Plant leaf species Identification using Curvelet Transform", Proceeding of 2nd IEEE International Conference on Computer and Communication Technology (ICCCT'11), (2011), pp. 646-652.

[8] Moshou, D.; Ramon, H.; Baerdemaeker, J.D. A weed species spectral detector based on neural networks. Precis. Agric. 2002, 3, 209-223

[9] Panda, S.S. Data mining Application in Production Management of Crop (Paper 1). Ph.D. Dissertation, North Dakota State University, Fargo, ND, USA, 2002.

[10] Casanova, D.; Epema, G.F.; Goudriaan, J. Monitoring rice reflectance at field level for estimating biomass and LAI. Field Crop Res. 1998, 55, 83-92.

[11] Kriegler, F.J.; Malila, W.A.; Nalepka, R.F.; Richardson, W. Preprocessing transformations and their effects on multi-spectral recognition. In Proceedings of the Sixth International Symposium on Remote Sensing of Environment, University of Michigan, Ann Arbor, MI, USA, 1969; pp. 97-131.

[12] E. M. Porcari, "Connecting People, Technology and Knowledge for Agricultural Innovation: Ubiquitous networks and cloud computing", (2009) May 10, http://ictkm.cgiar.org/other_activities/2252_Porcari_Ubiquitous_ networks_ and_cloud_computing__2_.pdf.

[13] Thiam, S.; Eastmen R.J. Chapter on vegetation indices. In Guide to GIS and Image Processing, Volume 2; Idrisi Production: Clarke University, Worcester, MA, USA, 1999; pp. 107-122.

[14] CARLSON, T. and RIPLEY, D., 1997, On the relation between NDVI, fractional vegetation cover, and leaf area index. Remote Sensing of Environment, 62, pp. 241–252.

[15] Chouhan R, Rao N," Vegetation detection in Multi spectral remote sensing images: protective Role-analysis of coastal vegetation in 2004 Indian Ocean Tsunami. Geo-Information for Disaster Management ", Procedia Technology 6, pp., 612 – 621., 2012.

[16] A.K. Bhandari, A. Kumar, "Feature Extraction using Normalized Difference Vegetation Index (NDVI): A Case Study of Jabalpur City", Proceedings of Communication, Computing & Security. Procedia Technology Volume 6, pp. 612– 621, 2012.

[17] . Nageswara PPR, Shobha SV, Ramesh, KS, Somashekhar RK," Satellite -based assessment of Agricultural drought in Karnataka State, Journal of the Indian society of remote sensing ", 33 (3), pp. 429-434., 2005