Applications of LiDAR

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Papers

-Bees as biosensors by Jerry Bromenshenk

-Field demonstration of a scanning LiDAR by Erik Carlsten

Outline

- Introduction & Background
- Bees as biosensors
- Experiments
- Results
- Conclusion
- Remarks
- Questions

Introduction and background

- Development of electronic tracking chips
- Why LiDAR?

Figure 1: Honey bee with RFID

Figure 2: Honey bee with harmonic radar

Bees as Biosensors(i)

Why choose bees as biosensor?

- - Superb ability to detect chemical signal, less easily distracted, short training period
- - Less than 2% probability of false positives or false negatives when properly conditioned

Applications of the technology

- Detect chemicals of military concern
- Bioenvironmental monitoring

Bees as biosensors(ii)

- Bees as chemical biosensors:
  - Chemical signals
  - Proboscis extension reflex
  - Methods for conditioning by Ribbands.
- Traceable, free-flying biosensors

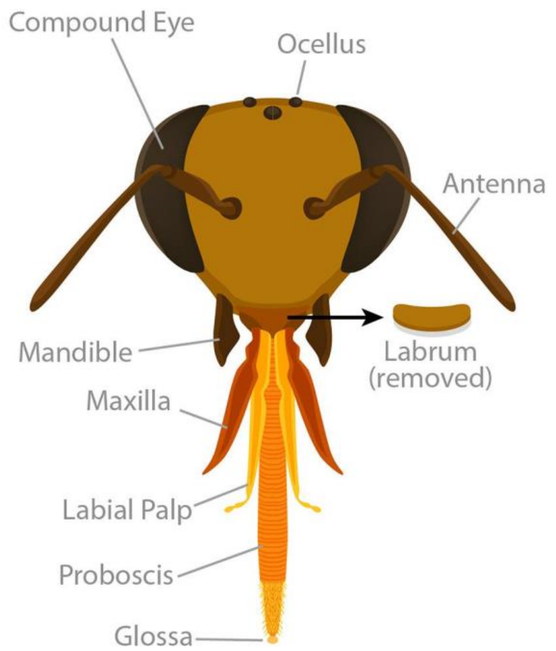

Figure 3: Bee anatomy

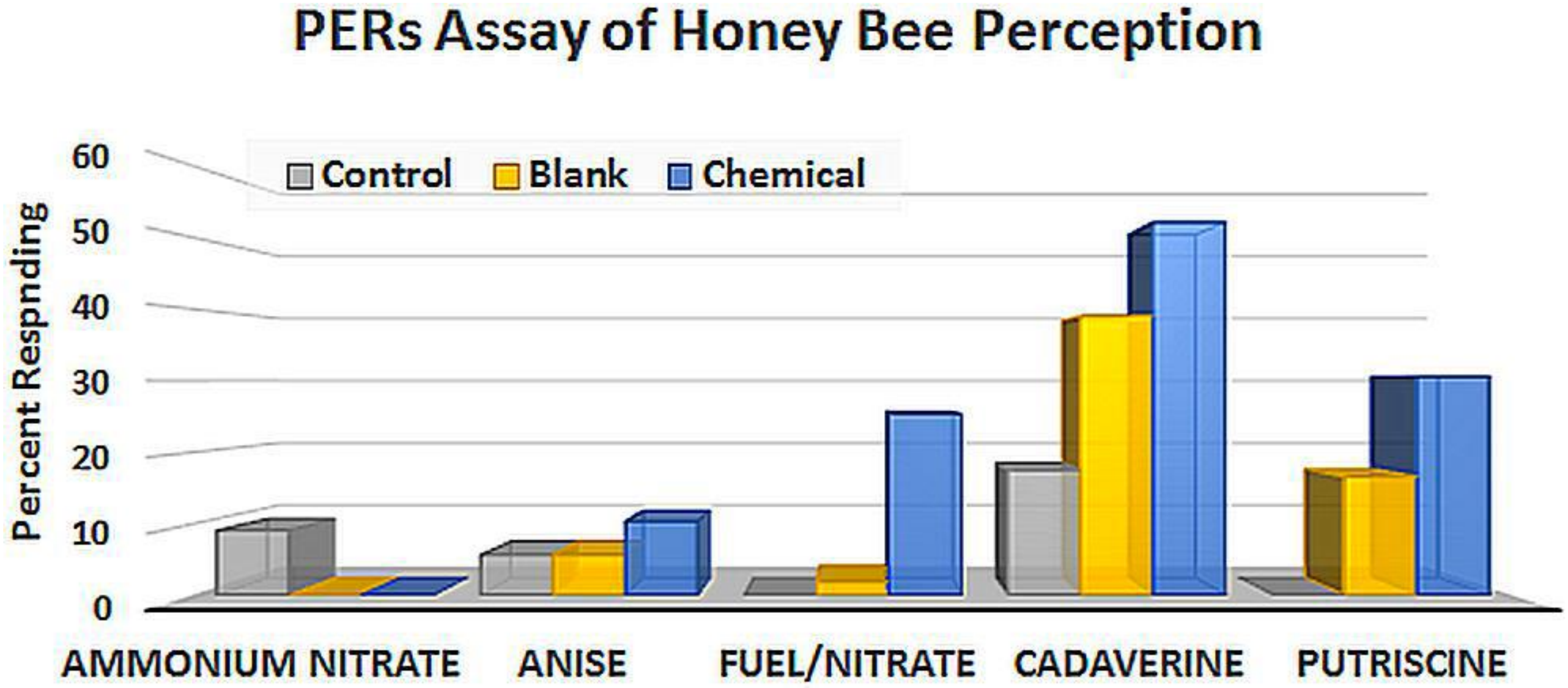

Figure 4: PERs results for chemical detection of fertilizer, fertilizer-based bombs, and decomposition products of animal carcasses compared to anise, a floral scent.

Experiment

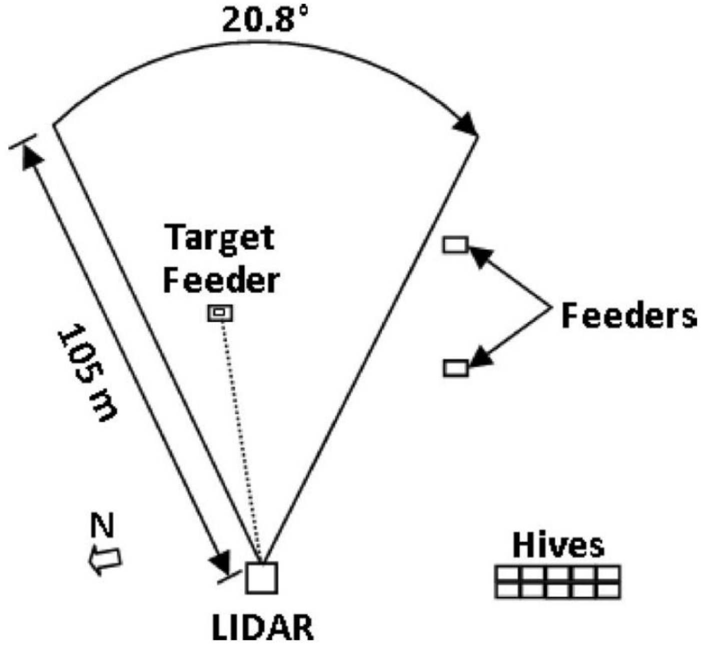

Fig. 7. A schematic of the experimental setup used for the Missoula, Montana, field experiment (target feeder location to scale, hives and external feeder locations approximate). The feeder footprint is 0.023 m × 0.023 m.

Figure 5: Schematic of the experimental setup used for the Missoula, Montana experiment

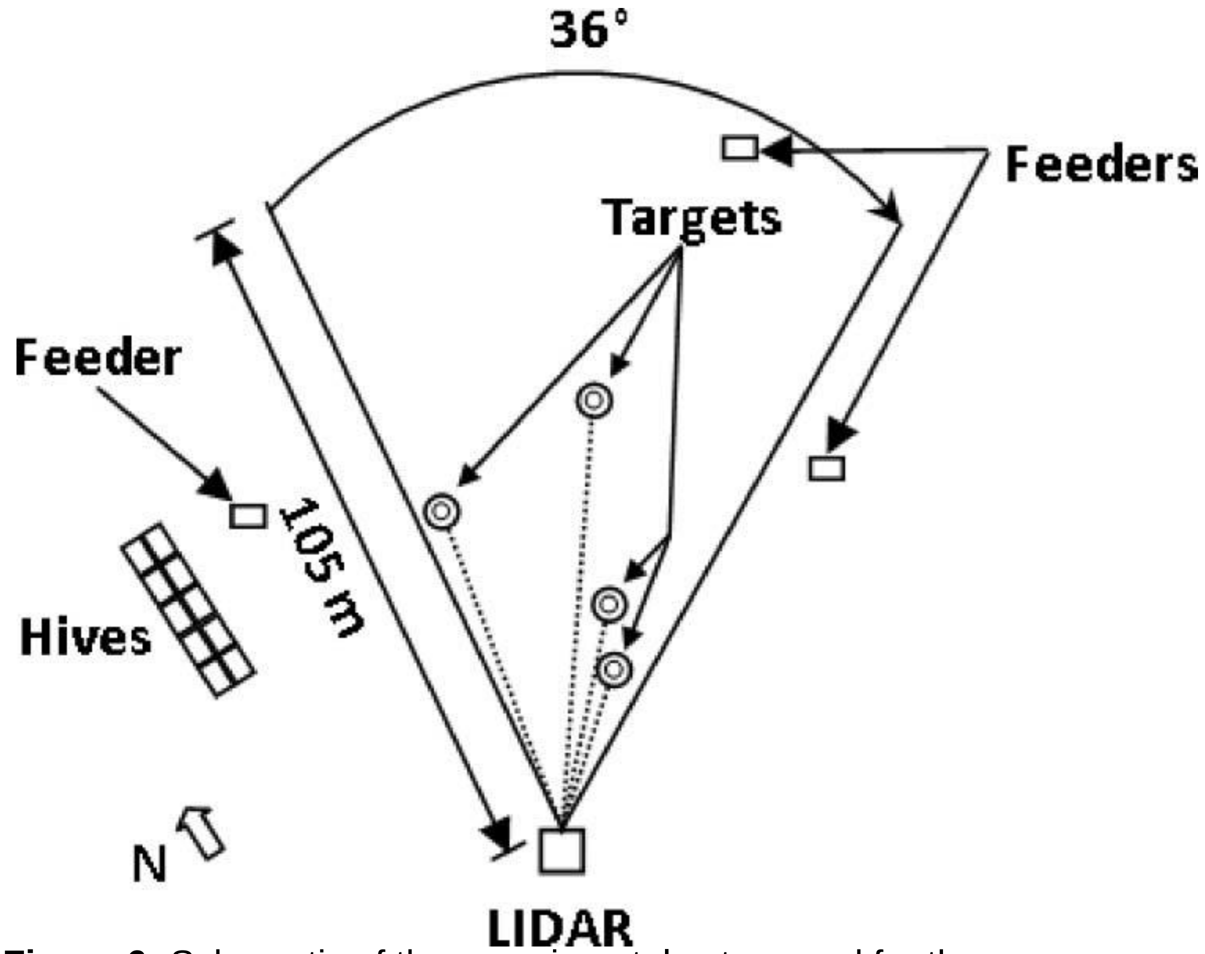

Figure 6: Schematic of the experimental setup used for the Missoula, Montana field experiment. Freeder footprint is 0.023m **x** 0.023m

Signal Processing

Figure 7: Time domain data

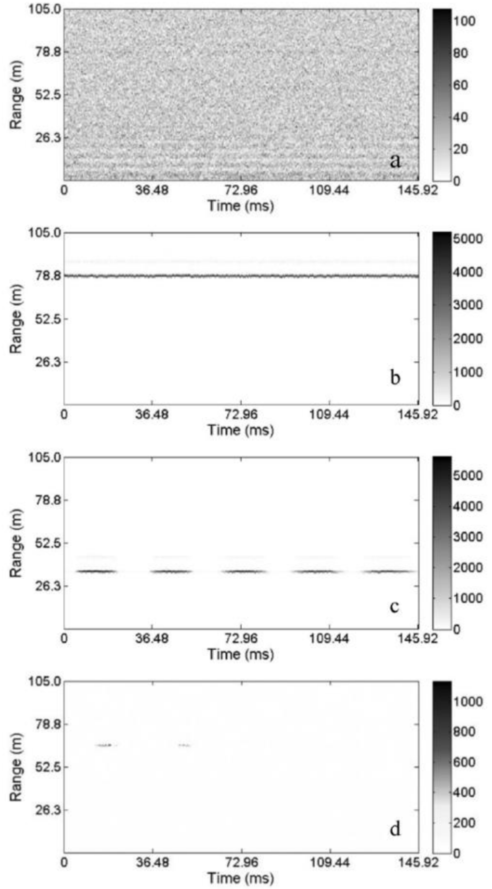

Fig. 3. Return as a function of the range bin and laser pulse number for the four signal classes. (a) Typical noise signal, (b) typical DC return signal, (c) typical modulated DC return, (d) typical return signal from a bee. As shown by the sidebars, each of these plots is scaled differently in order to illustrate the features of each class of signal.

Figure 8: Frequency domain data

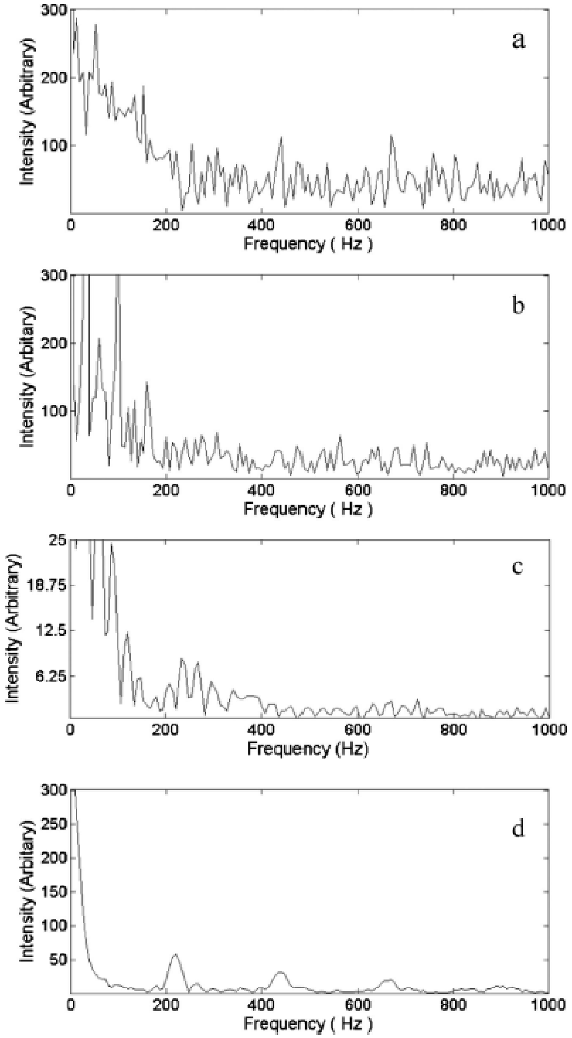

Fig. 5. Discrete Fourier transforms for the signals observed in 4(b) (DC), 4(c) (modulated DC), 4(d) (average bee return), and the lower plot in Fig. 2 (strong bee return), respectively.

Results(i)

A: Average voltage return
B: Filter out DC and noise returns
C: Get new score matrix, and use gaussian filter to get density map
D: Use fourier transform to get one more score matrix, use gaussian filter, to get density map of score matrix

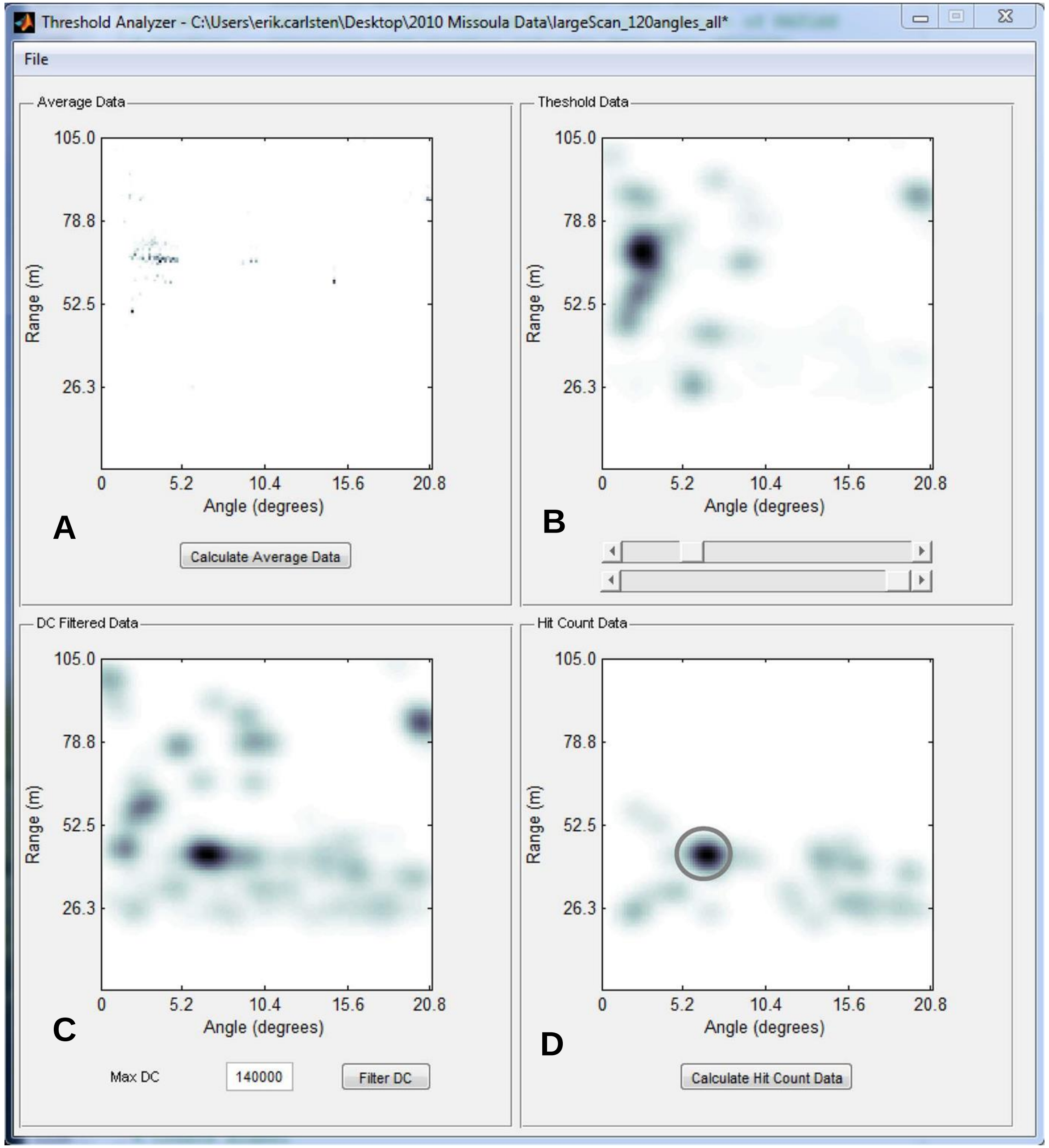

Figure 9: LiDAR results

Results(ii)

A: Average voltage return
B: Filter out DC and noise returns
C: Get new score matrix, and use gaussian filter to get density map
D: Use fourier transform to get one more score matrix, use gaussian filter, to get density map of score matrix

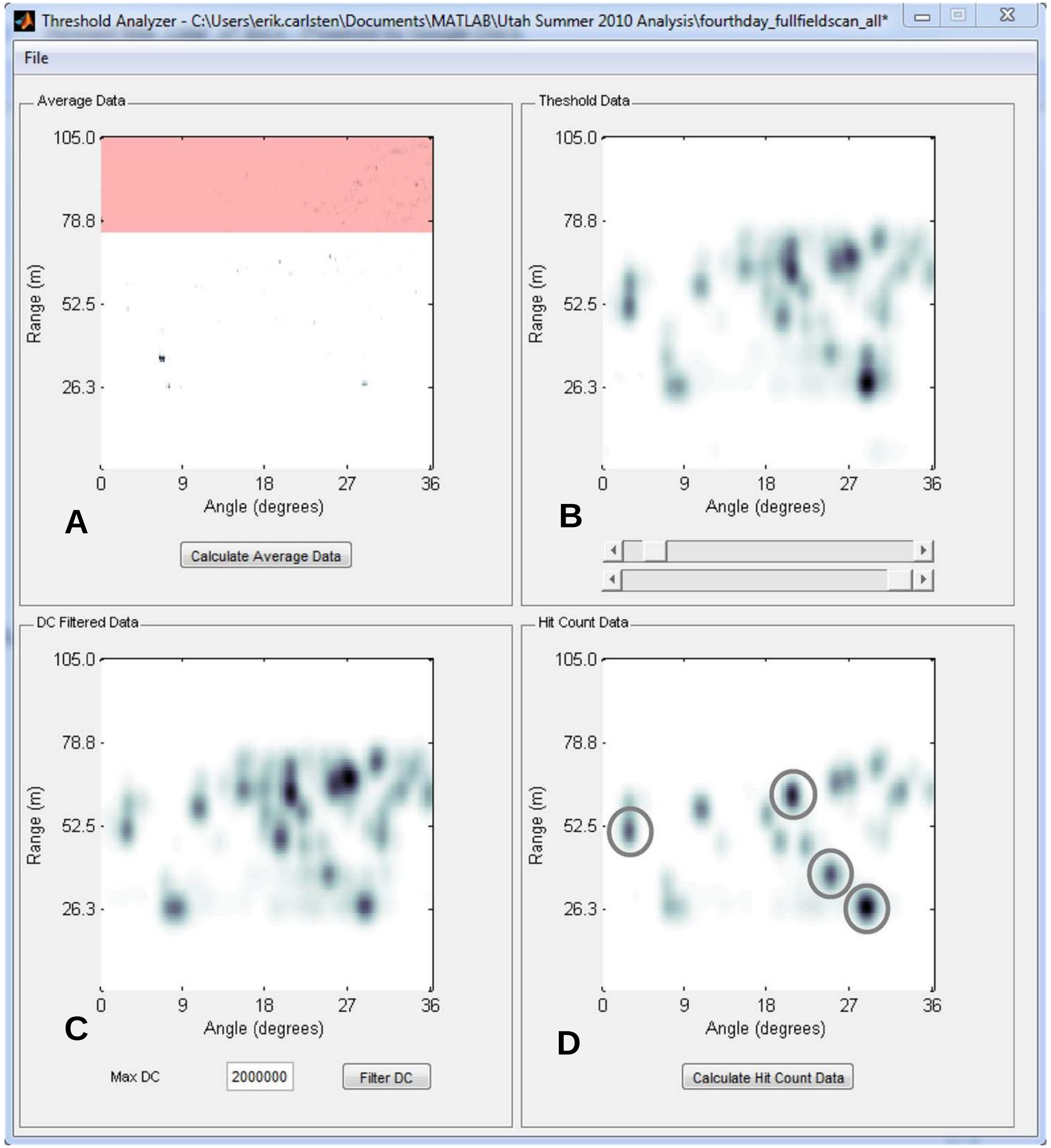

Figure 10: LiDAR results

Remarks

i) Determine upper and lower threshold values for variety of weather conditions rather than determine threshold value onsite.
ii) A more powerful laser for better output intensity. This would allow for a higher intensity peak like in figure 7.

Questions