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Managing multiple quadrotors in formation control experiments

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This semester project was about making quadrotors fly and see how they interact, but in a first time, the software had to be upgraded in order to simplify the flight procedure.

In order to be able to make some quadrotors (four or five ideally) fly simultaneously and without any trouble, an automatic launching of the nodes running on the quadrotors has been implemented in each quadrotor. This permitted to avoid running five terminals from the external computer for each robot in flight. Two functions were also added in order to command the robots easier.

The experiments done in order to define the interaction between two robots are the following; one robot was hovering at a certain height and another one had to cross the perturbation created by the first one. In order to cover the maximum space, the experiment was repeated at different heights and with different lateral shifts (not crossing exactly under the static robot). The extracted data permitted to find the perturbation force felt in the three dimensions depending on the relative position between the robots. By doing statistics on the data and analyzing it, it leaded to a mathematical model based on a Gaussian function on the three dimensions to model the perturbation between two quadrotors. This model has been validated by implementing it in the robot. The model there was computing the theoretical force created by the perturbation and the value (only along Z) was injected in the PID controller of the robot in order to counteract the perturbation. This validation was a partial success; this is why the model was also implemented in the simulator provided by Duarte Dias. This simulator was used to compare the amplitude of the perturbation in the simulation and in the real experiments. This gave good results, which validated the model found before.

This model can now be implemented in the robots to feedforward the perturbation or in the simulator to experiment this with more than two robots flying simultaneously.

In conclusion, the mathematical model is working well, but there is still an overshoot when leaving the perturbation. This is due to the fact that I ignored a phenomenon possibly due to the dynamics of the quadrotor. To upgrade this model, it is most probably possible to include this effect due to the dynamics.