Introduction to Computer Vision

•••

For Bio-GeoSpatial Technologies Seminar
By
Bharath Sudarsan

Human Challenges

Computer Vision

Basic Steps

1. Preprocessing and filters
2. Detection and tracking
3. Learning and response

Smoothing

Filters

1. Median
2. Mean
3. Gaussian
4. Thresholding Average

Human Vision

What do we see ?

Colours

Edges

Shapes

Enhancement - Edge detection

RGB color image

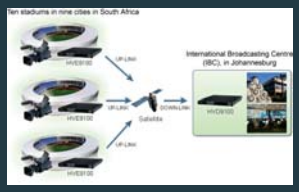
Canny Edge detection

Shape detection

Hough transform

Short Video of basic Real-time detection

Colour Spaces



YIQ or NTSC

Ycbcr or YUV

CMKY

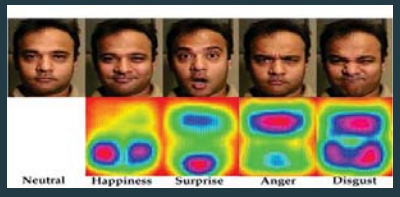
Interlude to past projects

A. UAV based Forest Fire Detection
B. UAV based Wake and Marine Mammal Detection
C. Microscope based Soil Texture Property Analysis
D. Robotics Competition

Color Detection

Machine Vision color detection

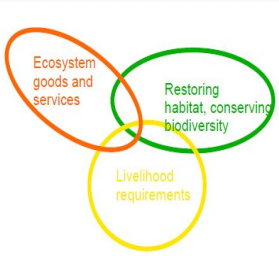
Machine Learning

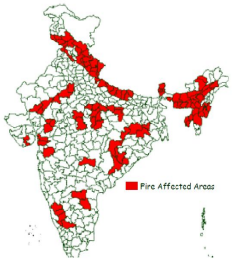


Research Project : I
Hex-Rotor Aerial Vehicle For Forest And Agricultural Supervision

Bharath Sudarsan
Krishna Subramani
Anna University
Chennai
Date: 18/05/2013

Forests - A Disappearing Wealth





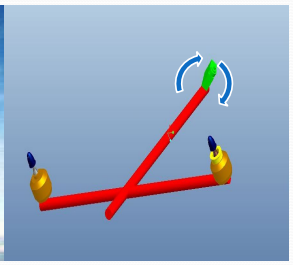
The Tradeoff : Speed vs Stability

Fixed Wing Design

Rotocraft Design

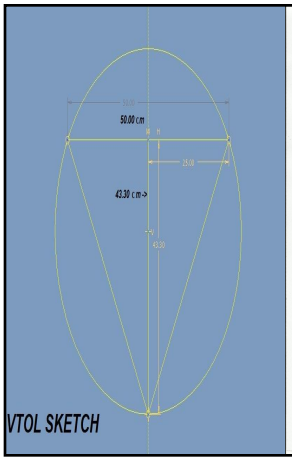
INITIAL DESIGN

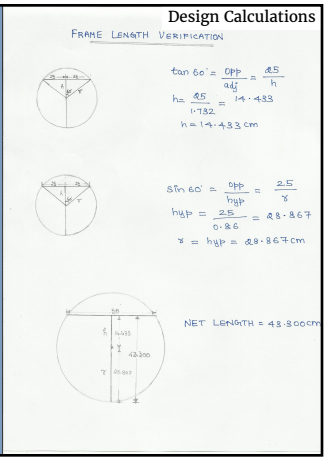
Inspiration : Being V-22 Osprey



Preliminary CAD render Prototype 1

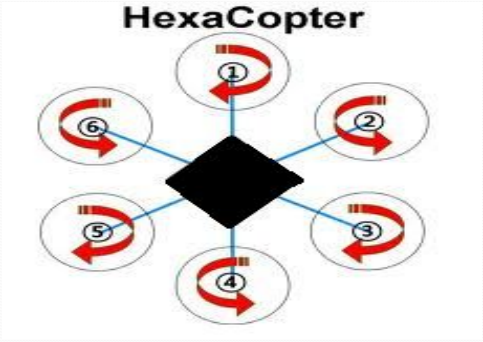
Design Calculations





Prototype Failure

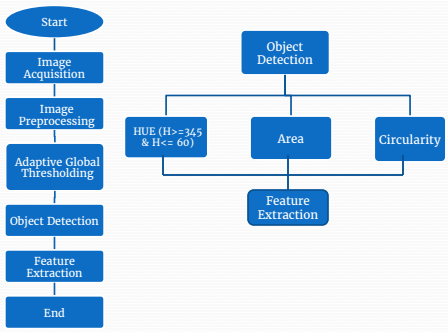
Final Design



Final Design

IMAGE PROCESSING

Flow Diagram



Parameters of Interest

Two Consecutive Frames - Night

Area Data from Frame 1 - Night

Variable Editor - cc.PixelIdxList

cc.PixelIdxList <1x3 cell>

	1	2	3	4	5	6
1	<310x1 double>	<51008x1 double>	<311x1 double>			
2						

Circularity Data from Frame 1 - Night

Variables - allCircularities

allCircularities <1x3 double>

	1	2	3	4	5	6	7	8	9
1	309.7158	1.7474	4.8075						
2									

Area Data from Frame 2 - Night

Variable Editor - cc.PixelIdxList

cc.PixelIdxList <1x3 cell>

	1	2	3	4	5	6
1	<467x1 double>	<36833x1 double>	<300x1 double>			
2						

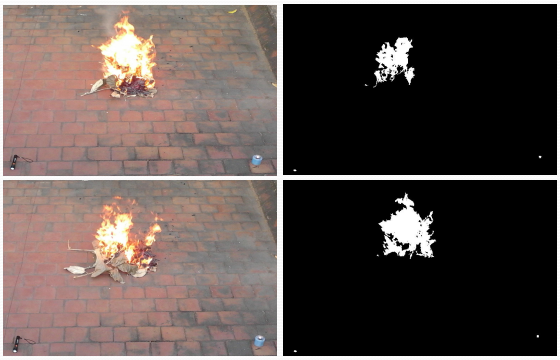
Circularity Data from Frame 2 - Night

Variables - allCircularities

allCircularities <1x3 double>

	1	2	3	4	5	6	7	8	9
1	386.9364	1.3682	4.9171						
2									

Two Consecutive Frames - Day



Area Data from Frame 1 - Day

Variable Editor - cc.PixelIdxList

cc.PixelIdxList <1x4 cell>

	1	2	3	4	5	6	7	8
1	<3465x1 do...	<25x1 doub...	<85233x1 d...	<95x1 doub...				
2								

Circularity Data from Frame 1 - Day

Variables - allCircularities

allCircularities <1x4 double>

	1	2	3	4	5	6	7	8	9
1	1.1599	7.8007	15.9860	1.4570					
2									

Area Data from Frame 2 - Day

Variable Editor - cc1.PixelIdxList

cc1.PixelIdxList <1x4 cell>

	1	2	3	4	5	6	7	8
1	<2582x1 do...	<1005x1 do...	<8339x1 d...	<86x1 doub...				
2								

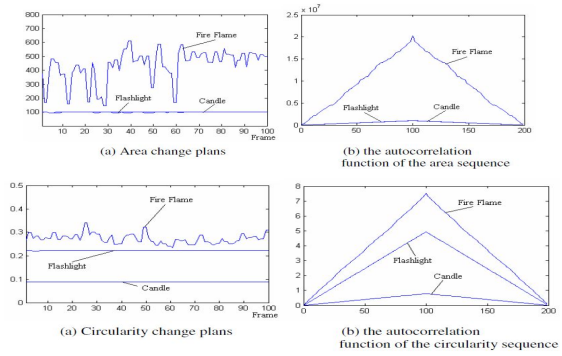
Circularity Data from Frame 2 - Day

Variables - allCircularities

allCircularities <1x4 double>

	1	2	3	4	5	6	7	8	9
1	1.0458	6.2141	16.0770	1.2814					
2									

Result Visualization



SCOPE FOR FURTHER DEVELOPMENTS

•**Preventive Action** : Smoke detection proves to be vital for early detection. This is essential as when a forest fire starts the economical and ecosystem damage might already be too great.

•**Rate of Response** : The area of every flame region in an image can be compared to the next immediate slide to calculate the increase in the spreading of fire which is crucial to decide the type and the pace of response.

REFERENCE

•Joceli Mayer,Ebroul Izquierdo"Efficient visual fire detection applied for video retrival",16th European signal processing conference (2008).

•A.C.Kermode, Mechanics Of Flight 11th edition, Pearson Perntice Hall Publications(2006).

•A.C.Kermode Flight without Formula 11th edition, Pearson Pemtice Hall Publications

•Luis merino, Anibal ollero , Xavier viegas, "Multi UAV experiments – application to forest fire".

•David W.Casbeer, Derek B.Kingston, Randal W.Beard, "Cooperative Forest Fire Surveillance Using a Team of Small Unmanned Air Vehicles", International journal of systems science. (2005), pg 1-18.

Thank you

QUERIES????

RESEARCH STUDY : II FRAME COMPARISON ALGORITHM TO DETECT WAKES

Authors:
Bharath Sudarsan
Krishna Subramani

Date: 12/02/2013

EXISTING TECHNIQUES

- Coast guard patrolling - Field Monitoring
- Remote-sensing – Satellite Monitoring.

COAST GUARD PATROLLING

- Requires 24x7 constant manual labor
- Subject to inaccuracies and misinterpretation
- Technique is compromised during extreme weather and calamities

SATELLITE REMOTE SENSING

- Provides up-to-date information.
- Noise due to environmental factors : humidity, density and temperature

UAVs - THE FUTURE OF SURVEILLANCE

MILITARY DRONE

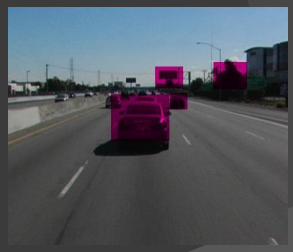
OUR DESIGN

WAKE

KELVIN WAKE

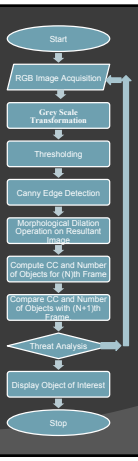
TURBULENT WAKE

COMPUTER VISION AND VEHICULAR TELEMETRY



REAL TIME TARGET DETECTION AND TRACKING

Simplified Image Processing Flow Diagram

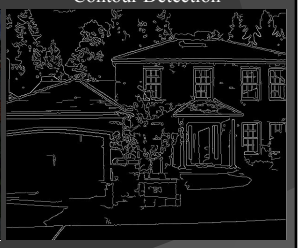


Feature Extraction

RGB Image

Sample Input

Contour Detection



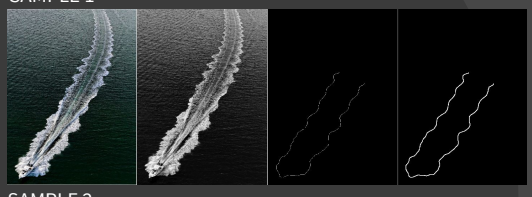
Sample output

SIGMA – DATA vs. NOISE

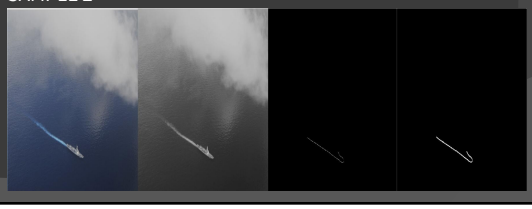
Sigma = 0.2

Sigma = 2.0

SAMPLE 1

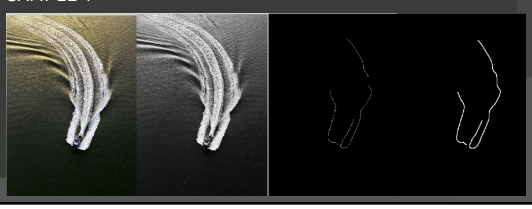


SAMPLE 2

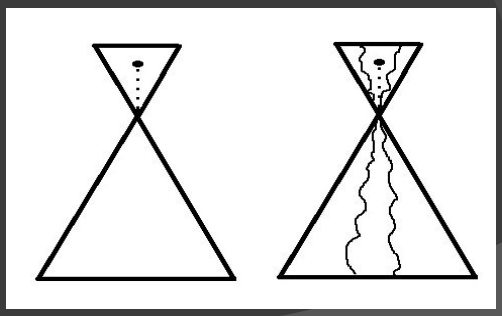


SAMPLE 3

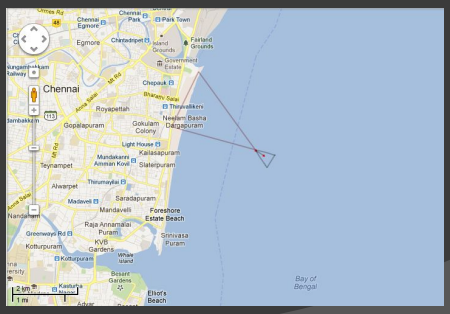
SAMPLE 4



WAKE SHADOWING TECHNIQUE



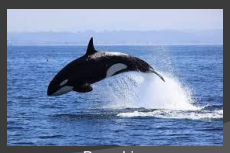
MAP INTERPRETATION



BEHAVIOUR of MARINE ORGANISMS

Tail slapping

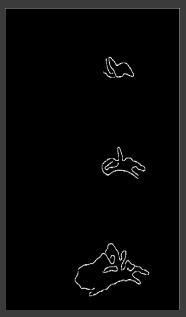
Porpoising



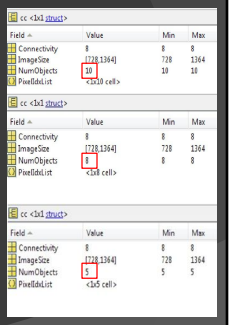
Breaching

SURFACE MOTION 1

RGB IMAGE

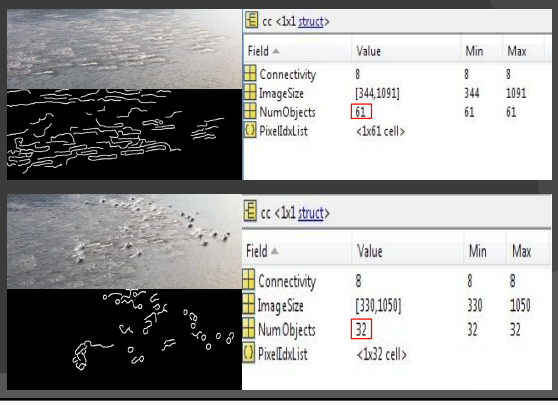


DILATED OUTPUT

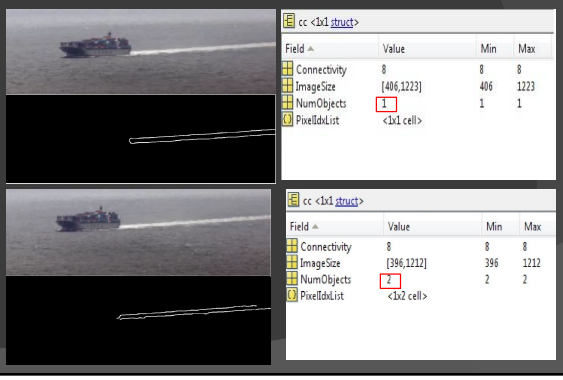


NUMBER OF OBJECTS

DECOY ELIMINATION – PART 1



DECOY ELIMINATION – PART 2



WORK IN PROGRESS

REFERENCES

[1] A.C.Kermode, Mechanics Of Flight 11th edition, Pearson Prentice Hall Publications(2006).

[2] M.Kontitsis, K.P.Vlavanis, R.Garcia, “A Simple low cost vision system for small unmanned VTOL vehicles”.

[3] Andreas Arnold- Bos, Arnaud Martin, Ali Khencaf , “Obtaining a Ship’s Speed and Direction from its Kelvin Wake Spectrum Using Stochastic Matched Filtering”.

[4] Lijun Ding, Ardeshir Goshtasby, “On the Canny edge detector”.

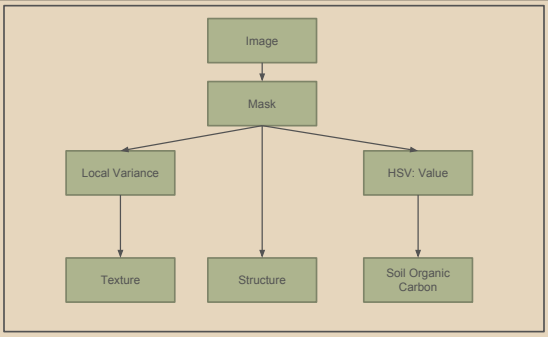
[5] David W.Casbeer, Derek B.Kingston, Randal W.Beard, ”Cooperative Forest Fire Surveillance Using a Team of Small Unmanned Air Vehicles”.

THANK YOU

Analysis of Soil Properties using Machine Vision

Bharath Sudarsan[1]
Dr. Viacheslav Adamchuk[1] and **Dr. Asim Biswas**[2]
[1] Department of Bioresource Engineering, McGill University
[2] Department of Natural Resource Sciences, McGill University

Research Question



Soil Texture

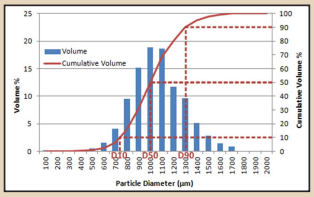
Relative proportion of soil mineral particles between designated maximum and minimum diameters (sand, silt and clay).

Importance:

- pH
- Drainage
- Aeration
- Organic matter
- Buffering capacity
- ...

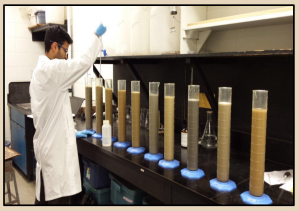
Particle Size Distribution (PSD)

It is the list of values or statistical distribution that defines the relative amount of different size fractions of soil particles.



Traditional Methods

Soil Sieving Method



Hydrometer Method

Need for Faster Techniques

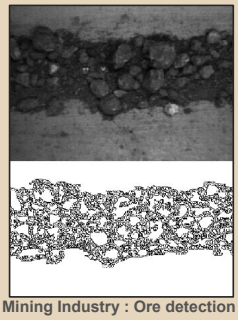
Field Sampling Break Summer 2014

Modern Methods

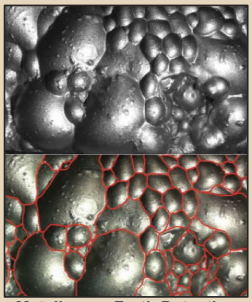
Laser Diffraction Method

Image Analysis

Image Processing



Mining Industry : Ore detection



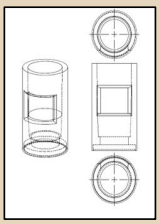
Metallurgy : Froth Detection

Image Sensor

Dino-Lite Digital Microscope

Specifications:
Microscope- Dino-Lite AD-7013MT
Resolution- 5 MP
Magnification- 200X

Image Acquisition System



CAD Holder Schematic

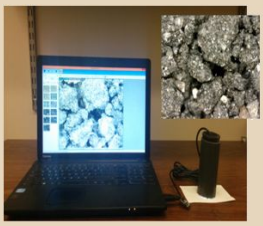
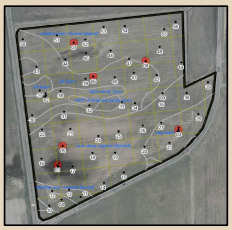


Image Acquisition System

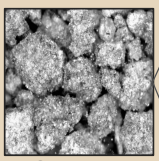
Sampling



Field 26 – Macdonald Campus farm

In-situ soil data collection- Field 26

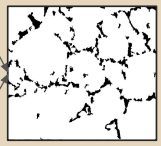
Mask Development



Gray Image

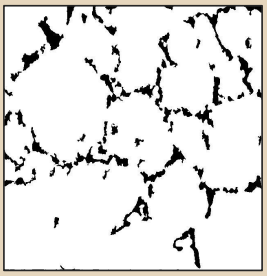
Window 1

Window 2



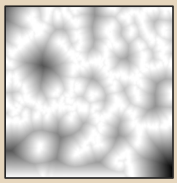
Mask

Connected Components

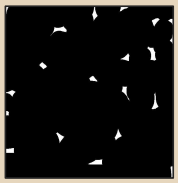


Mask(Pre-Segmented)

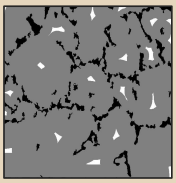
Mask Development



Euclidean Distance Transform

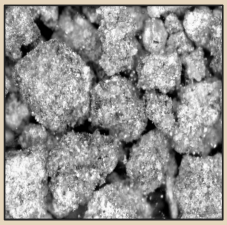


Detected Minima



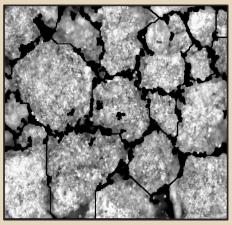
Imposed minima

Application of Mask



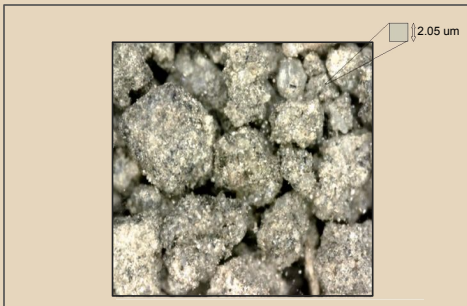
Gray Image

Segmented Mask

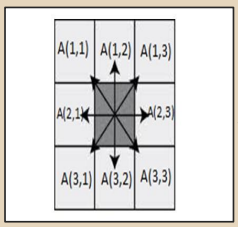


Masked Image

Scaling



Moving Window



Kernel

Local Variogram

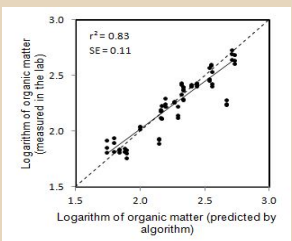
1. A(i,j) = 0.5[(A(i,j)-A(2,2))^0.5]
2. A(2,2) = ∑A(i,j)
3. NaN mean(F(x,y))

Variable Size

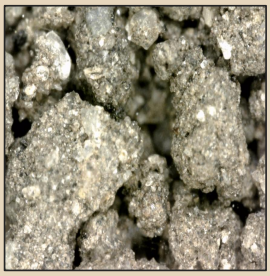
1. 02 um window - 1 pixel distance.
2. 10 um window - 5 pixel distance.
3. 50 um window - 25 pixel distance.

Prediction: Sand (g/kg)

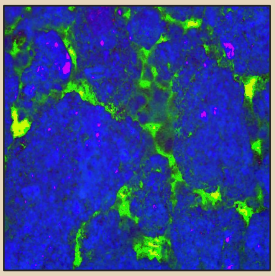
Performance
r^2 = 0.63
SE = 68.24 g/kg
N = 56 X 3 = 168



HSV: Significance of Value



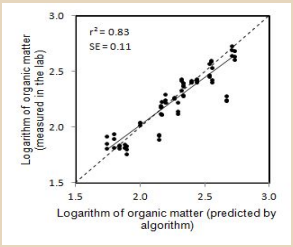
RGB Image



HSV Image

Prediction: OM (g/kg)

Performance
r^2 = 0.83
SE = 0.11
N = 56 X 3 = 168



Summary

Conclusion:

- Low cost in-situ soil property sensor.
- Local variance method is feasible.
- Further testing is essential.

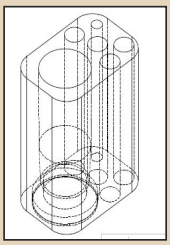
Field 86 – Macdonald Campus farm

Future work

Scope :

- Soil structure.
- Potential for sensor fusion.

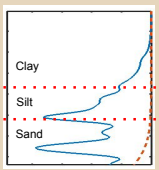
Aggregates



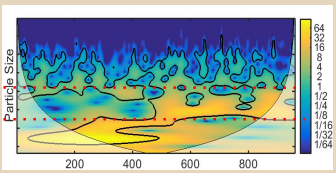
OSA - Holder

Wavelet

More advanced mathematical approaches like wavelet are currently being explored.



PSD



Wavelet Transformation

Acknowledgements

I would like to extend my gratitude to

- Dr.Wenjun Ji , Mr.Fransisco Ruiz & Mr.Florian Reumont
- Mr.Antoine Pouliot ing. Jr agr.
- Mr.Trevor Stanhope

Thank you

Contact:
Department of Bioresource Engineering
E-mail: bharath.sudarsan@mail.mcgill.ca
Office: MS1-094, phone: 514-398-7657
Robotics Lab: MSB-024, phone: 514-398-8712

McGill

www.mcgill.ca