Monitoring and surveillance in car parks using computer vision and deep learning

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Case of study
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- Increasing of peopleś preferences to live in apartments instead of houses.
- That means people with cars uses the car parks or rent a space.
- Some cases of disappear or stolen things between neighbors.

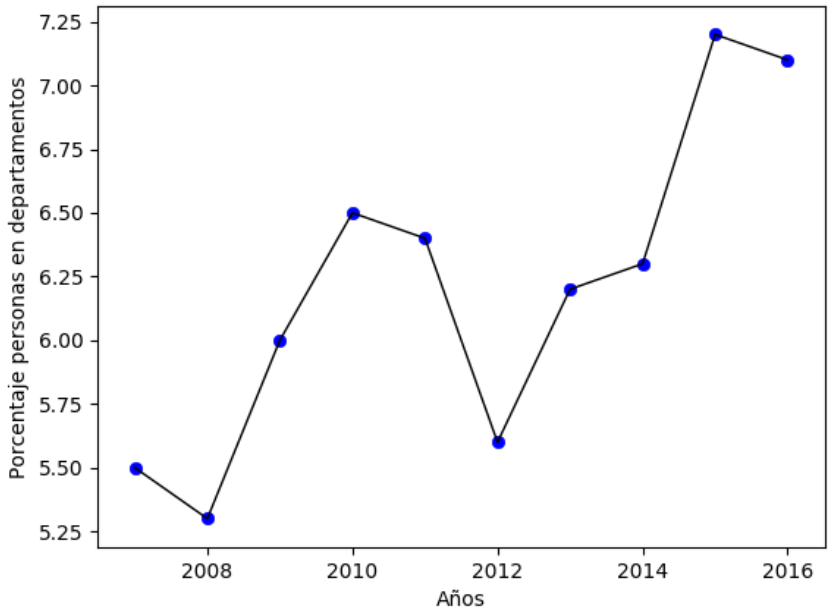

Figura: Graphics of tenants

Data from INEI and SUNARP

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- We construct a database with all information about the tenants.

ID Depart.	Name	ID parking lot	Car model	License Plate	Car	Bicycle	...
1101	Pedro	23	Toyota	ACM-123	Si	No	...
1502	Juan	34	Gol	ABC-345	No	Si	...

(a) DataBase

Car monitoring
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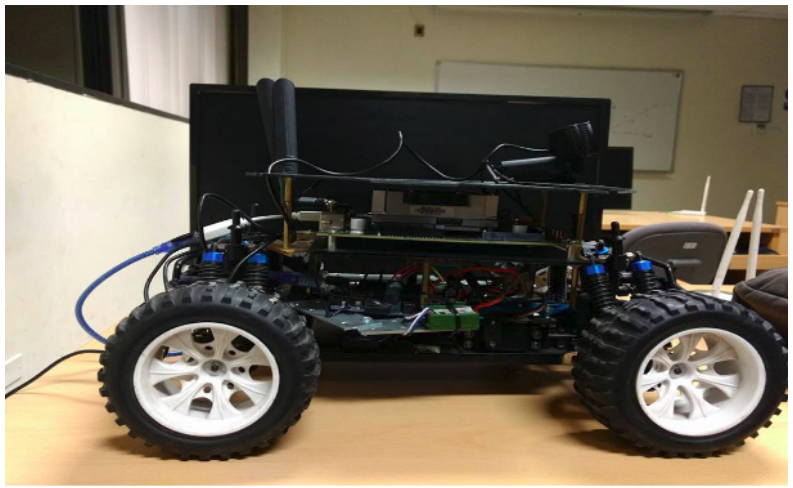
- Built using a base of a Monster Truck 1/10 with a motor and 2 servos for the movement of front and rear tires.
- An Arduino UNO communicate with the NVIDIA Jetson TX1 board.



(b) Vehicle

Model
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- Convolutional NN based on NVIDIA (End to End for self-driving cars).
- Conv24-Conv36-Dropout-Conv48-Dropout-Conv64-Dropout-Conv64-Dropout-FC-FC-FC-FC with non - linear activation function ReLU.
- NVIDIA P4000 with a partition of 20 % validation set and 80 % training set and the ADAM optimizer method.

Vehicle and Path Detection

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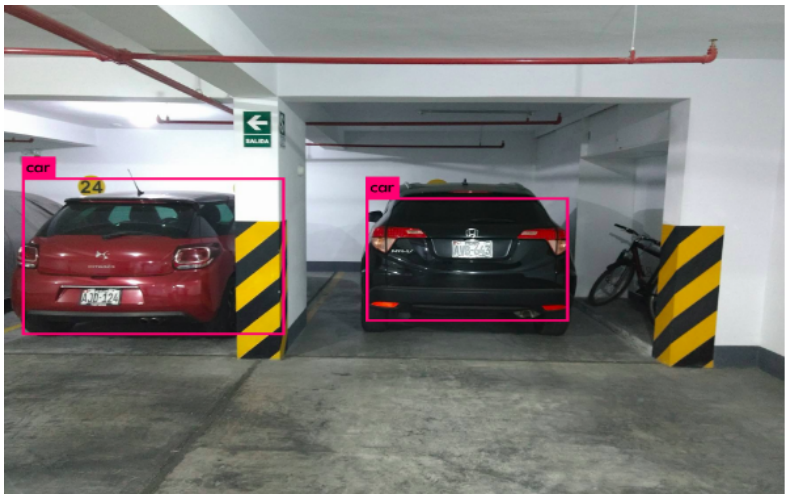
- NN architecture: Tiny YOLO model consists in a convolutional neuronal network with 9 convolutional layers of 16, 32, 64, 128, 256, 512, 1024, 512, 425 filters each one.
- NN test: NVIDIA Jetson TX1 board with a C920 camera obtaining 15 fps which works well with the tiny YOLO model.

(c) Cars Recognition



(d) Path Recognition

Licenses plate recognition
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- OpenALPR library has been tried to detect the plate license of each car and later to compare with SUNARP dataset.

(e) SUNARP FORM

Calculating position

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- To calculate the position, we use Beacons and we triangular position.

$$E_i : (x - x_i)^2 + (y - y_i)^2 = d_1^2$$
for i=1, ..., 3

For this system formed proceeds to solve: Take (x_i, y_i) as coordinates of each beacon, we deduce $r_i = r_c + d_i$.
So, The module is taken:

$$\|r_i\|^2 = \|r_c\|^2 + 2(r_c)(r_i) + \|d_i\|^2.$$

Calculating:

$$\|r_i\|^2 - \|r_j\|^2$$

We obtain:

$$r_c(d_i - d_j) = \|d_j\|^2 - \|d_i\|^2 + \|r_i\|^2 - \|r_j\|^2 = Y_i$$

By which we would have:

$$x_c(x_i - x_j) + y_c(y_i - y_j) = Y_i, \text{ AX = Y}$$

Calculating position
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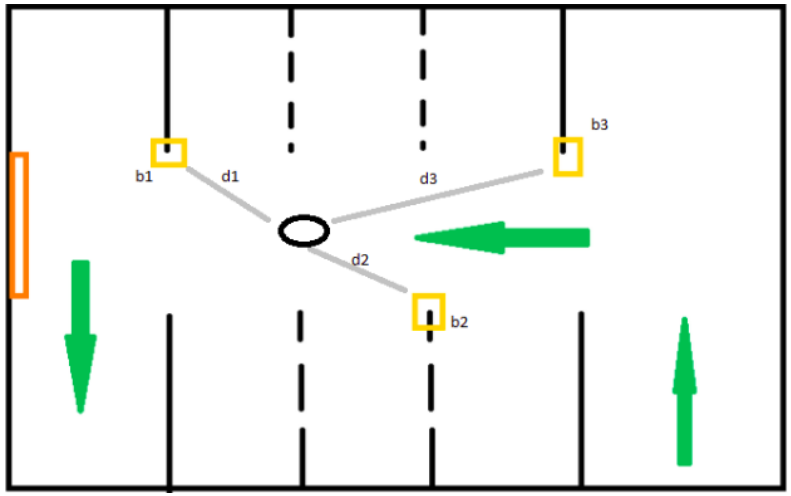
Where:

$x = (x_c, y_c)^t$: is the column vector of the mini-robot positions.

A: is the matrix forms by row vectors.

$$A = \begin{bmatrix} x_1 - x_2 & y_1 - y_2 \\ x_2 - x_3 & y_2 - y_3 \\ x_3 - x_1 & y_3 - y_1 \end{bmatrix}$$



(f) Triangular position

System structure

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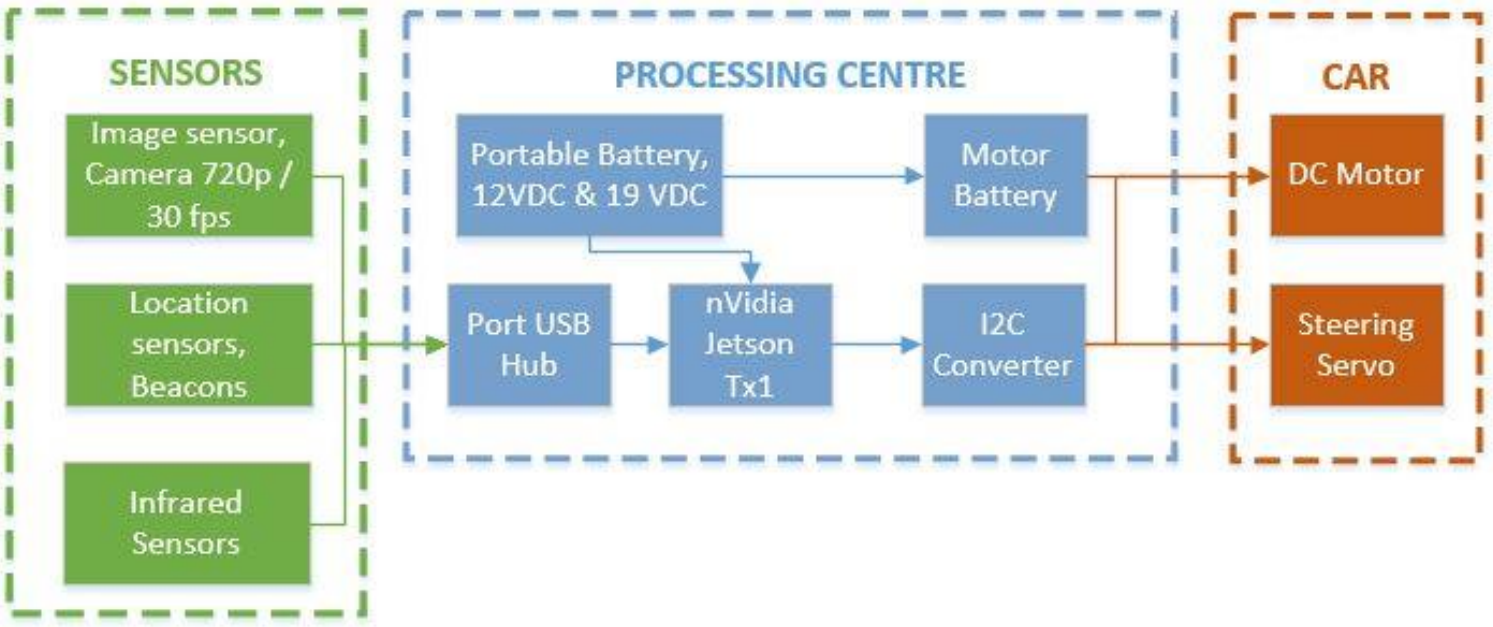

(g) Hardware Communication

Hardware Communication

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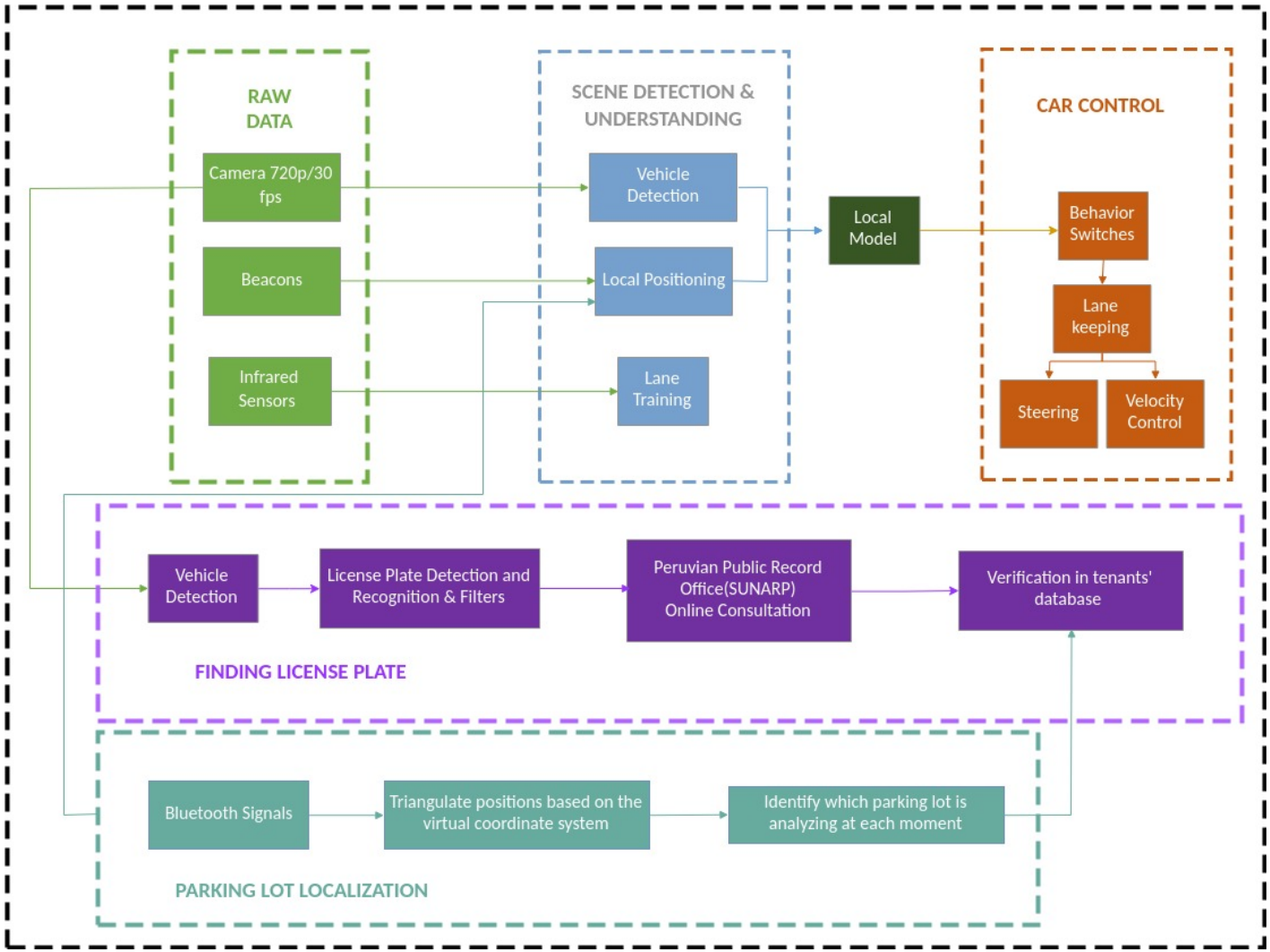

(h) System Structure

Gracias!