

The 30th International Bird Strike Committee Conference



Image sensing technique for flying bird detection and classification in natural background



Kotaro TAKESHIMA*, Yuji TASAKA*, Yuichi MURAI*
Yasushi TAKEDA**, Hiroyuki KUMENO***



*Graduate School of Engineering, Hokkaido University

**Solution Research Laboratory, Tokyo Institute of Technology

***NEC Corporation

LFC supported by NEC

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coordinated

IBSC : Japan : Four presentations

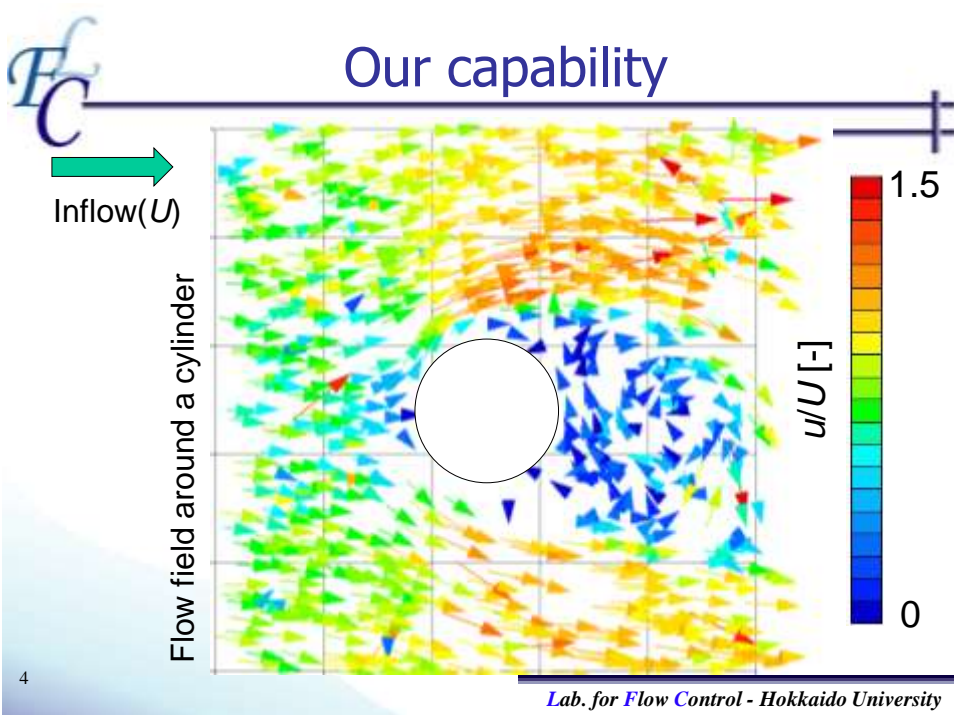
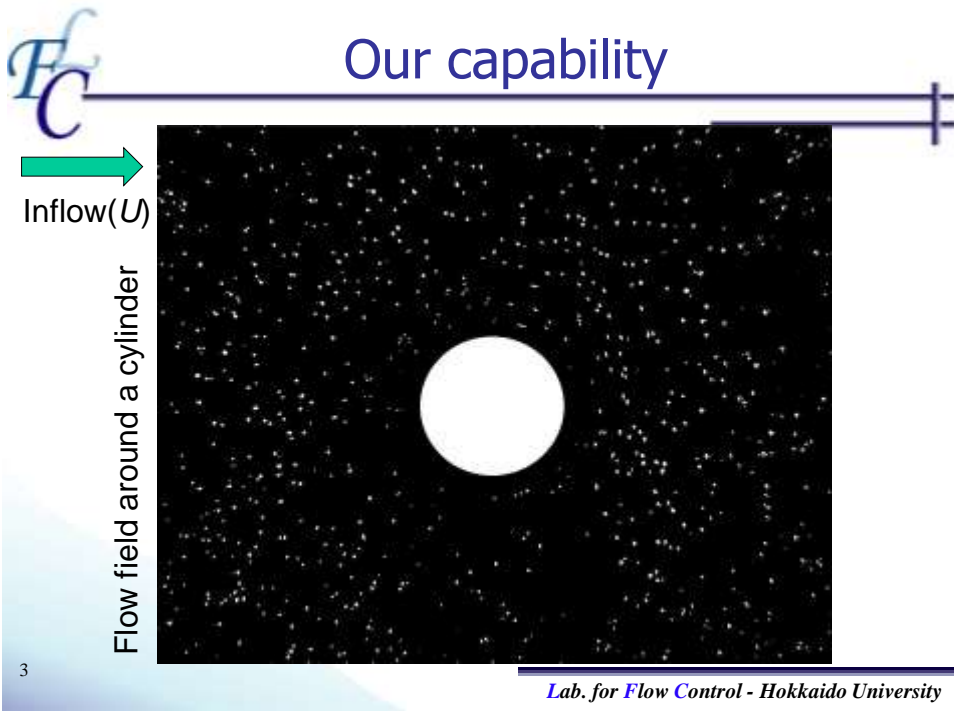
**Tue. 10:50 Bird Strike Control and Reduction system in
JAPAN** Tokui Takahiro

**Thu 15:40 Bird Detection System Deployment for Tokyo
International Airport** Rafael Eichler

**Thu 16:30 Image sensing technique for flying bird detection
and classification in natural background**
Kotaro Takeshima

**Fri. 09:45 Height distribution of BS occurrence - some
analysis of worldwide BS database**
Yasushi Takeda

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Particle Tracking Velocimetry (PTV)

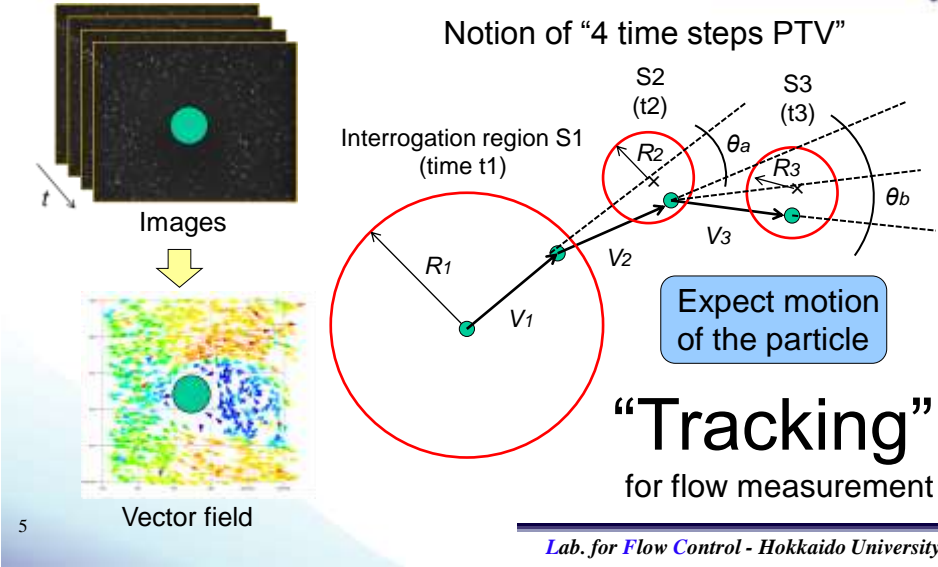
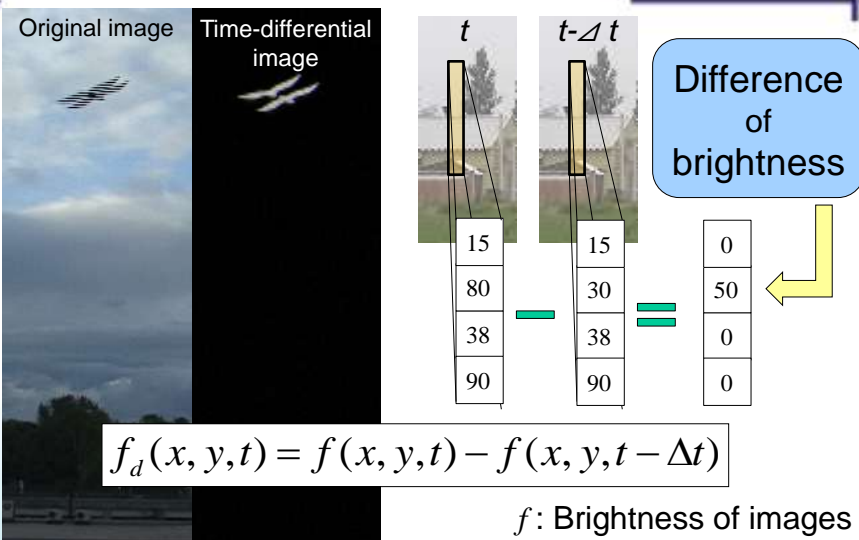


Image sensing techniques in previous study





Time-differential images

Bird Strike at Manchester, UK



Reference : Youtube

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Time-differential images

Bird Strike at Manchester, UK



Reference : Youtube

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Time-differential images



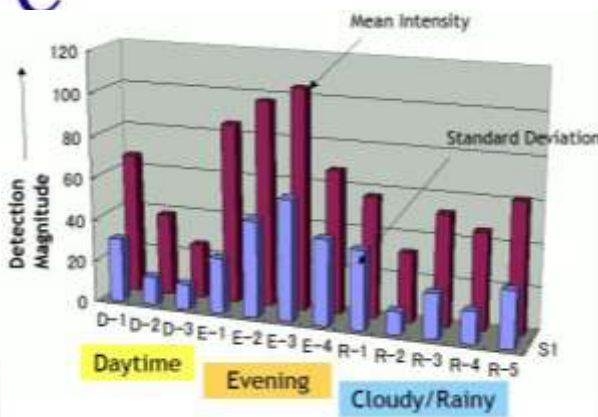
$$f_d(x, y, t) = f(x, y, t) - f(x, y, t - \Delta t)$$

Detect only moving objects

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Image sensing techniques in previous study



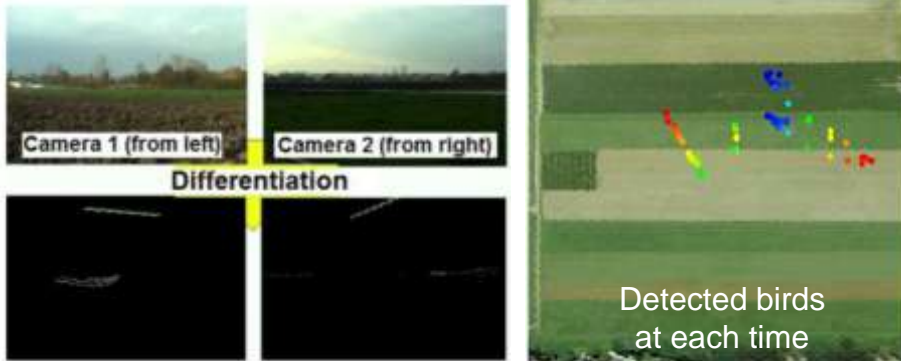
Murai et. al,(2009)



Robustness
for hours and weather differences

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FC Image sensing techniques in previous study

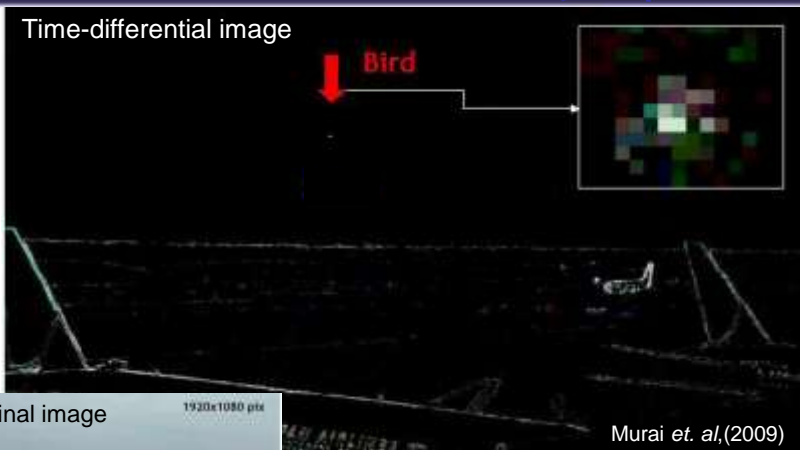


Stereoscopic bird detection for measuring **3-D trajectories** by two cameras

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FC Detection test at CTS, Japan



Murai et. al.(2009)

Detected birds at **1,500 m** from the camera

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Next trial

Provisions for Bird strike

- Bird-patrol team
- Habitat control
(→ Reduce feeds, nest spots)
- Radar systems etc.

Bird database include
classification

High efficiency
More effective

Next step

To investigate a possibility of bird classification by PTV

Our advantage technique : "Tracking"

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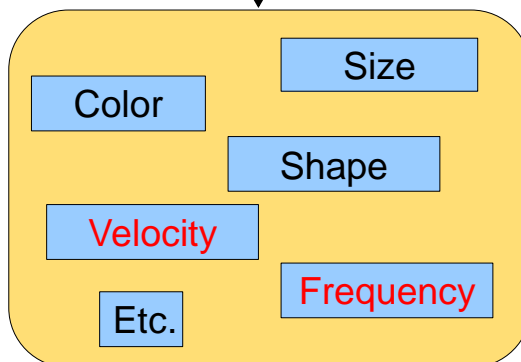


How to classify birds ?

Input



Characteristic quantities



Analysis for each quantity

Ans.

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Optimum process

- Eliminate method
 - ➔ Delete unsatisfying class from the database
- Calculate probability method
 - ➔ Calculate the sum total of probabilities for each quantity
- Neural network method
 - ➔ Applying Neural network to classification process

etc.

In planning

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Which characteristic is more effective ?

	Freq.	Instantaneous velocity	Color	Shape	Path line
Focus	☆☆☆	☆☆	☆☆☆	☆	☆☆☆
Weather	☆☆☆☆	☆☆☆☆	☆	☆☆☆	☆☆☆☆
Hour	☆☆☆☆	☆☆☆☆	☆	☆☆☆	☆☆☆☆
Frame number	☆	☆	☆☆☆☆	☆☆☆☆	☆
Distance	☆☆	☆☆	☆	☆	☆☆
Season	☆☆☆☆	☆☆☆☆	☆	☆☆☆☆	☆☆☆☆

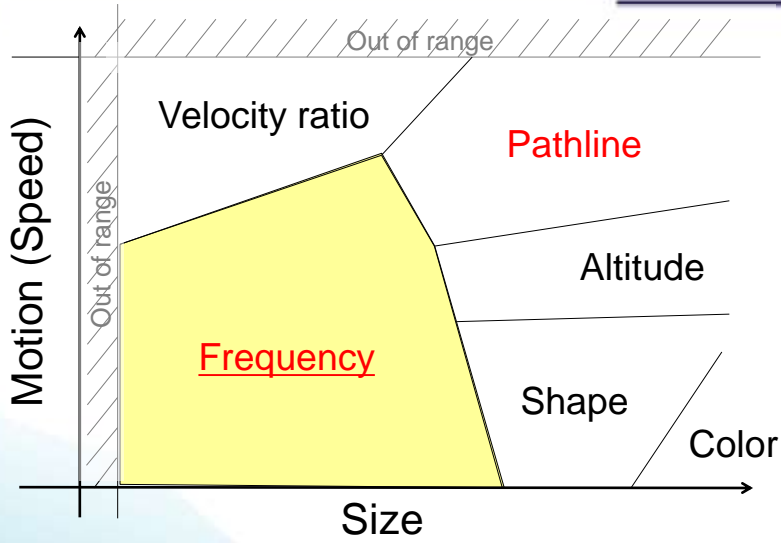
Temporal quantities are robust

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Effective parameter diagram

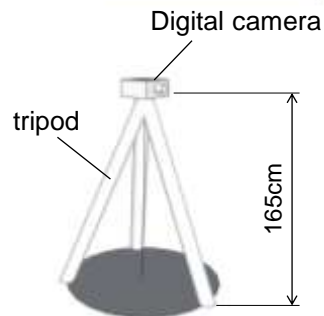
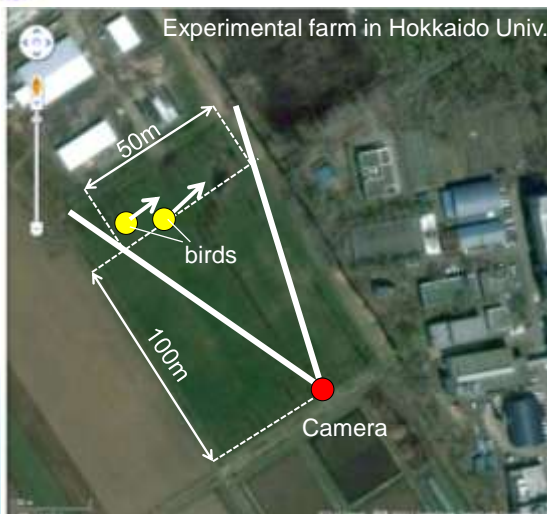


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Recording location and conditions



Camera conditions	
Frame rate	30 [fps]
Image size	1280 × 720 [pixel]

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Sample of original images

Experimental farm in Hokkaido Univ.

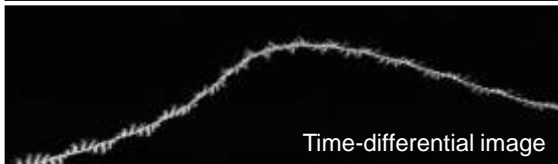
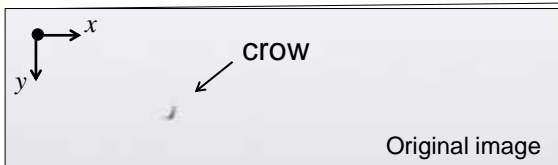


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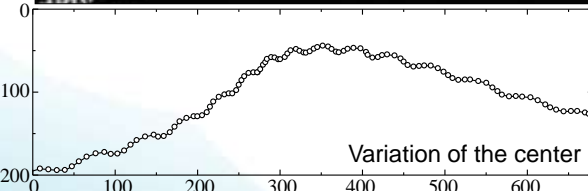
Does temporal variations have characteristics of birds?



Characteristics for bird classification



- Path line
- Area
- Shape etc.



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Difference between Crows and Ducks

Crow

Duck

Bird's moving represents their motion.

Frequency { Spatial freq. → Path line
Temporal freq. → Velocity, size

Focus on

• Velocity fluctuation { Vertical component (v)
Horizontal component (u)

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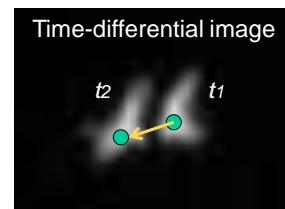
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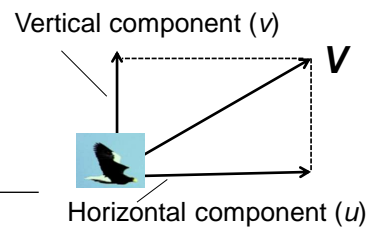
Calculating velocity of the birds

Conditions of birds

Labeling	Number of images [frames]	Average size (S_a) [pixel]
Crow1	157	150.8
Crow2	132	98.29
Crow3	146	75.15
Crow4	176	85.67
Duck1	133	76.03
Duck2	134	20.76
Duck3	132	24.43
Duck4	139	24.75



Calculate velocity

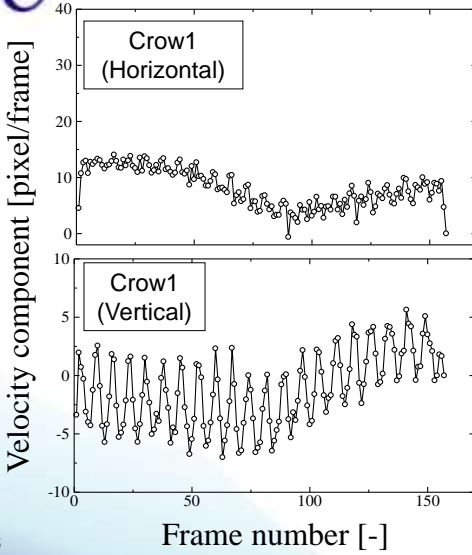


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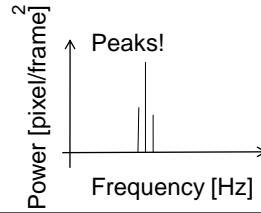
Velocity fluctuations of the birds



Periodic?

FFT

Spectrum analysis



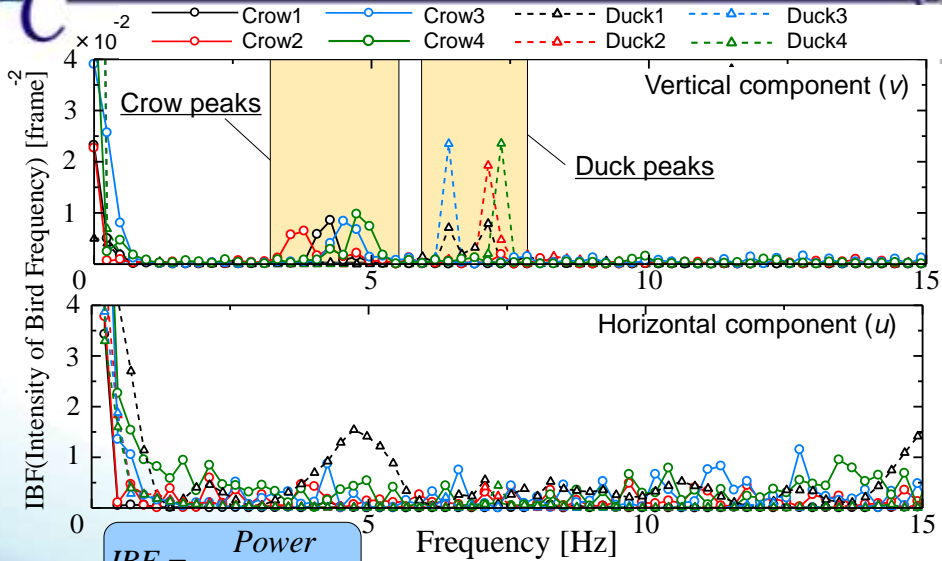
Extract their characteristics like their songs

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Spectra of the Velocity fluctuations (n=128)



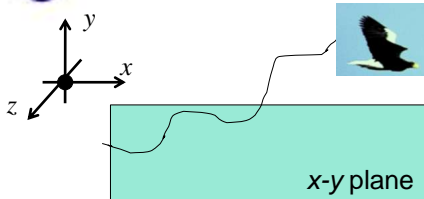
$$IBF = \frac{Power}{AverageSize}$$

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Consideration to the difference



Effect of
3D-motion

Velocity fluctuation of vertical component is more robust than horizontal component against 3D-motion.

Effective characteristics to distinct birds

Velocity fluctuation (u)

Velocity fluctuation (v)

☆☆

☆☆☆☆

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Conclusion

- We applied for PTV measurement to birds in natural background.
- "Crow" and "Duck" have different peaks in spectra of velocity fluctuation (v -component).



Analysis of vertical velocity fluctuation
may be effective toward classification

This detection method has a potential to classify flying birds.

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Thank you for your listening



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Image of the system

Simple

JPY 400,000
USD 5000



Wide Range

Advanced

JPY 500,000,000
USD 6,250,000

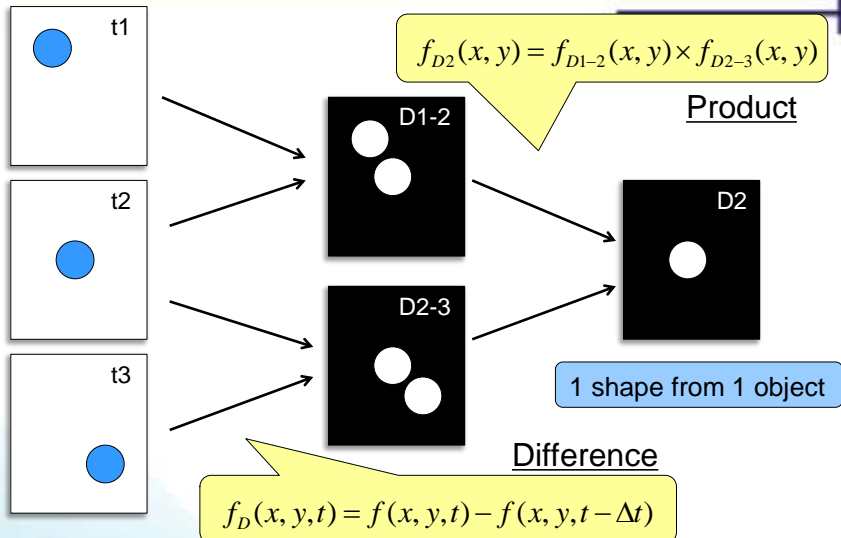


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Improvement of Time-differential images



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Example of the analysis



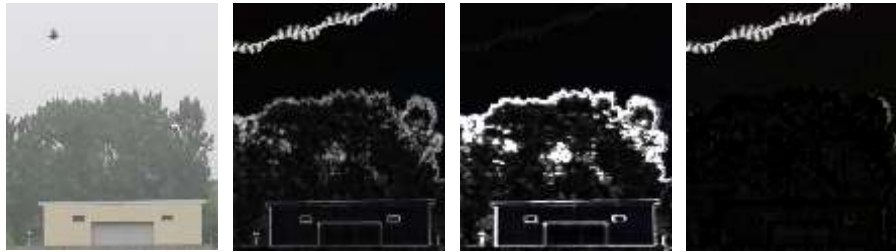
Detect the bird at the same position

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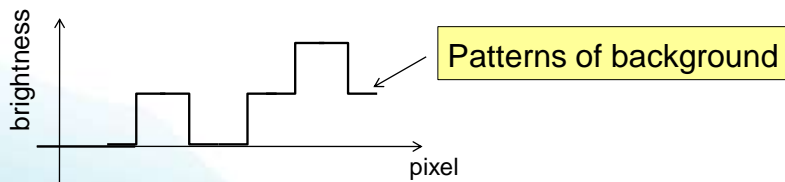
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1. Decrease background noise



(a) Original image (b) Time differential image with background (c) Background image (d) Time differential image without background

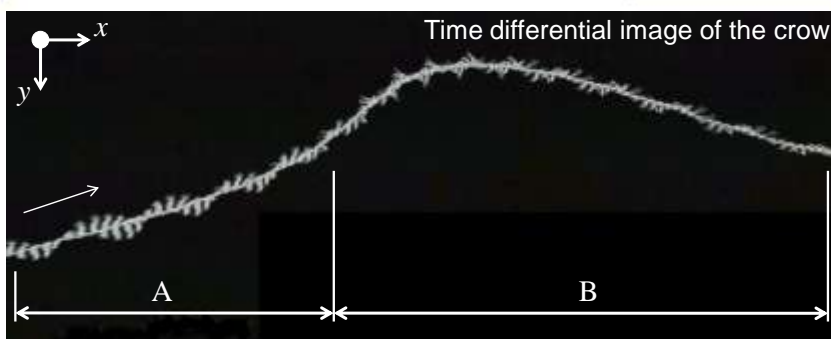


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2. Extract characteristics of the crow



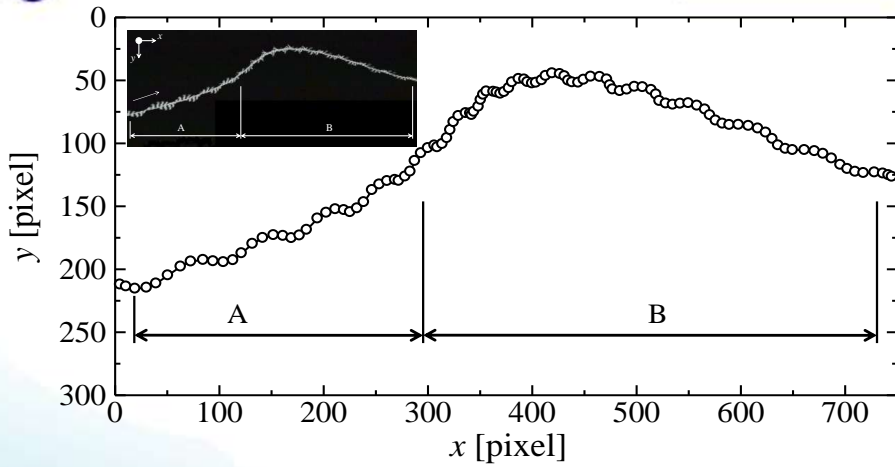
A : The crow **flies horizontally** against the camera
 B : The crow **doesn't fly horizontally** against the camera

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Characteristics of the crow



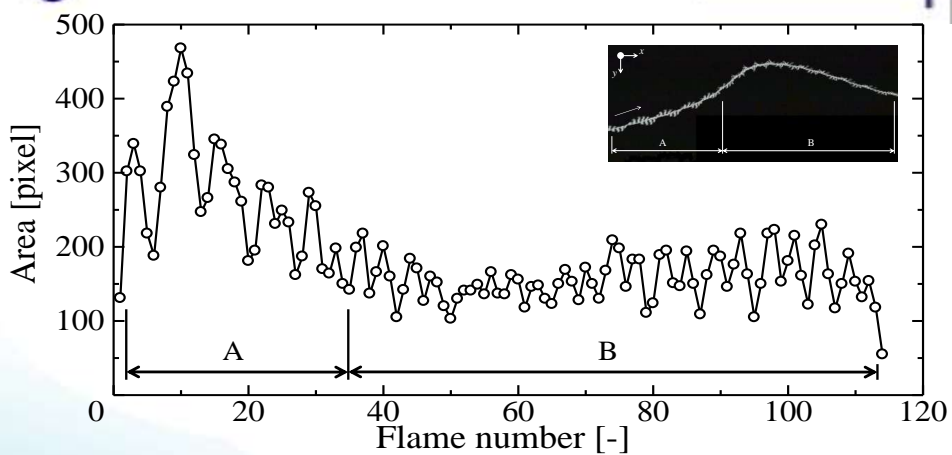
Variation of the center of the crow

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Characteristics of the crow



Variation of the area of the crow

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Distinction of species of the birds



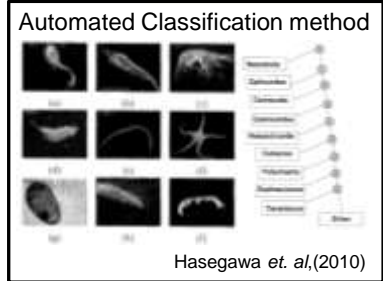
Time differential image of the gray-starlings



Clearly differences against the crow



Distinction of species of the birds



Vector quantity

- Size
- Velocity
- Color • Group
- etc.