SOTICOL Robotics Systems

OPTIMAL SOLUTION

Research on the role of Industrial Technological Innovation

Researching in new technologies to grow through *Efficiency, Innovation & Security*

SOluciones **T**ecnológicas **I**nnovadoras para **C**ontrol **Ó**ptimo y p**L**anificación (SOTICOL)

Sense And Avoid (SAA)

The technological product marketed by SOTICOL for *Sense And Avoid (SAA)* tasks has been developed in order to implement capabilities of safe flight in outdoor/indoor scenarios. Three technologies can be used:

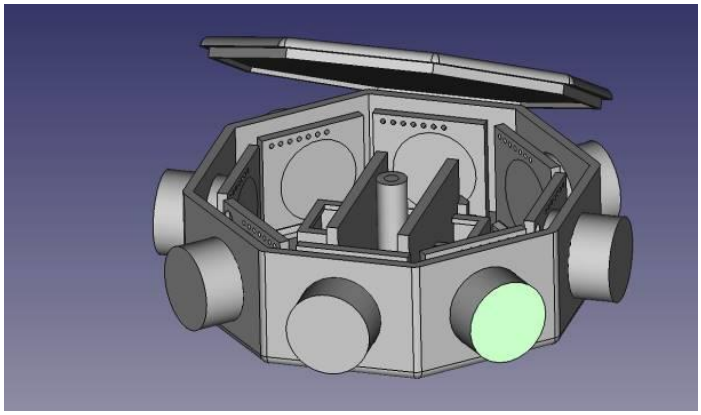
- Sonar
- Light Detection and Ranging (LIDAR)
- Optical Flow

These technologies can be combined to make sensorial fusion. Thus, the advantages of each technology are utilized.

Sonar

This product is based on sonar technology with a resolution of 1cm and a maximum range of 765cm (300 inches). This product has been designed to provide reliable information even in environments with strong acoustic or electrical noise sources.

The following Figure shows the layout of each of the sonars in a 360º arrangement. In this way, blind spots are minimized and the SAA is not affected by the turbulence due to motors. Also, SAA has two sensors in top and bottom sides.



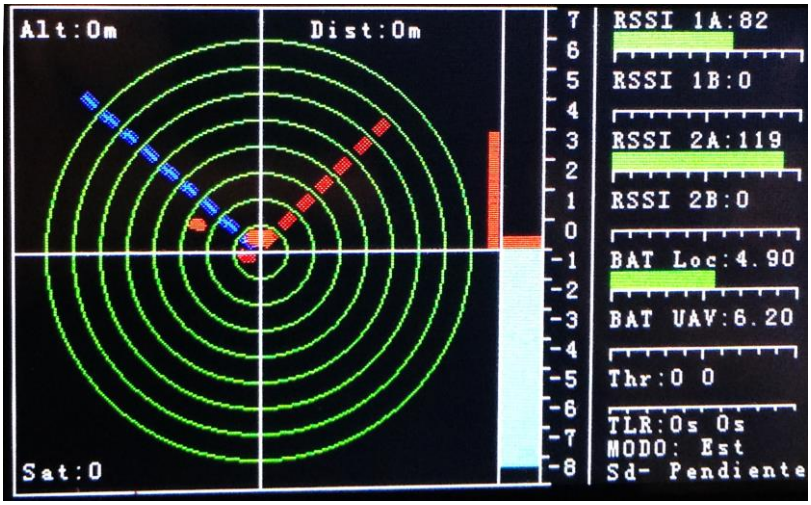
FUNCTIONAL CAPABILITIES

The SAA is governed by a control system, which runs a synchronization algorithm in order to avoid possible interferences between different sonar beams. Thanks to this control system, SAA takes decisions to avoid collisions during the mission.

- ***Sonar 3D-360-2***

  With an arrangement of 8 sonars each 45º in azimuth and 2 sonars on the top and the bottom sides, the volumetric detection is optimized along all perimeter detection.

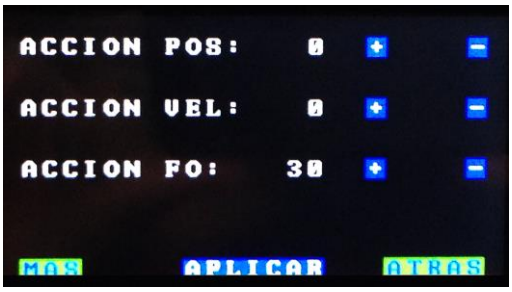
  The user interface can be integrated in a remote control and lets us know the state of all detections and monitor the most relevant navigation data of the platform.



- ***Detection and Avoidance***

  The capabilities of safe flight are firstly based on detection and estimation of objects in a perimeter space of about 7.5m. After processing and filtering data from each sensor, the position of any possible object and the relative velocity with respect to the platform are calculated.

  According to the following Figures, the detection and avoidance capabilities can be configured in order to adapt the SAA to the constraints of the environment.



Avoidance configuration

Defence configuration

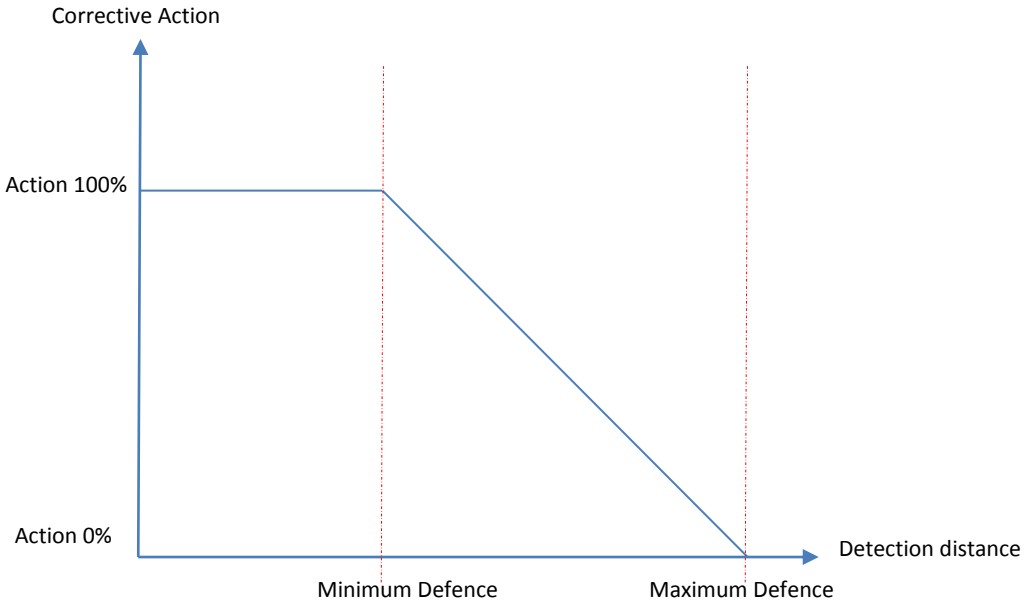
- ***Avoidance configuration***

  The *avoidance* manoeuvre consists of adding the detection vector of all sensors. In this way, a single avoidance vector is performed in real-time, which applies to "pitch", "roll" and "throttle".

  The different parameters of the previous Figure are constants that control the sensitivity of the single avoidance vector. These parameters can be tuned in real-time to set the response time.

- ***Defence configuration***

  The defence concept is based on a criterion of perimeter distance. Two levels are set: minimum and maximum. The magnitude of the single avoidance vector is proportional to the distance according to the following Figure.



LIDAR

Using LIDAR, the measuring accuracy can be of 10mm to 40mm. This technology is currently being developed to reach two goals:

- SAA
- 3D elevation profiles
- 3D Simultaneous Localization And Mapping (SLAM)

The control system associated to LIDAR is in charge of processing the millions of points received from the different obstacles. When doing this, our software is able to re-build 3D elevation profiles. Also, LIDAR is used to implement the SLAM technique when GPS is absent.

Two main advantages are achieved when using LIDAR for SAA:

- Higher measurement accuracy
- Detection of smaller obstacles
- Higher detection distances

Optical flow

The optical flow sensor is attached to the sonar system and it is used as a positioning system to improve GPS position or in absence of GPS.

According to the Avoidance configuration explained in "Sonar Section", the sensibility of this sensor can be adjusted in real-time.

It works processing the digital image from a camera and detecting the relative displacement of representative points, selected by contrast.

The system is working in ground distance below 10m and makes possible the indoor operation under control.

Ground distance	1m	3m	10m
16mm lens	2.4m/s	7.2m/s	24m/s
8mm lens	4.8m/s	14.4m/s	48m/s
6mm lens	6.4m/s	19.2m/s	64m/s
4mm lens	9.6m/s	28.8m/s	96m/s