



“LitterDrone: Development and Exploitation of Innovative Tools for Remote Marine Litter Control and Management through UAV’s”

Universidade de Vigo



Supported by:



With the collaboration of:



PARQUE NACIONAL MARÍTIMO TERRESTRE DE LAS ISLAS ATLÁNTICAS DE GALICIA

Co-funded by the UE



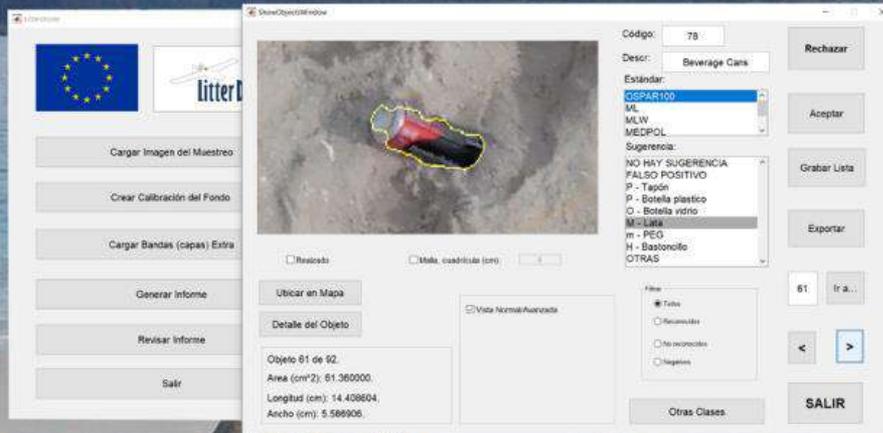


THE PROJECT



Litter Drone

DRONE-BASED IMAGE ACQUISITION + COMPUTER BASED IMAGE ANALYSIS



¿WHAT IS MARINE LITTER?

Man made solid waste that, for any cause, are abandoned in marine or coastal environment



SOURCE: PNUMA

LITTERDRONE ORIGIN

- Marine litter **characterization** as a key factor to eradicate them
- Official **monitoring** program for marine litter on beaches (MAPAMA)
- **Standardization** and **automation** of marine litter characterization



SOURCE: Surfrider España

FUNDED BY EU (BLU-LABS PROGRAM)



➤ EASME/EMFF/2016/1.2.1.4

Blue Labs

Innovative Solutions for Maritime Challenges



➤ Supported by:



➤ With Collaboration of:



➤ Partners:



UniversidadeVigo





DRONES & FLIGHTS

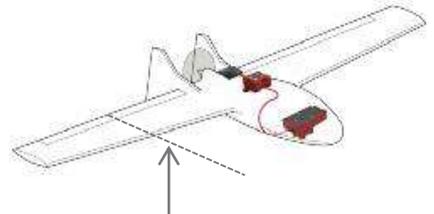


Litter Drone

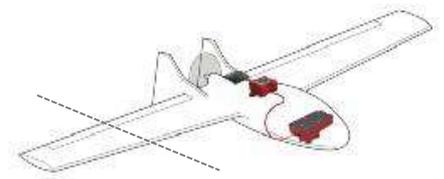
UAV'S & CAMERAS



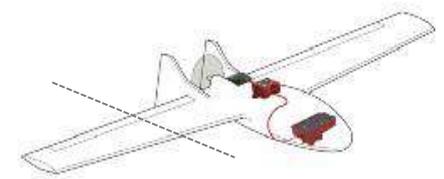
20-50 meters



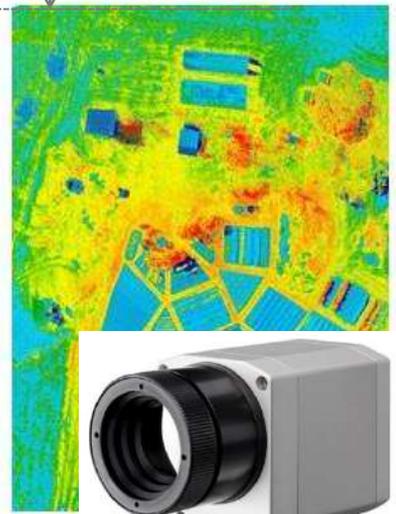
Visible



Multi-spectral

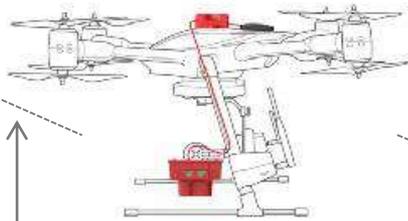


Thermal

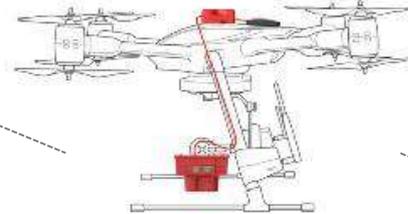


UAV'S & CAMERAS

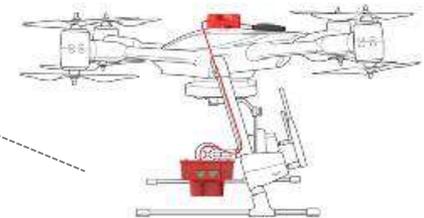
10-15 meters



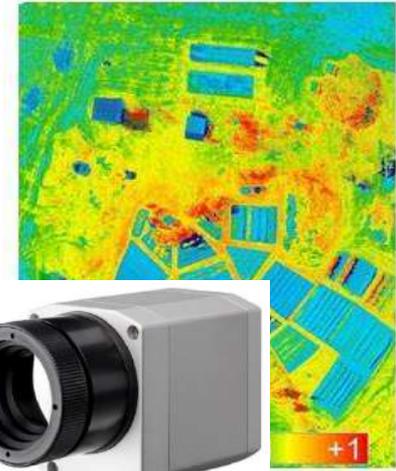
Visible



Multi-spectral



Thermal



REAL FLIGHTS



IMAGE ACQUISITION: ORTHO-PHOTO

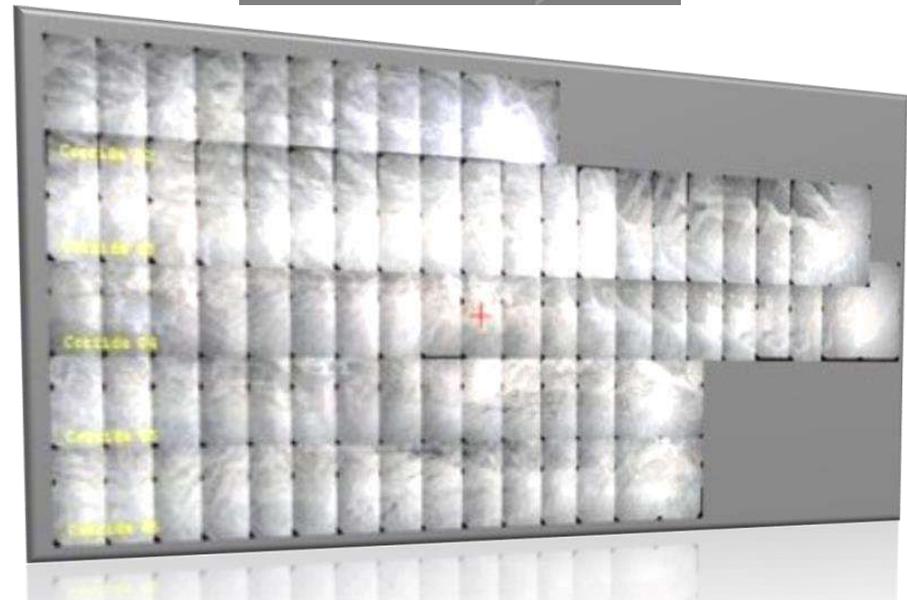
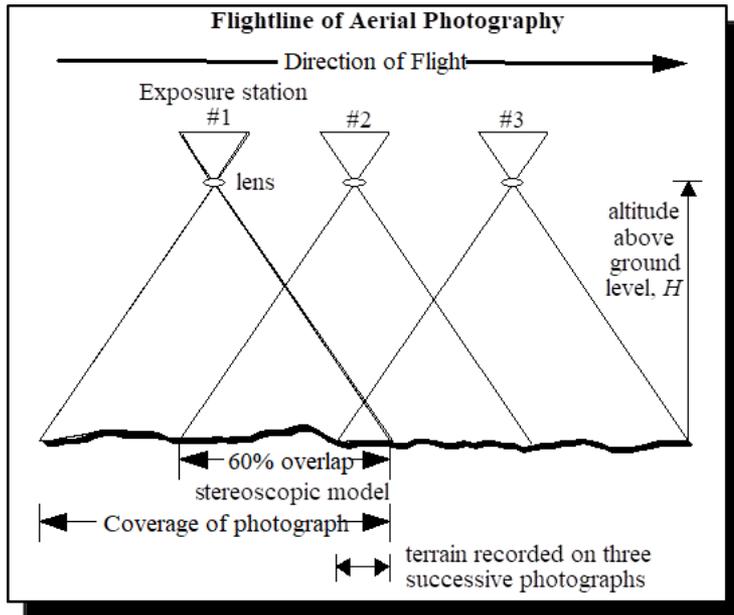
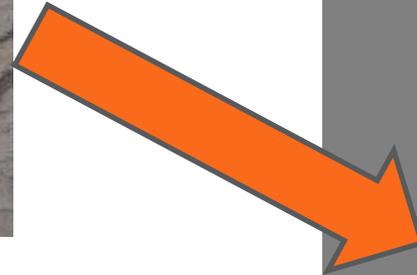


IMAGE ACQUISITION: ORTHO-PHOTO



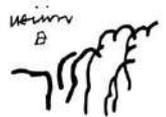
Photomodeler: from photos to
Ortho-photo (geo-referenced,
exact)



TEST ZONE



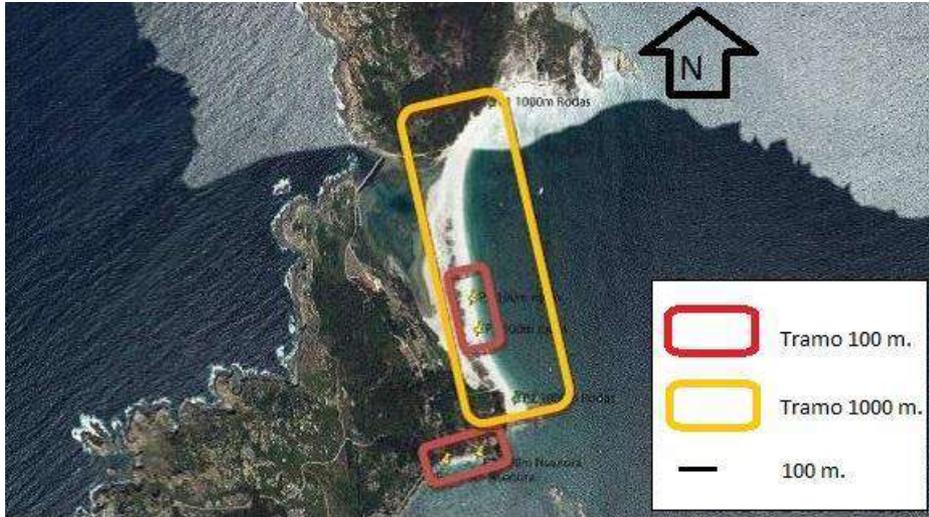
- Flying on one of the monitored beaches: “playa de Rodas” (Galician Atlantic Islands Maritime-Terrestrial National Park)
- Detection of true marine litter and comparison with official data
- Flying on another (non monitored) beach



PARQUE NACIONAL MARÍTIMO TERRESTRE
DAS ILLAS ATLÁNTICAS
DE GALICIA

With the collaboration of

REAL FLIGHTS



Flight transects

Flight with individual photo shots labelled

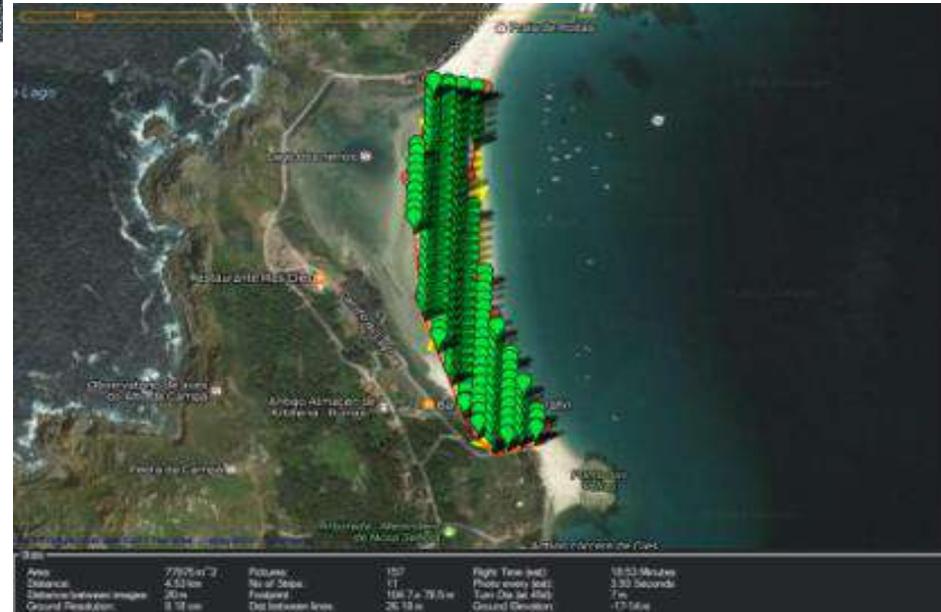




IMAGE PROCESSING

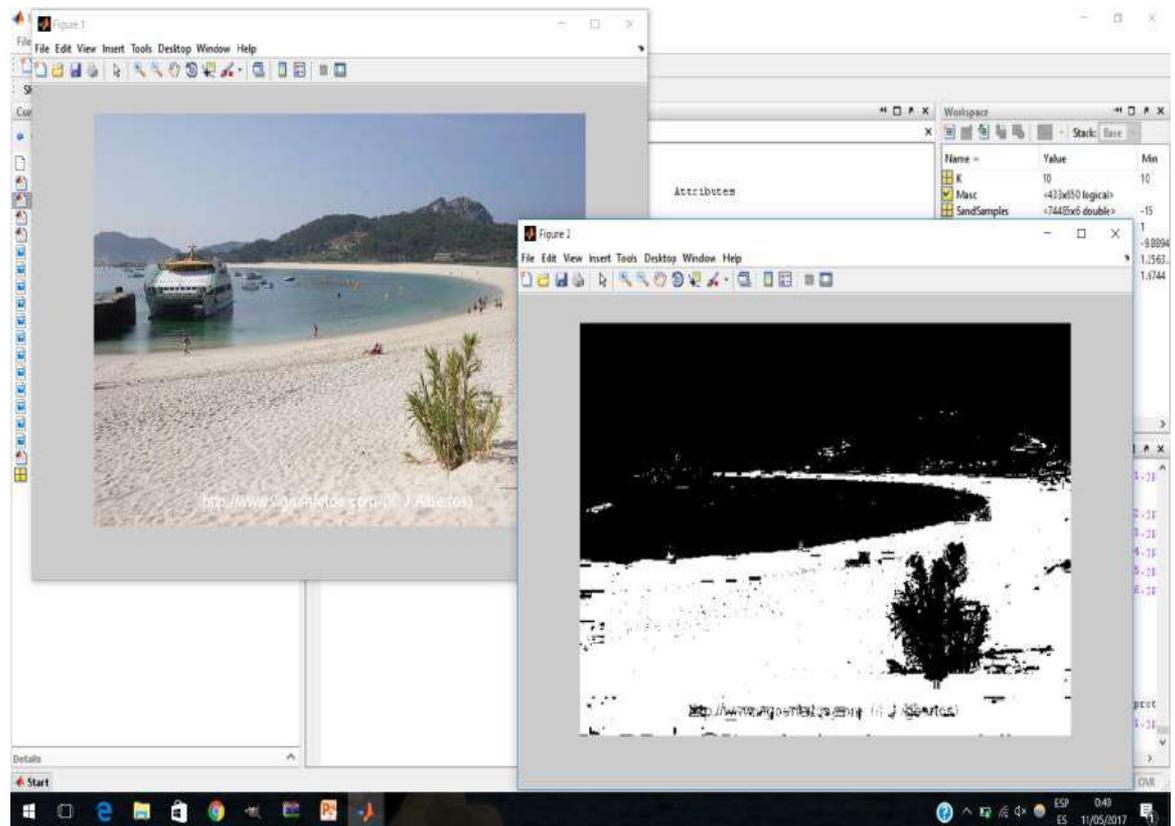
Litter Drone

IMAGE PROCESSING

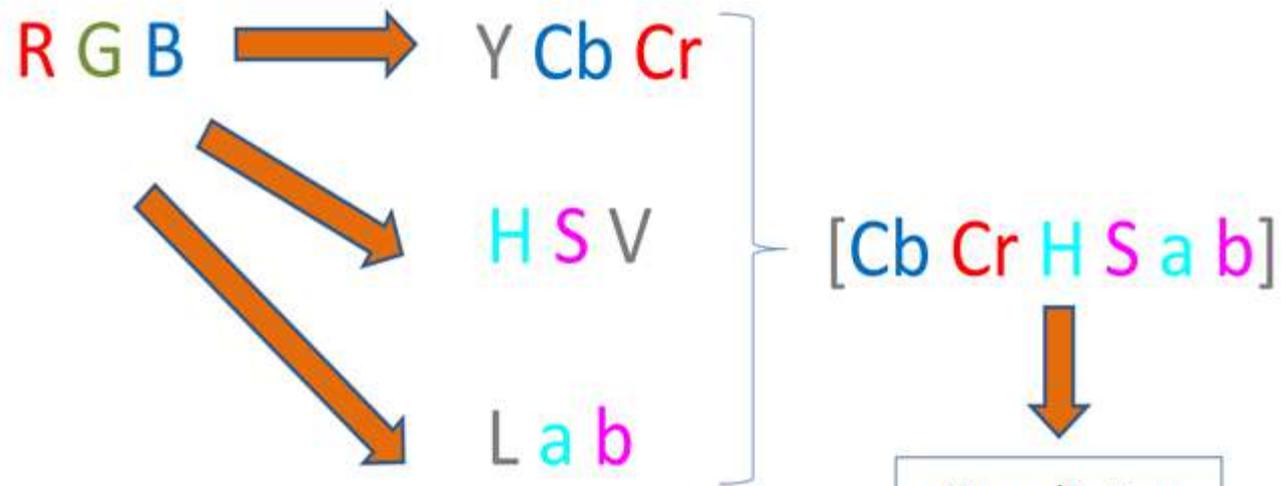


Objects detection with beta version:
sand characterization

IMAGE TYPE: RGB
VISIBLE
CONVENTIONAL CAMERA



SAND CHARACTERIZATION



Normalization
[0,1]

K-means with
calibration
examples

Recognition:

- 1-NN with K-means prototypes, nearest prototype: P_{NN} .
- Empirical threshold: U .
- **$\text{Dist}(\text{pixel_actual}, P_{NN}) < U \implies \text{FONDO.}$**

SAND CHARACTERIZATION (method II)

Use of differential components (R-G, R-B, G-B).



Future Lines:

Use of normalized differential indexes: $(c2-c1)/(c1+c2)$

OBJECT DETECTION

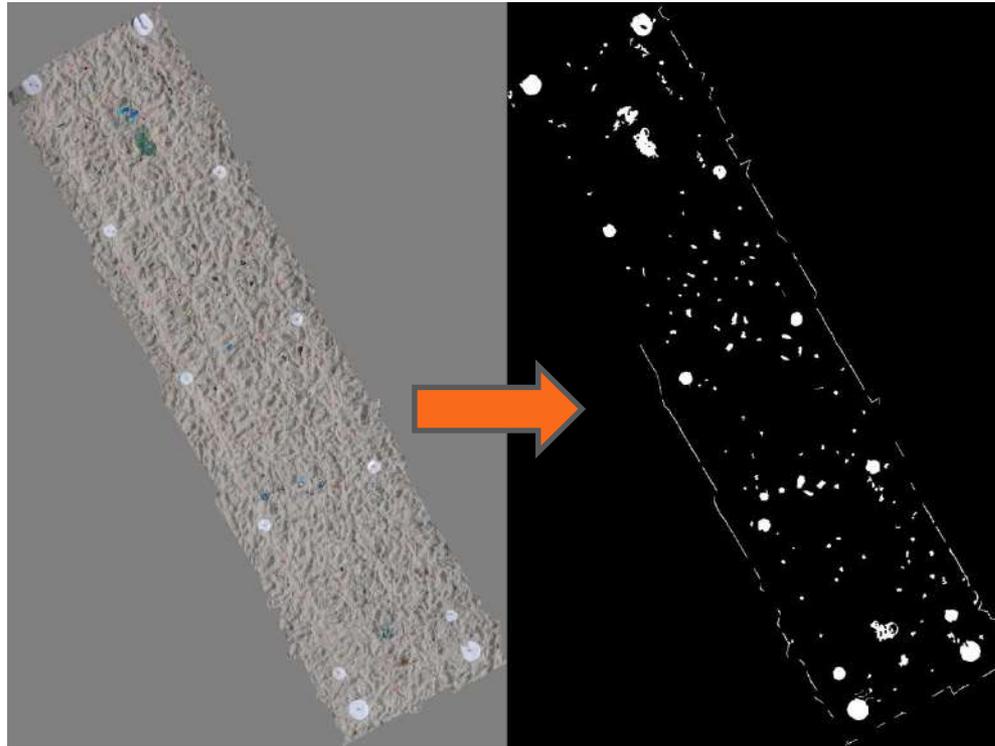


IMAGE TYPE: RGB

VISIBLE,
CONVENTIONAL CAMERA



GLOBAL REPORT



**FAST &
AUTOMATIC**

IMAGE SUPERPOSITION

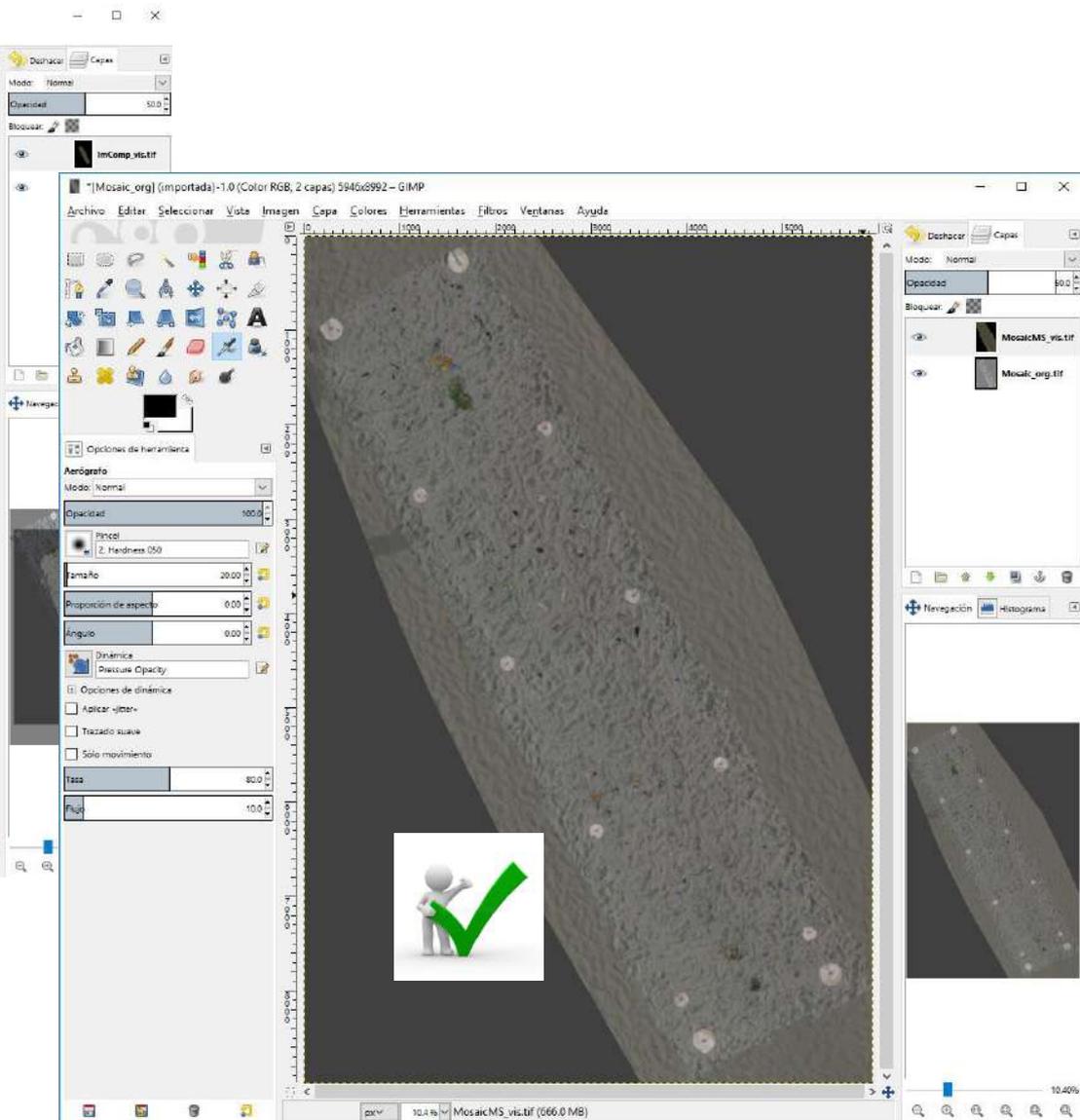
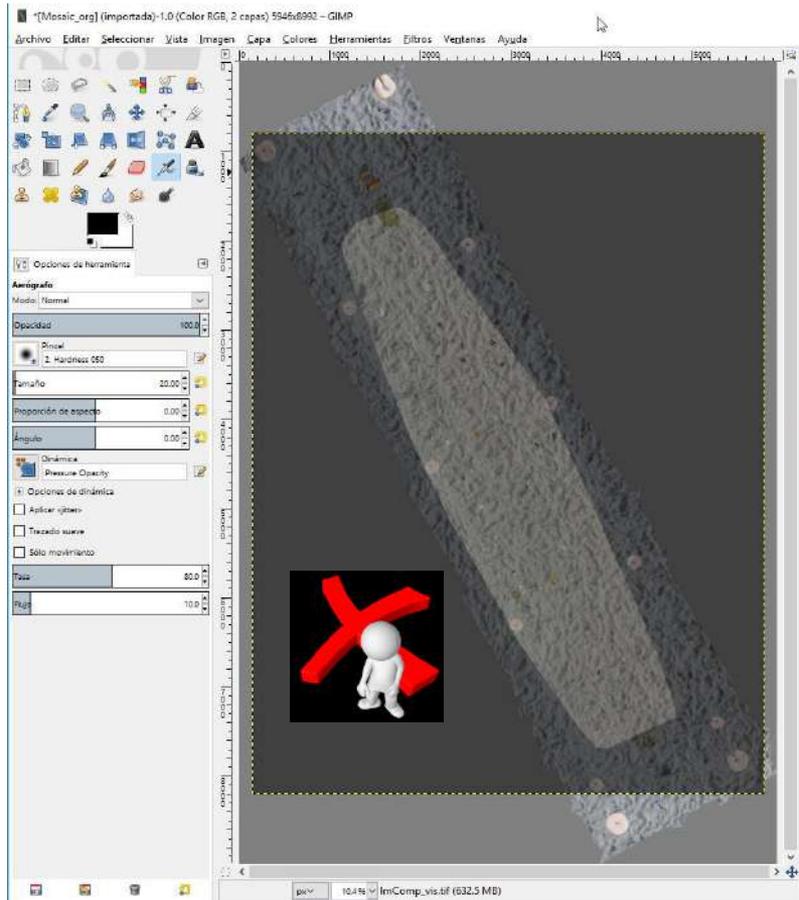


IMAGE SUPERPOSITION: methods



- Manual selection of (at least three control points) and affine transformation.
- Use of geo-referentiation files: scale info + one control point from image origins.
- Manual introduction of scale info + one control point (for displacement).

Future Lines:

- Two control points → definition of two “control vectors” → enough to deduce scale info and displacement).

IMAGE SUPERPOSITION:



e
x
a
m
p
l
e

*[procesado 1 rodas 100m_index_rgb] (importada)-1.0 (Color RGB, 2 capas) 6363x11221 – GIMP

Archivo Editar Seleccionar Vista Imagen Capa Colores Herramientas Filtros Ventanas Ayuda

Capas Historial de deshacer

Modo: Normal

Opacidad 50,0

Bloquear:

- termica-registrada.png
- procesado 1 rodas 100m_index_rgb

Navegación de la vista Histograma

7,45 % termica-registrada.png (890,8 MB)

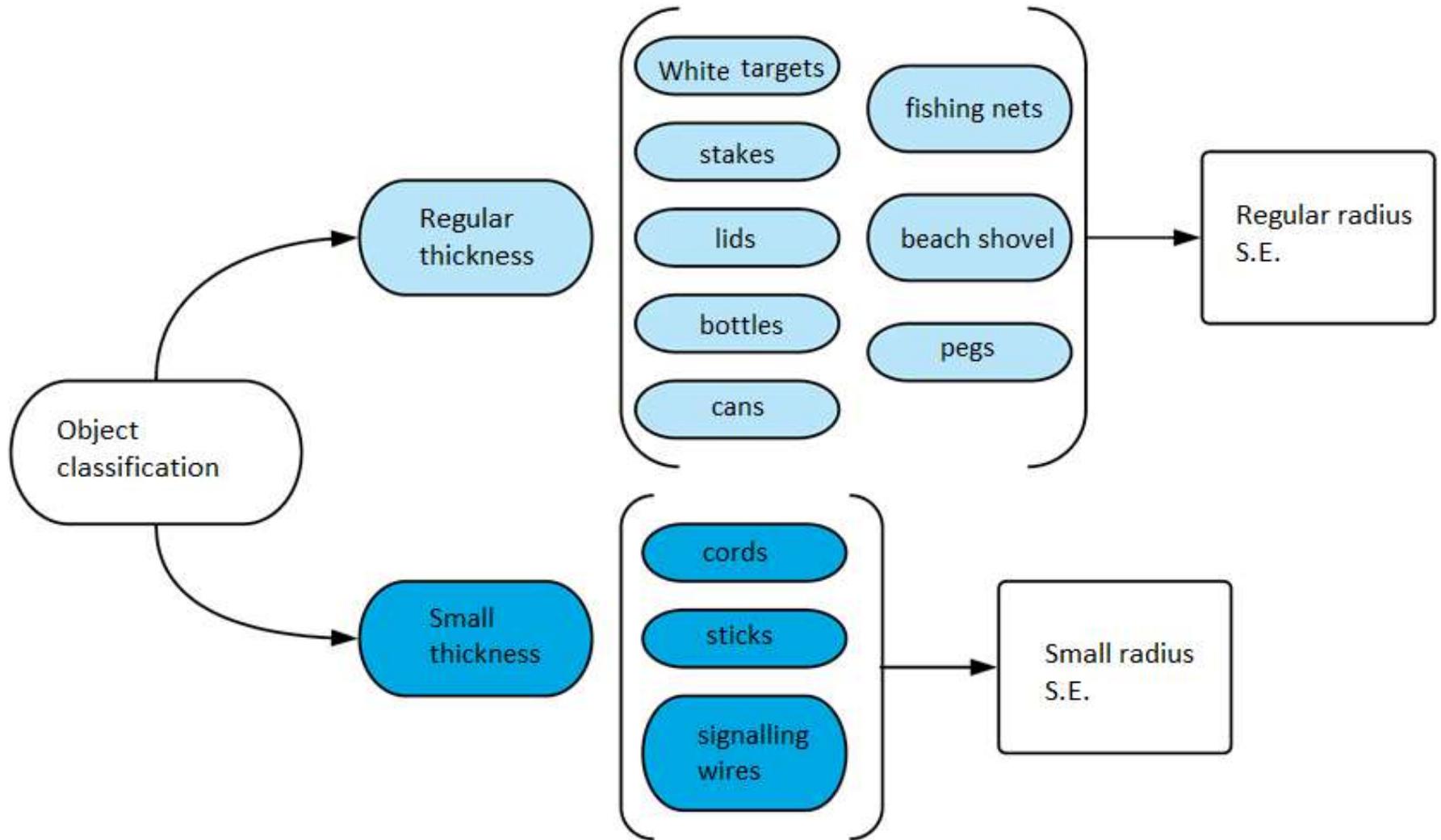
OBJECT RECOGNITION



Automatic recognition of more common objects: lids, bottles, cans, sticks...
and also auxiliary objects (white targets)

The screenshot displays the Litter Drone software interface. On the left, a sidebar contains several buttons: "Cargar Imagen del Muestreo", "Crear Calibración del Fondo", "Cargar Bandas (capas) Extra", "Generar Informe", "Revisar Informe", and "Salir". The main window, titled "ShowObjectsWindow", shows a central image of a red and black beverage can on a sandy surface, outlined in yellow. Below the image are checkboxes for "Realzado" and "Malla, cuadrícula (cm):" with a value of 5. To the right of the image is a "Detalle del Objeto" section displaying: "Objeto 61 de 92.", "Area (cm²): 61.360000.", "Longitud (cm): 14.408604.", and "Ancho (cm): 5.586906.". Further right, a "Filtrar" section has radio buttons for "Todos" (selected), "Reconocidos", "No reconocidos", and "Negativos". The rightmost panel contains a "Código:" field with "78", a "Descr:" field with "Beverage Cans", and a dropdown menu for "Estándar:" with "OSPAR100" selected. Below this is a "Sugerencia:" dropdown with "M - Lata" selected. At the bottom of this panel are buttons for "Rechazar", "Aceptar", "Grabar Lista", "Exportar", "61", "Ir a...", and "SALIR". A "Otras Clases" button is also present.

OBJECT RECOGNITION



OBJECT RECOGNITION



Decision tree is implemented computing discriminant functions.
For class i , at stage n , we take into account feature value x :

$$D_i^{n+1} = D_i^n \cdot d_i(x)$$

$$d_i(x) = \begin{cases} 0, x > x_{max} \cup x < x_{min} \\ \exp \left[-1/2 \left(\frac{x - x_{med}}{x_{desv}} \right)^2 \right] \end{cases}$$

Empirical equations inspired by Bayes rule and gaussian distribution.

OBJECT RECOGNITION



Human correction of non recognized objects

The screenshot displays the Litter Drone software interface. A central window titled "ShowObjectsWindow" shows a satellite image of a beach with two blue flip-flops and a green net. Below the image are checkboxes for "Realzado" and "Malla, cuadrícula". A "Detalle del Objeto" window shows the following data for "Objeto 19 de 118":

- Area (cm²): 1557.720000.
- Longitud (cm): 73.305953.
- Ancho (cm): 37.499557.

An "Elegir clase:" dialog box is open, showing a list of categories. The "PLÁSTICO" category is selected, and the "Redes y piezas de redes, Cuerdas y" item is highlighted in the "Objeto (item):" list. The dialog also includes "Aceptar" and "Cancelar" buttons.

The background shows the Litter Drone main interface with a European Union flag and buttons for "Cargar Imagen", "Crear Calificación", "Cargar Base de Datos", "Generar Reporte", and "Revisar". The Windows taskbar at the bottom shows the system tray with the date "04/12/2018" and time "23:06".



CONCLUSIONS



Litter Drone

CONCLUSIONS



- Interesting project, ended at January, 2019.
- Future Lines:
 - ✓ Testing New Cameras.
 - ✓ Improving Object Recognition.
 - ✓ Jump to Market.

**MEETING OF DRONE TECHNOLOGY, REMOTE SENSING AND COMPUTER VISION,
MORE PROJECTS OF THIS KIND ARE EXPECTED IN THE FUTURE**

THANK YOU !

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LITTERDRONE PROJECT

The **LitterDrone** project seeks to develop innovative tools for the control and management of marine litter through unmanned drones.

[PROJECT](#)[CONTACT](#)

www.litterdrone.eu