Automatic Landing Detection System

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Introduction

- The Automatic Landing Detection System (ALDS) aims to help judges to score the precision landings.
- ALDS allows reducing the number of judges needed during the competition.
- After each landing, the ALDS will have a provisional score immediately. The score is broadcasted directly to the streaming platforms enabling a tentative raking instantaneously for competitors and public.

Principle of work

The system integrates air pipelines sealed on one side, and connected to inexpensive air pressure sensors on the other.

The analog signal is amplified and processed to detect sudden peaks of pressure, meaning that an air tube has been pressed.

The system is independent of ambient air pressure changes: no calibration required.

System components

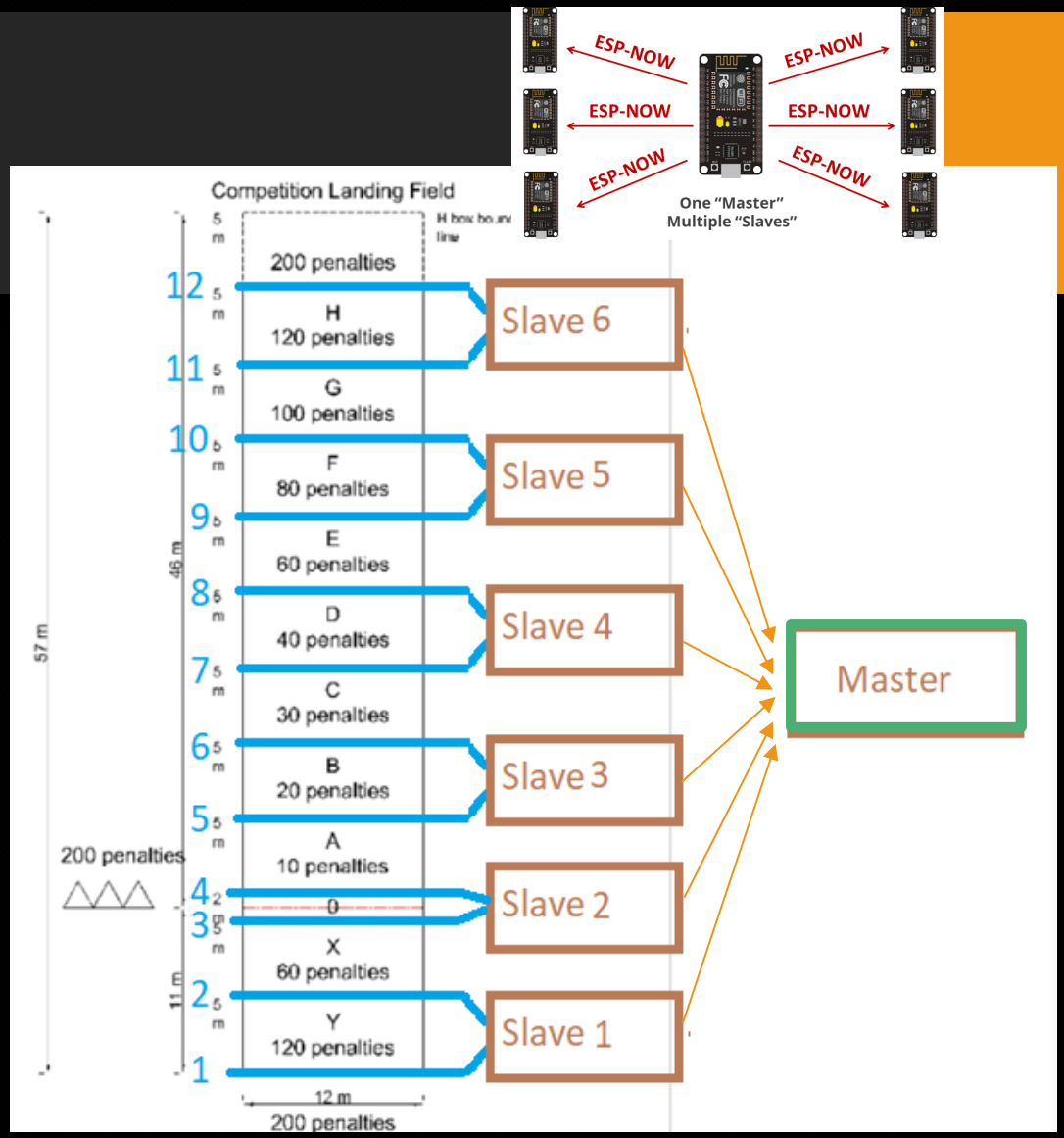
The system is composed of:

- 0.5mm diameter **air tube**. Each landing area is separated by an air tube.
- **Slave modules** with a custom detector. Each one collects the signal from 2 different air lines. 6 units in the figure.
- One **master module**.

Slave modules send signals to the **master module** to determine the landing score, depending on which line has been pressed.

Slaves send data to the master module thanks to its embedded WiFi sensor, and they are all powered via 18650 cells, with more than 10 hours endurance.

The master module has a web server where the result is shown; it can also send the score to a 3rd party software, like AirSports, if connected to a network with internet connection via API HTTP.



Example: If lines 1st , 2nd and 3rd are not pressed, but 4th and onwards are pressed, it means that the score of the landing is 0 points penalty, according to the Spanish championship rules.

Bill of Materials

Slave and master modules with WiFi sensor: NODEMCU 

Pressure sensor (automotive): MPS20N0040D 

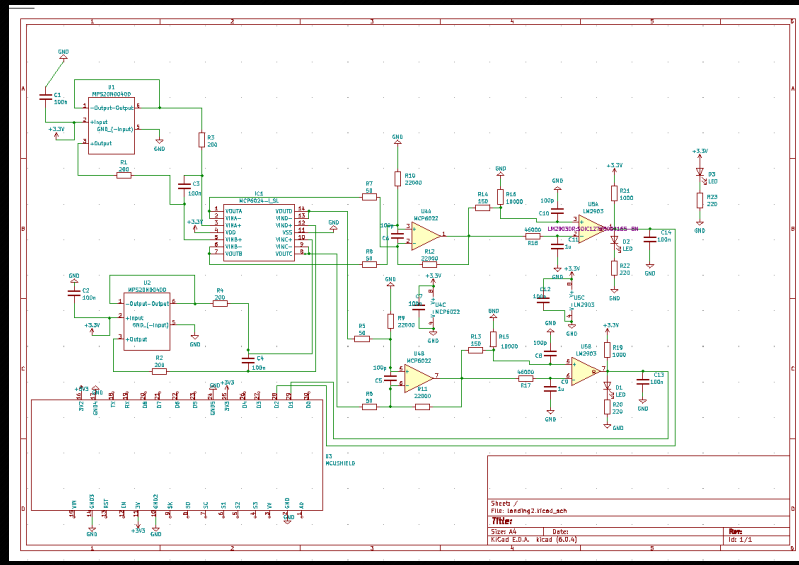
Electronics:

-Operational amplifier (MCP6024) as a voltage follower

-Operational amplifier (MCP6022) with ~500 times gain

-Filtering (resistors and capacitors)

-Comparator LM2903. Compares the raw signal with a voltage divider (to ensure no false triggers) vs filtered signal



Communication: ESP-NOW (protocol developed by Espressif

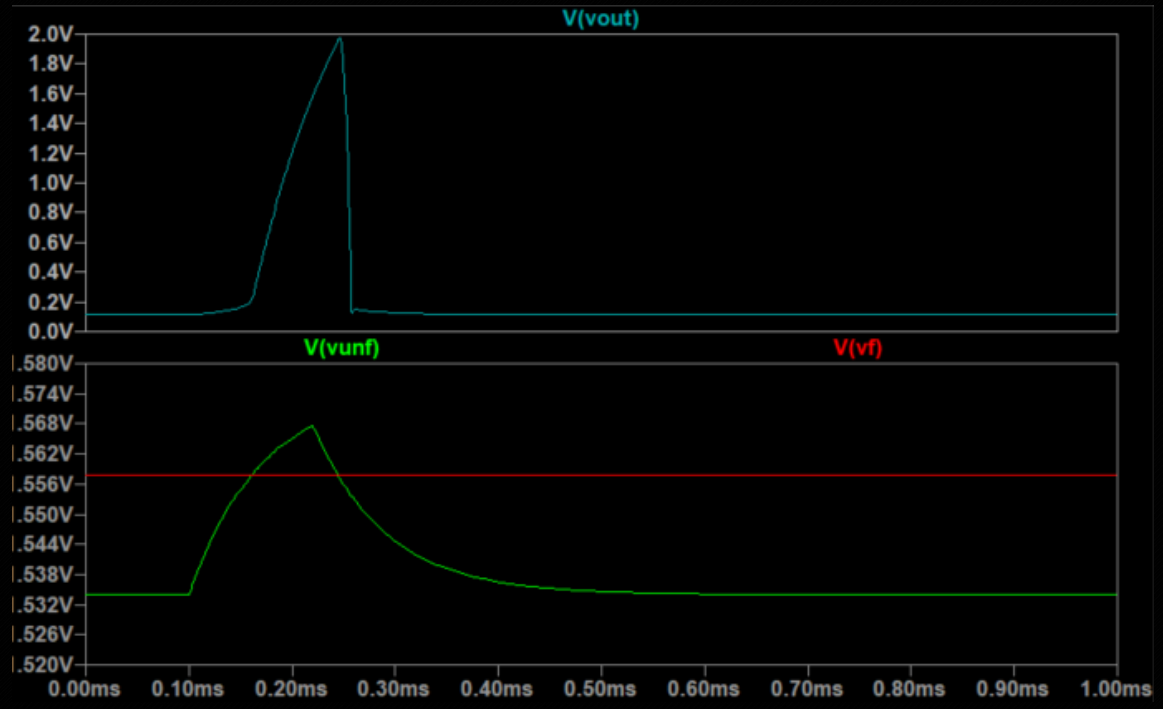
This protocol allows a very fast peer to peer communication

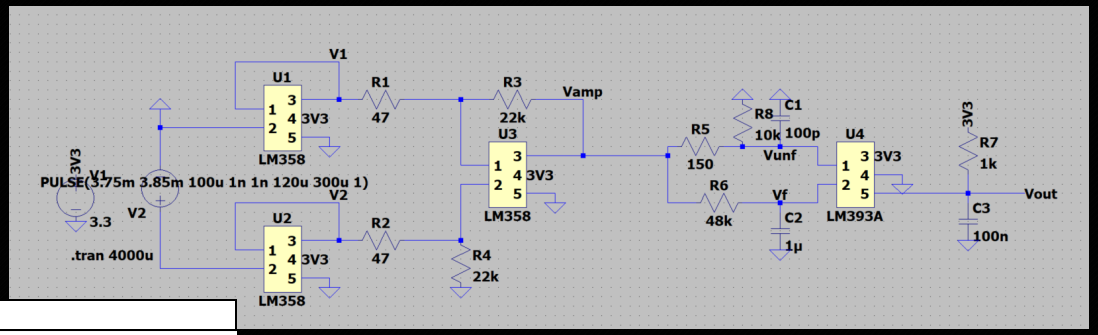
Simulations

LTSpice simulations to confirm filters work, and voltage divider

When there is a sudden pressure increase, the signal **unfiltered** increase above the **filtered** signal. As a result, the **comparator**, changes from 0 to 1.

This signal is caught by the Arduino as an interruption and sent to the master module.





Vmax landing		
	130	km/h
	36,1111111	m/s
V min landing		
	40	km/h
	11,1111111	m/s
Pipe diameter		
	0,004	meters
	0,005	meters

Pulse length		
t min	0,000111	s
t max	0,000450	s
Min freq	9027,78	Hz
Max freq	2222,22	Hz

Pulses length between 0.1 and 0.5ms, depending on the landing speed and air tube diameter.

Cost study

Cost per detection module (2 tubes capability): ~54€

If 6 modules (12 lines), total cost would be: 36,59€ * 6 + 3,32€(master) = 222,88€

	Cost	units	Total
NodeMCU	3,32 €	1	3,32 €
Battery holder	2,54 €	1	2,54 €
18650 Cell	4,00 €	1	4,00 €
Pipelines	0,71 €	30	21,30 €
Components	5,00 €	1	5,00 €
Print control board	0,43 €	1	0,43 €
Assembly ?	?		
			36,59 €

Validation

- The first preliminar tests with 2 lines deployed gave a 100% of reliability
- Pending to be tested with 12 lines, 6 slaves sensors and 1 master sensor. E