Mobile Mapping System v2

IENE 2020
INTERNATIONAL CONFERENCE
LIFELINES
Linear Infrastructure Networks
with Ecological Solutions
ONLINE | 12-14 January 2021

LIFE LINES
Linear Infrastructure Networks
with Ecological Solutions

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PROJECT ROADKILLS PTDC/BIA-BIC/4296/2012

We previously developed a **cheap, easy to implement, and automatic solution for detecting road-kills using** *computer vision* **techniques from robotics**

- **over large areas (broad monitoring)**
- **over time (continuous monitoring)**

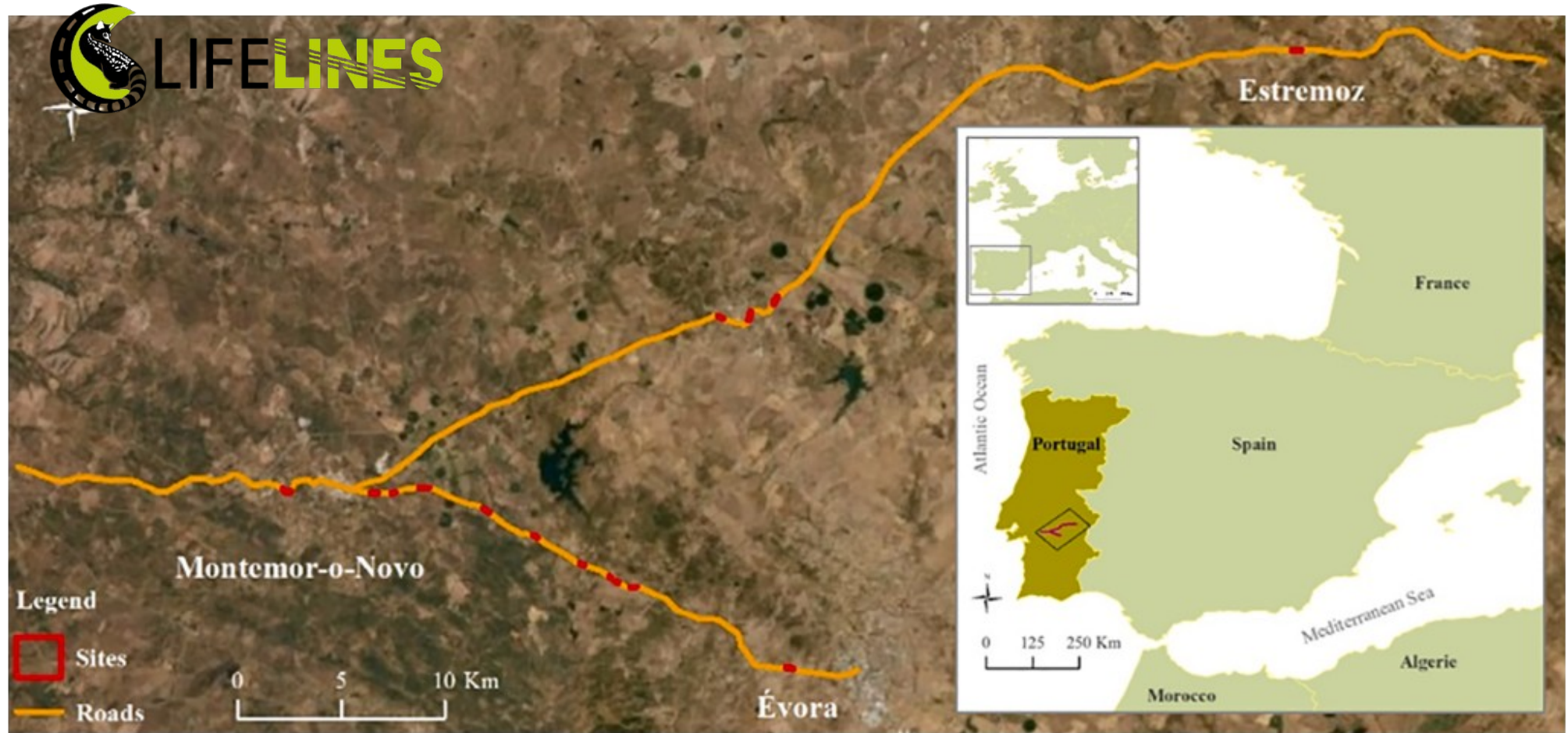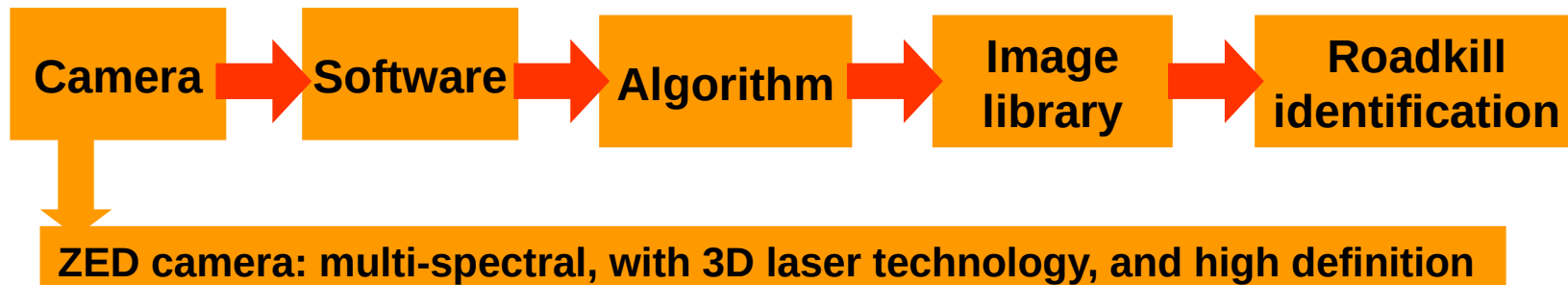**Intelligent systems for mapping amphibian mortality on Portuguese roads**

Lopes et al (2016) Sensors, 16(4), 1–16

GPS · INDUSTRIAL COMPUTER · ELECTRICITY SUPPLY · DAZZLING MINIMISER · LINEAR ILLUMINATION · LINEAR CAMERA

- **Improved version of the Mobile Mapping System 1**

- **A better system for detecting amphibians and small birds road-kills**

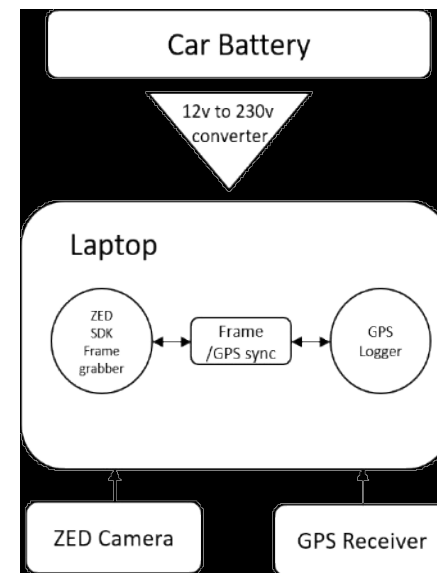**Camera** ➡ **Software** ➡ **Algorithm** ➡ **Image library** ➡ **Roadkill identification**

ZED camera: multi-spectral, with 3D laser technology, and high definition
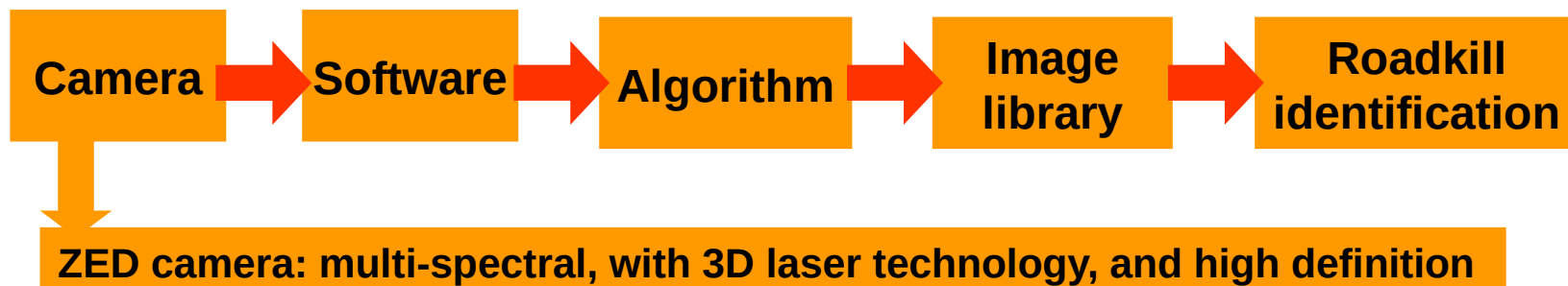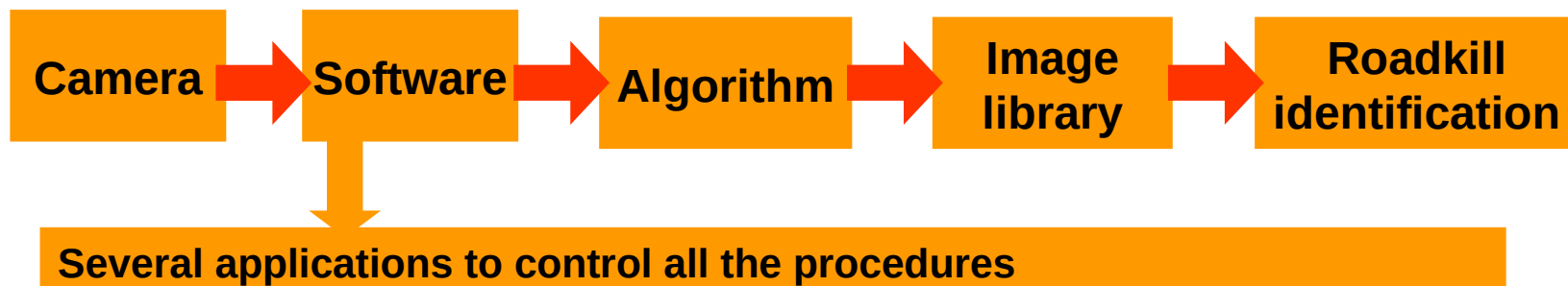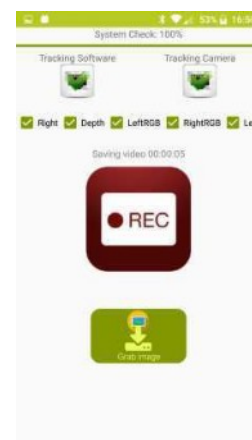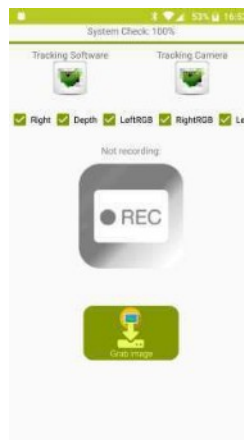
- Device attached directly to the back or front of any car
- Algorithm prepared for the use of one or two ZED cameras
- Reduced size and energetic consumption

Camera → **Software** → **Algorithm** → **Image library** → **Roadkill identification**

ZED camera: multi-spectral, with 3D laser technology, and high definition

| Camera | → | Software | → | Algorithm | → | Image library | → | Roadkill identification |

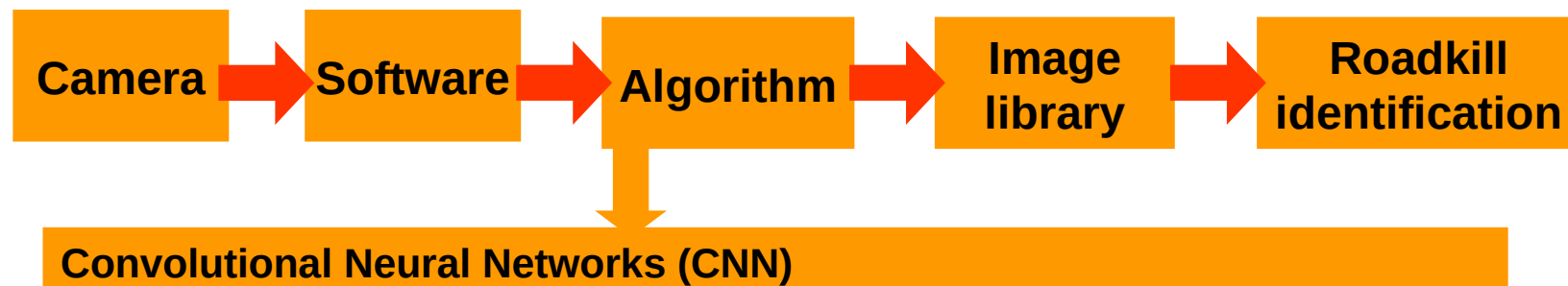**Several applications to control all the procedures**

- Mobile software to turn on/off device, written in Java
- Desktop software to collect and save ZED images, written in C++
- Desktop software to detect animals in ZED images, written in C++, Java, Python, and PHP

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Camera → Software → Algorithm → Image library → Roadkill identification
                         ↓
Convolutional Neural Networks (CNN)
```
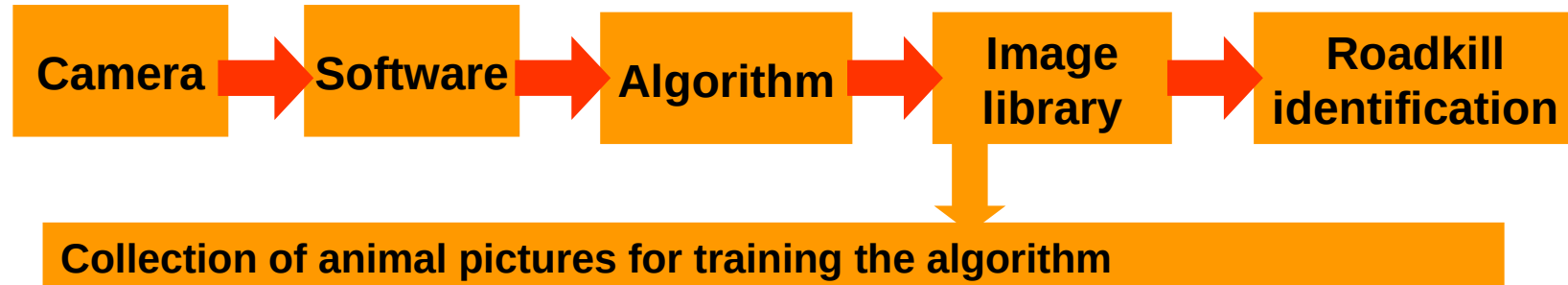
Initial tests:
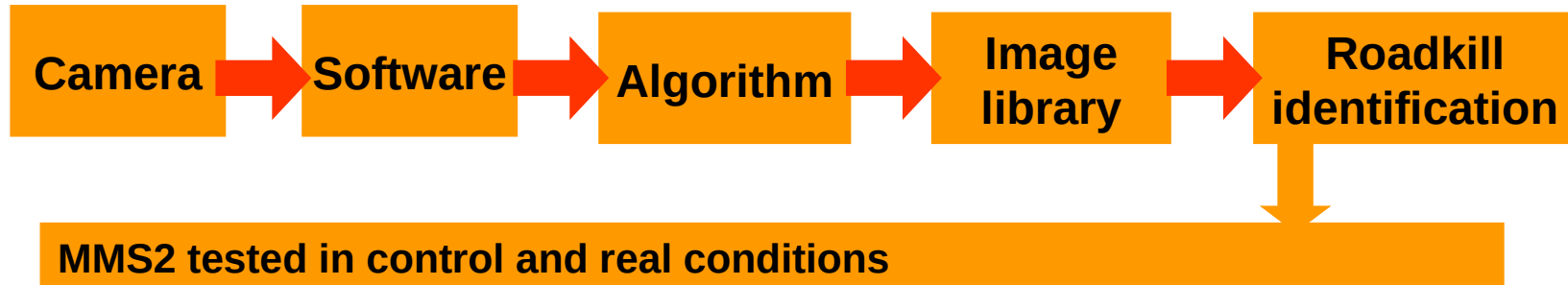
Done using 150 images, with 25 containing animals

Different architectures from the CNN and initial detection results:

- VGG19 -> 42%
- ResNet50 -> 35%
- Inception V3 -> 62%
- 97 Xception -> 23%
- VGG16 -> 62%

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Camera → Software → Algorithm → Image library → Roadkill identification
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Image library → **Collection of animal pictures for training the algorithm**

Final selection VGG16 algorithm:

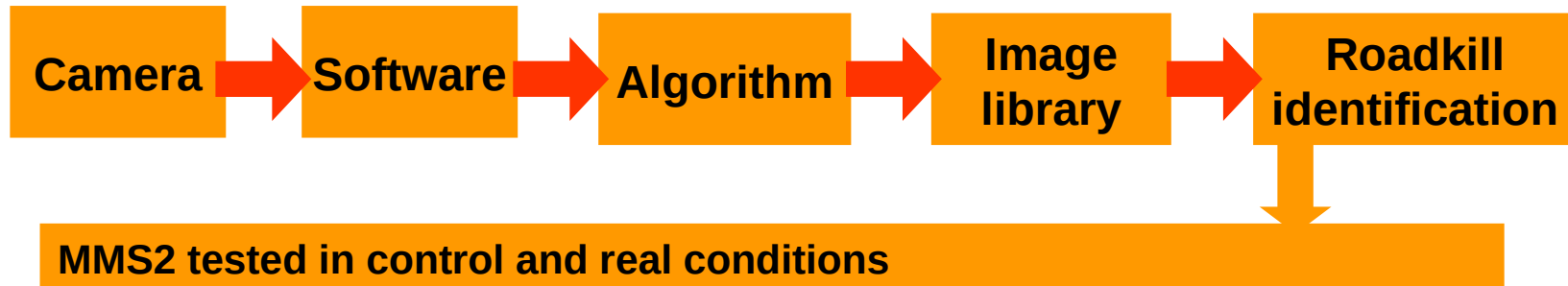- Pre-trained on ImageNet challenge with 1000 classes already trained
- Some containing animals that also were helpful for us
- The post-training was done using our subset of images (amphibians and birds).
- The model run on 25 epochs with the 2546 images of the training database.
- **1296 images acquired by MOVE (Kindly delivered by Luis G. Sousa)**
- **1250 images acquired by initial ZED in field tests**

Camera → Software → Algorithm → Image library → Roadkill identification

MMS2 tested in control and real conditions

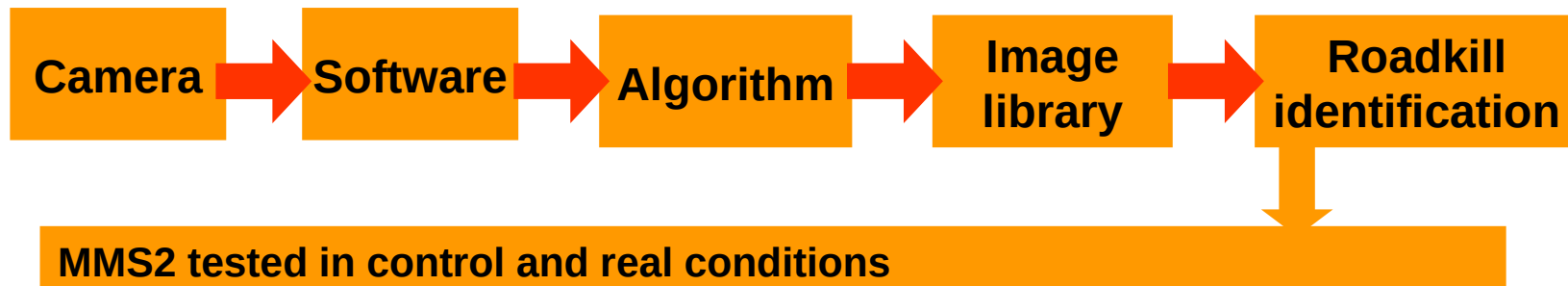- Control tests with collection specimens of amphibians and birds
- Real tests on road surveys in Portugal

Camera → Software → Algorithm → Image library → Roadkill identification

MMS2 tested in control and real conditions

Camera → Software → Algorithm → Image library → Roadkill identification

MMS2 tested in control and real conditions

38.728508 | -7.7676548 | 48.80 KM/H | 10-02-2019 10:03:45   Confidence: 81%

Camera → **Software** → **Algorithm** → **Image library** → **Roadkill identification**

MMS2 tested in control and real conditions

38.592697 | -7.8881085 | 62.19 KM/H | 10-02-2019 10:24:08

Confidence: 64%

Camera → **Software** → **Algorithm** → **Image library** → **Roadkill identification**

MMS2 tested in control and real conditions

38.682493 | -8.1245314 | 52.65 KM/H | 11-02-2019 09:23:45   Confidence: 81%

Camera → **Software** → **Algorithm** → **Image library** → **Roadkill identification**

MMS2 tested in control and real conditions

38.602259 | -8.0391014 | 41.35 KM/H | 13-02-2019 11:33:53   Confidence: 54%

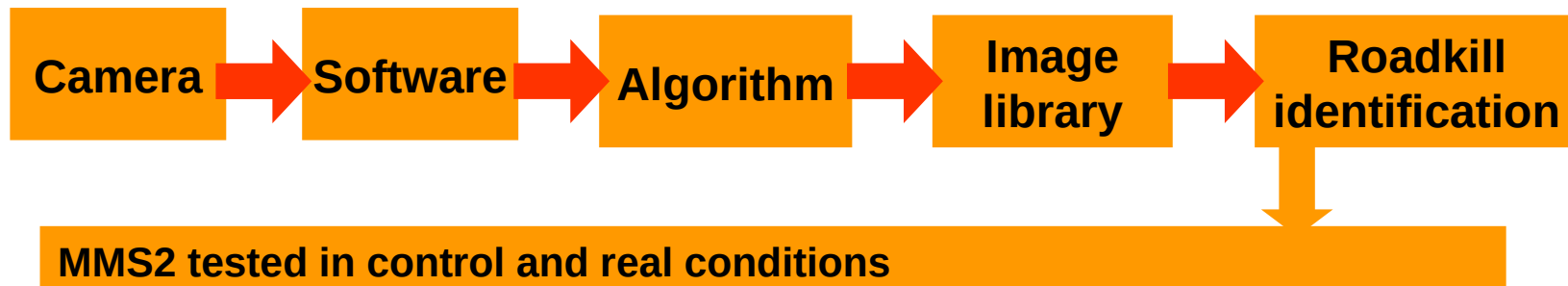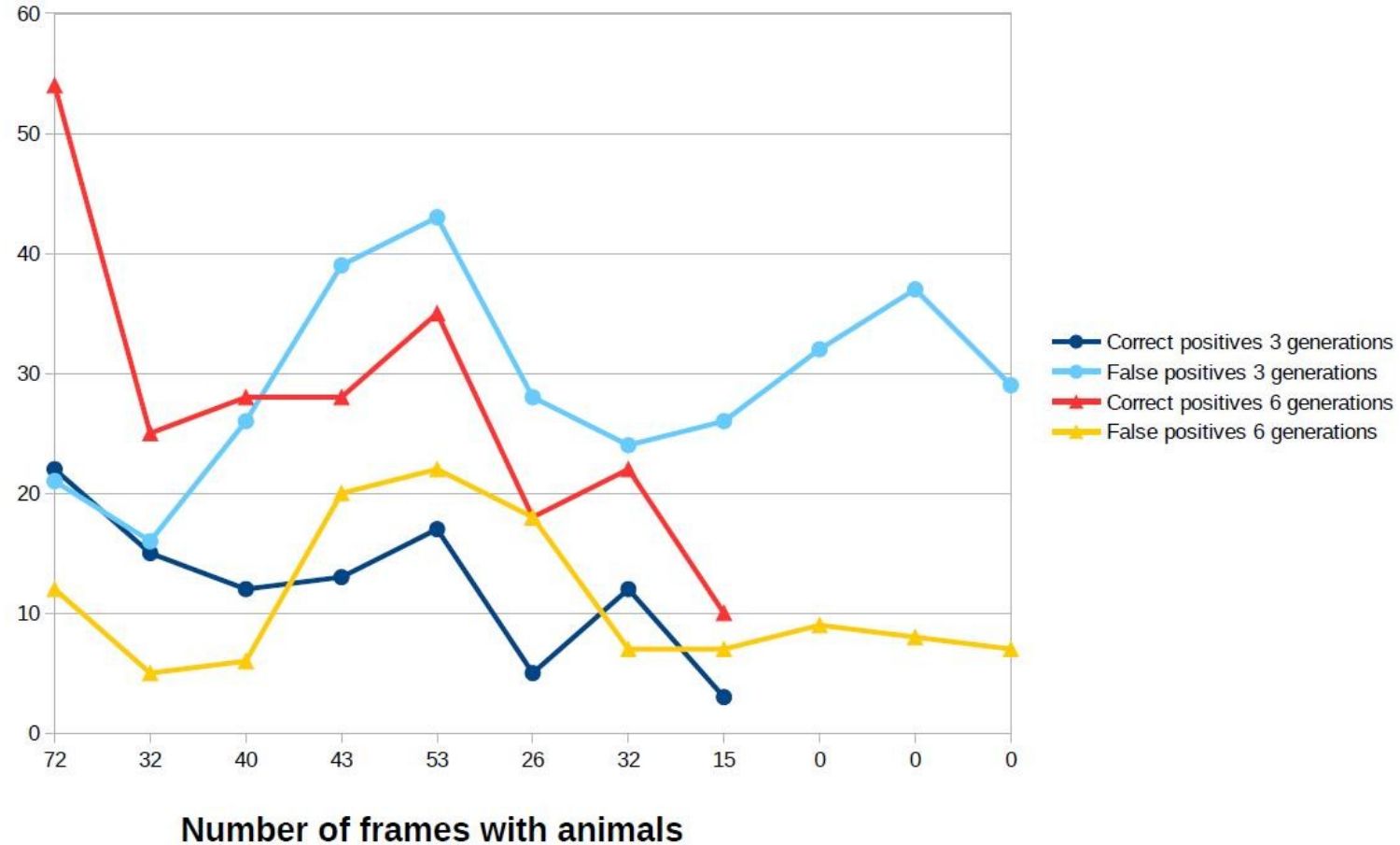**Number of frames with animals**

The configuration with the best performance was the combination of a resolution of 2208 × 1242, 30 FPS, and a vehicle speed of 60 km/h with 80% of correct classifications, 20% of failed classifications, and 20% of false positives

Resolution	FPS	Speed	Total Images	Images with Animals	True Positives	Failed Classification	False Positives	Correct Classification
2208 × 1242	60	80 km/h	1406	53	39	14 (26.4%)	9 (18.8%)	73.5%
2208 × 1242	**30**	**60 km/h**	**980**	**25**	**20**	**5 (20%)**	**5 (20%)**	**80%**
1920 × 1080	60	30 km/h	1250	42	31	11 (26.2%)	7 (18.4%)	73.8%
1920 × 1080	30	60 km/h	680	35	27	8 (22.9%)	6 (18.2%)	77.1%
1280 × 720	60	70 km/h	1560	32	24	8 (25%)	6 (20%)	75%
1280 × 720	30	30 km/h	850	42	31	11 (26.2%)	7 (18.4%)	73.8%
1280 × 720	80	20 km/h	2230	52	37	15 (28.8%)	9 (19.6%)	71.2%
1280 × 720	60	100 km/h	1120	30	19	11 (36.7%)	6 (24%)	63.3%
2208 × 1242	60	30 km/h	1420	25	19	6 (24%)	4 (17.4%)	76%
1920 × 1080	60	30 km/h	1600	26	19	7 (26.9%)	5 (20.8%)	73.1%
2208 × 1242	30	40 km/h	820	32	25	7 (21.9%)	6 (19.4%)	78.1%
1920 × 1080	30	40 km/h	905	34	26	8 (23.5%)	6 (18.8%)	76.5%

- **Successful identification of animals on roads**
- **Algorithms can be trained with other animal groups or objects**
- **Successfully reduced the size and energetic consumption**
- **Developed using low cost components**
- **Attachable to any vehicle**
- **Saved funds, time and personal resources**

Obrigado! Thank You!