Sensor Fusion to Sense Plant Height, Yield and Topographic Features in Real-time

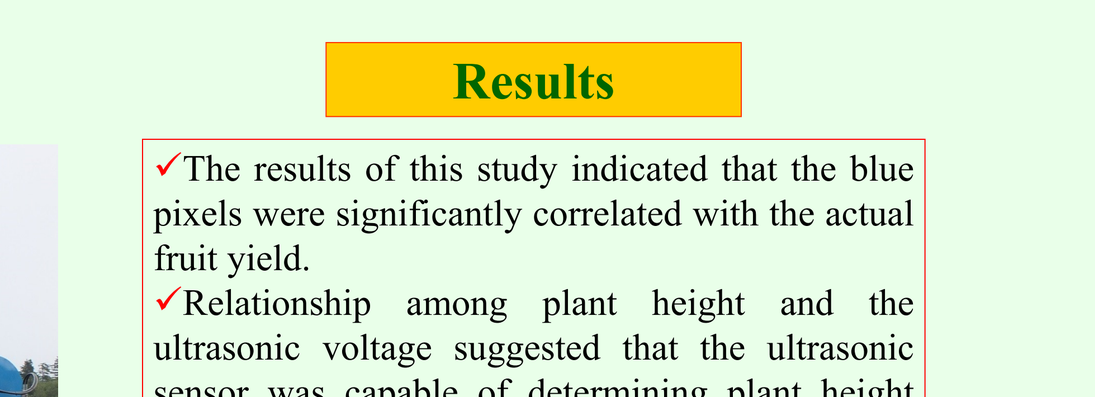
Precision Agriculture Research Program

Introduction

Mobile ground sensors are an emerging technology to deliver data of high spatial resolution to assess pre-harvest yield, and can be integrated with material delivery systems to facilitate real-time applications. The unique features of wild blueberry cropping system emphasis the need to merge different sensors for real-time mapping of fruit yield and crop characteristics.

Objective:

The objective was to develop an integrated automated sensing system including ultrasonic sensors, RTK-GPS, µEye camera, custom software and a laptop computer to estimate plant height, fruit yield, slope and elevation in real-time.



Field layouts representing crop and weed coverage in monitoring sites

Yield monitoring system, ultrasonic sensor and RTK-GPS incorporated into a harvester

Results

✓The results of this study indicated that the blue pixels were significantly correlated with the actual fruit yield.

✓Relationship among plant height and the ultrasonic voltage suggested that the ultrasonic sensor was capable of determining plant height rapidly and reliably in real-time.

✓Software classified the measured height as a tall weed (goldenrod, grass, fern, etc.) if the height was greater than 30 cm, and bare spots if the height was less than 9 cm.

✓The maps developed in ArcGIS 10 suggested lower yield in the areas where the plants were tall or weeds were present.

✓Kriged maps suggested higher fruit yield in low lying areas (mild slope) and vice versa.

✓The low fruit yield on the steep slope areas may be due to erosion of nutrients.

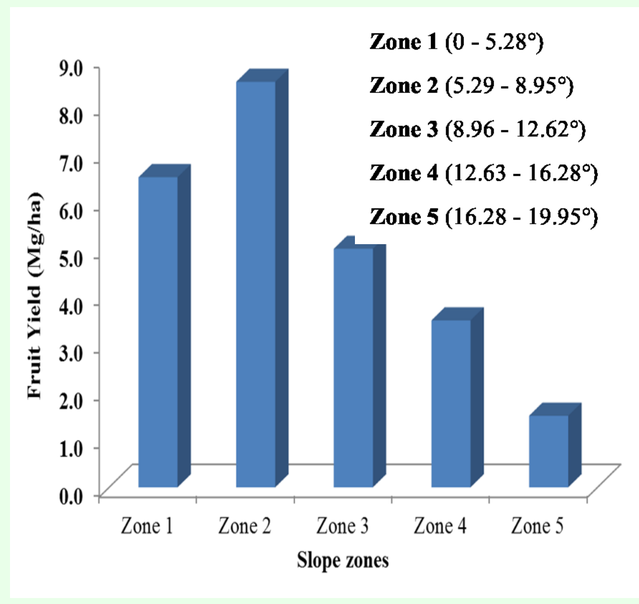
✓Zonal statistics in ArcGIS 10 showed higher plant height in low lying (mild slope) areas and vice versa.

✓The zonal statistics suggested higher fruit yield in low plant height areas and lower fruit yield in tall plants areas.

Conclusion

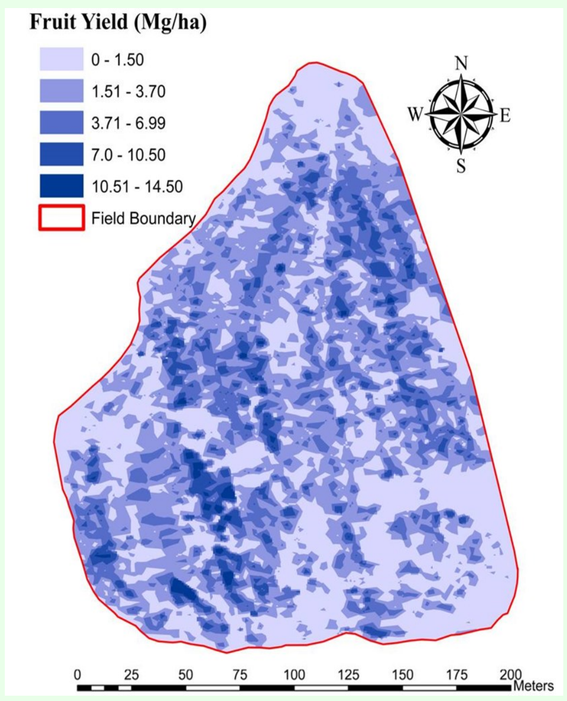
The developed system was efficient enough to map slope, fruit yield, height and elevation in real-time.

The information from the system could be used to estimate pre-harvest fruit yield. Other advantage is the implementation of site-specific management.

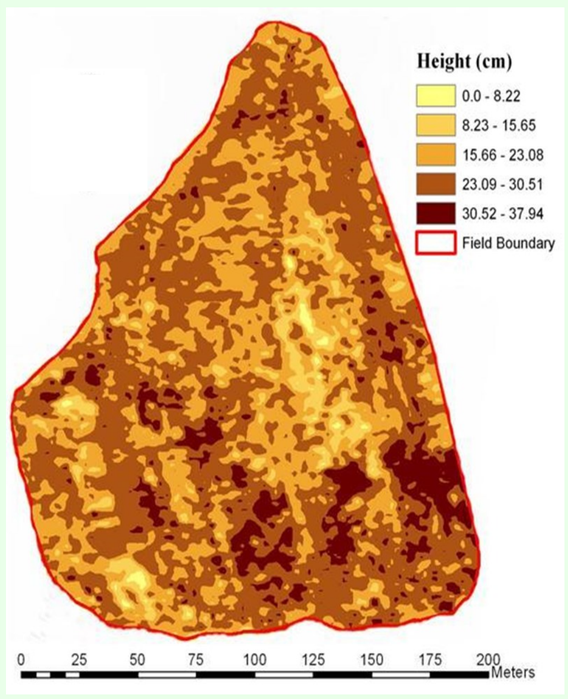


Methodology

The sensors, camera and RTK-GPS were connected to a laptop computer via custom developed software interface and serial cables. Two wild blueberry fields were selected and boundary and weed patches were mapped. The µEye camera for yield estimation was calibrated using a frame of 0.91 x 0.70 m. The height sensor was also calibrated. The developed system was operated in both fields after calibrations to map fruit yield, plant height, elevation and slope reliably. The maps were developed in ArcGIS 10 for visual display of mapped parameters.

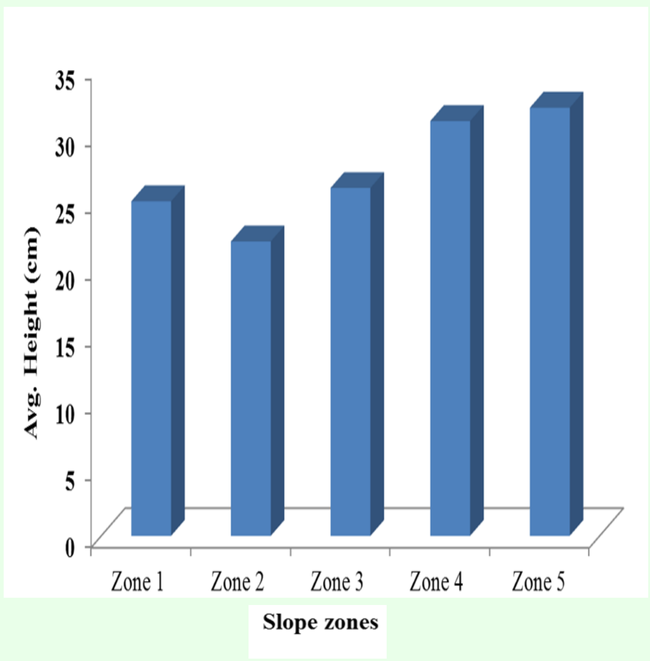


(a)



(b)

Kriged maps (a) Fruit yield (b) Plant height



Zonal statistics among the fruit yield, plant height and slope