ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Laboratoire d'Automatique

Baby Hovercraft

Presentation

A small or "baby"-hovercraft has been conceived, based on an exiting quadcopter. The emphasis was put on the design of a shell-structure and on the necessary programming to enable a control of the hovercraft. The lift mechanism was not part of the project, as an air-hockey table was being used as an appropriate mechanism to lift the device off the ground.

The guidelines were flexible:

- Quadcopter: Bitcraze. (Crazyflie 2.0).
- Using 3D printing technology.
- Move in all directions on a 2D surface.
- Fit more or less in a sphere of 10cm.

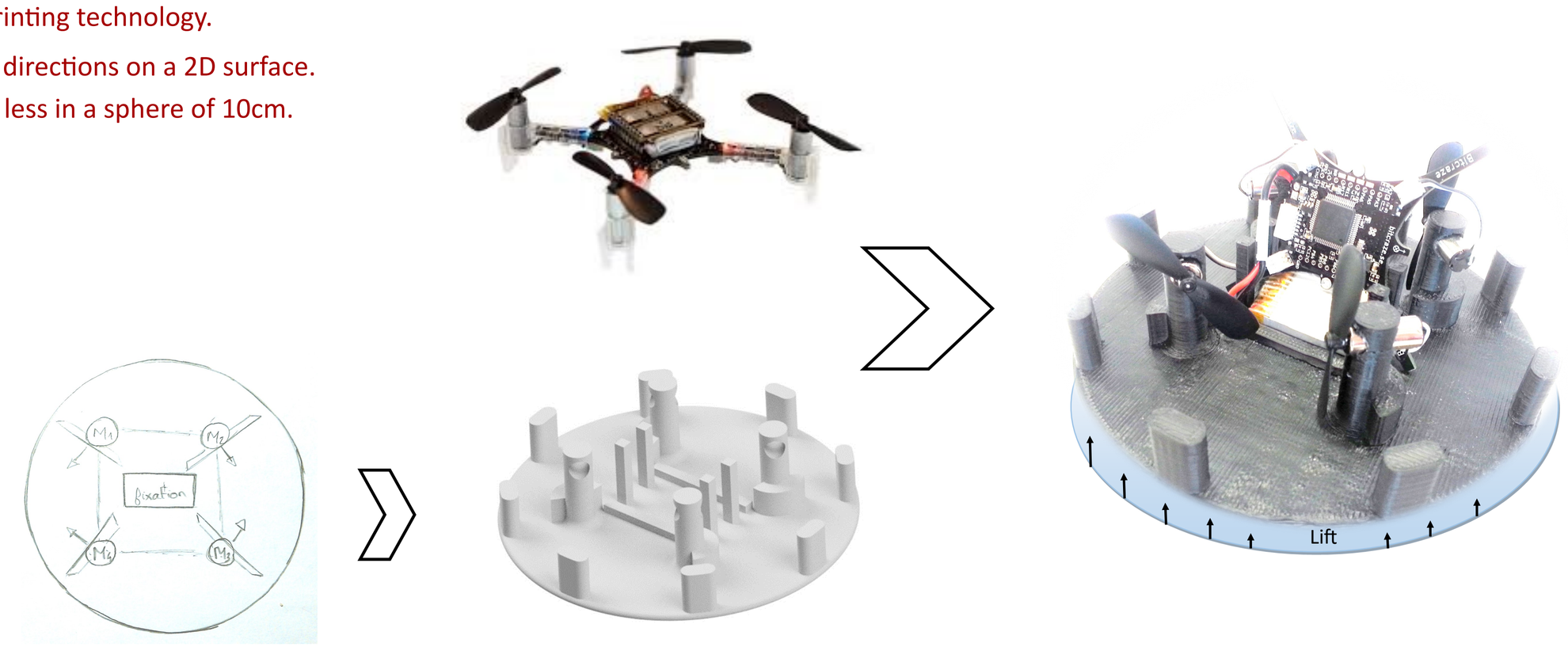


Figure 1 : From model to prototype

The structure had to be designed in such a way, as to accommodate the engines, and the microprocessor system. In addition, a new operational logic has been designed, in order to maneuver the hovercraft correctly.

Use and operation

The user interface is based on the available mobile application to control the quadcopter via Bluetooth. In the most recent version [State: May, 2016] one can perceive two buttons. We used the left button to send a X-Y direction of movement commands. The magnitude or in other words, the distance from the origin by witch the button is displaced in a certain direction provides another intuitive way to regulate the velocity of the movement. A rotation around the Z-Axis of the hovercraft can be established by pushing the right button either to the left, for negative rotations or to the right for positive rotations. The rotation speed is set to a constant value and cannot be changed by the user.

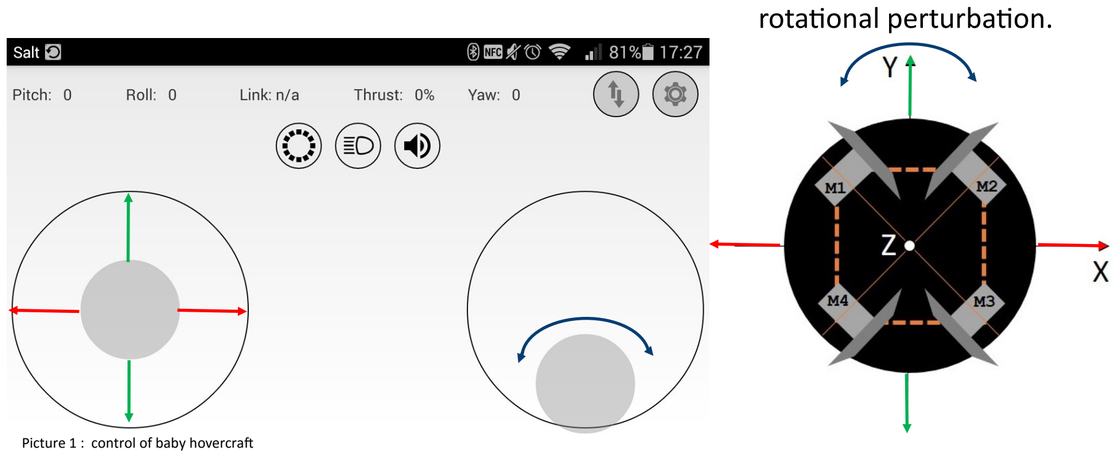
In order to prevent a rotation around the Z-axis, induced by exterior forces, a rotational stabilizer was deceived. The stabilizer represents a proportional controller, with the gyro data as proportional factor. Test showed a very quick and agile response to exterior rotational perturbation.

Movement	M1	M2	M3	M4
X +	1	0	0	1
X -	0	1	0	0
Y +	1	1	0	0
Y -	0	0	1	1

ROTATION

Movement	M1	M2	M3	M4
Rotation +	1	0	1	0
Rotation -	0	1	0	1

Table 1 : motors assignments



Picture 1 : control of baby hovercraft

Outlook: Enhanced control through video processing

A closed loop implementation through video analysis was established theoretically. The aim of the closed loop, is the implementation of a precise, self-correcting, positioning system and hence maneuvering system of the hovercraft.

The aim of this algorithm is to bring the red dot back to the origin. The x-y position will eventually be found by video analysis and tracking software of the red dot.

Figure 2 : state diagram

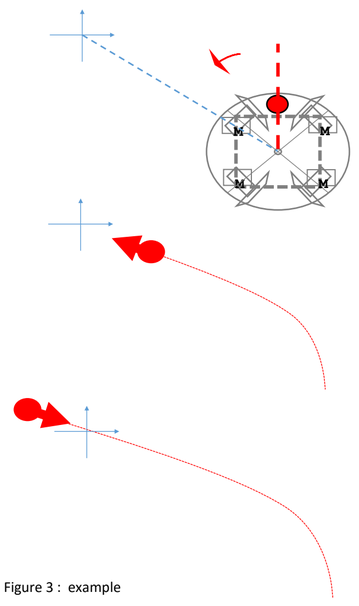


Figure 3 : example

The state diagram is composed of two main blocks, #1 and #2. Both make sure that the red dot is always aligned on a virtual axis going from the center of the hovercraft to the origin, therefore being the shortest path to the origin.

The difference is, that the first block positions the red dot at the front and the second block positions the red dot at the back. If the x, y-coordinates of the position marker (red dot) are unequal to zero, the state is switched to block #1, if then the sign of the y-coordinates switches, the state is switched to block#2 and will then keep switching between the two blocks every time the sign of the y-coordinate switches.

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