Methods for Autonomous Wristband Placement with a Search-and-Rescue Aerial Manipulator

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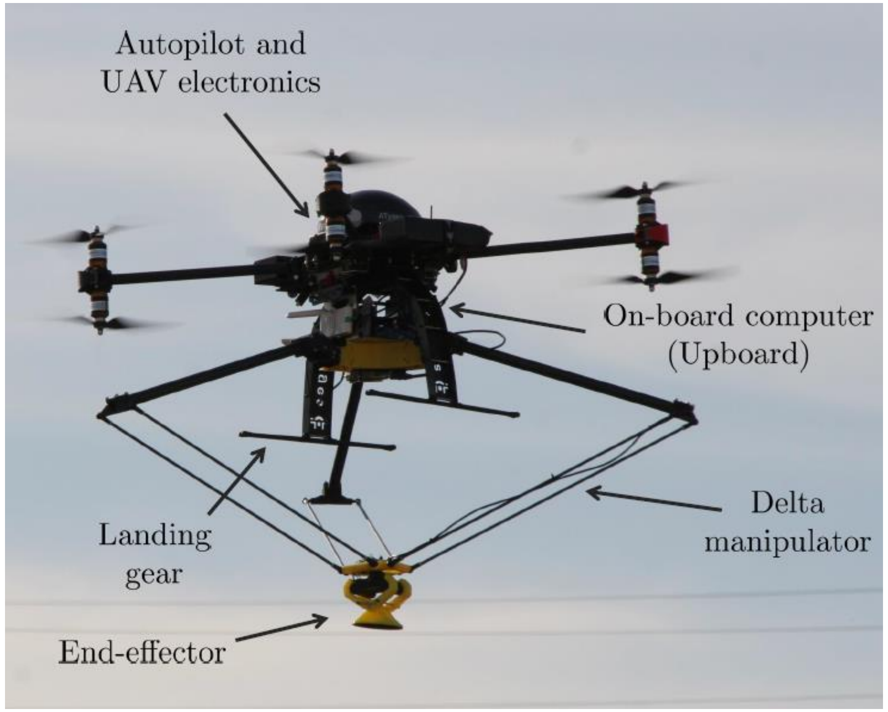
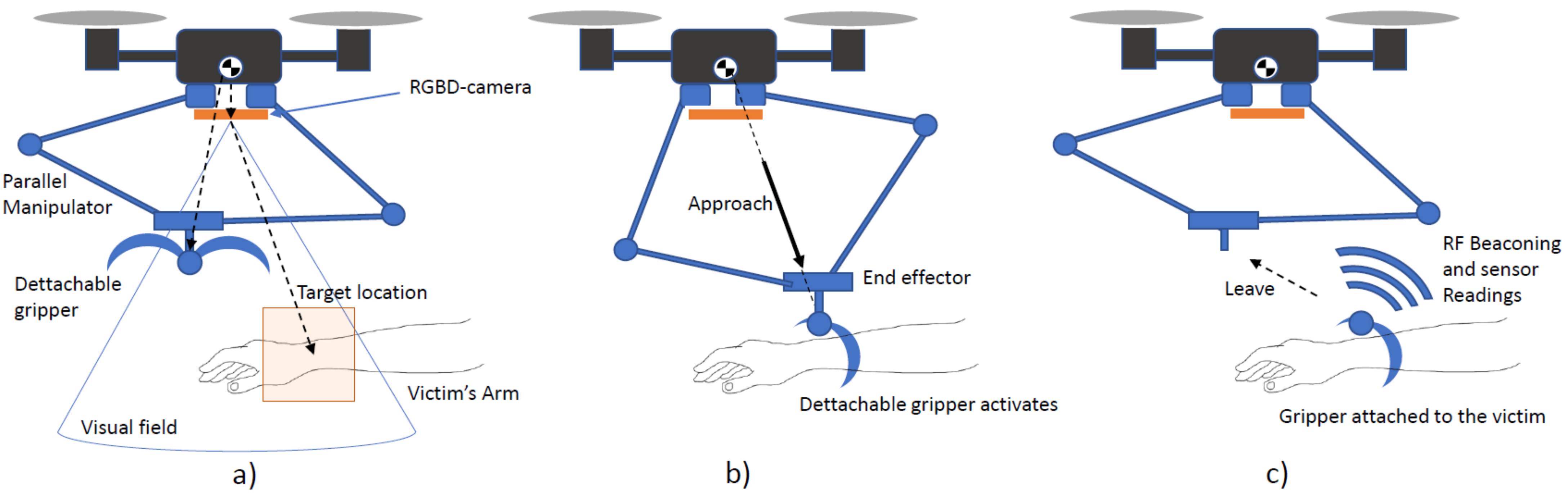
1. Aerial Manipulator

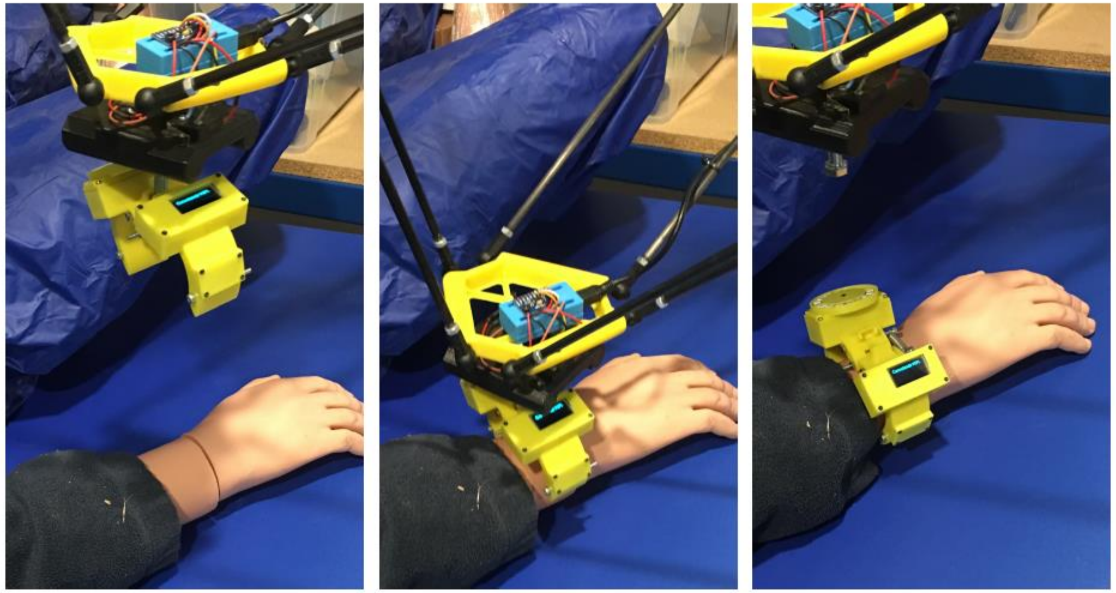


- Light-weight 3 DOF delta manipulator
- Intel r200 RGB-D camera
- Detachable and sensorized wristband.
- Developed under ROS

2. Problem Statement

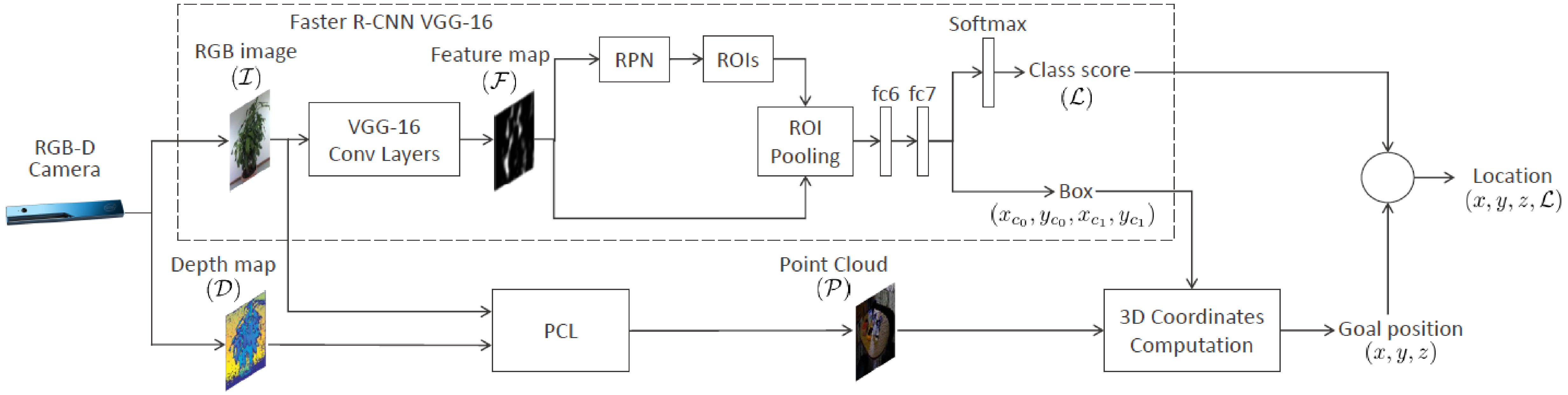


3. Detachable Wristband and Trajectory Planning



- The system can attach a wristband to a victim
- Wristband equipped with e-Health sensors
- Trajectory: Following the Center of Masses to minimize the inertias on the UAS

4. Wrist Recognition Using Deep Learning



5. Conclusions and future work

- HUGE problem
- We applied and tested solutions for each task
- Use OpenPose instead of Faster R-CNN
- Put all the subsystems together

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6. Training the Faster R-CNN method

$$\varepsilon_n = \varepsilon_0 \cdot \gamma^{(n/\xi)}$$

7. Trajectory Planning

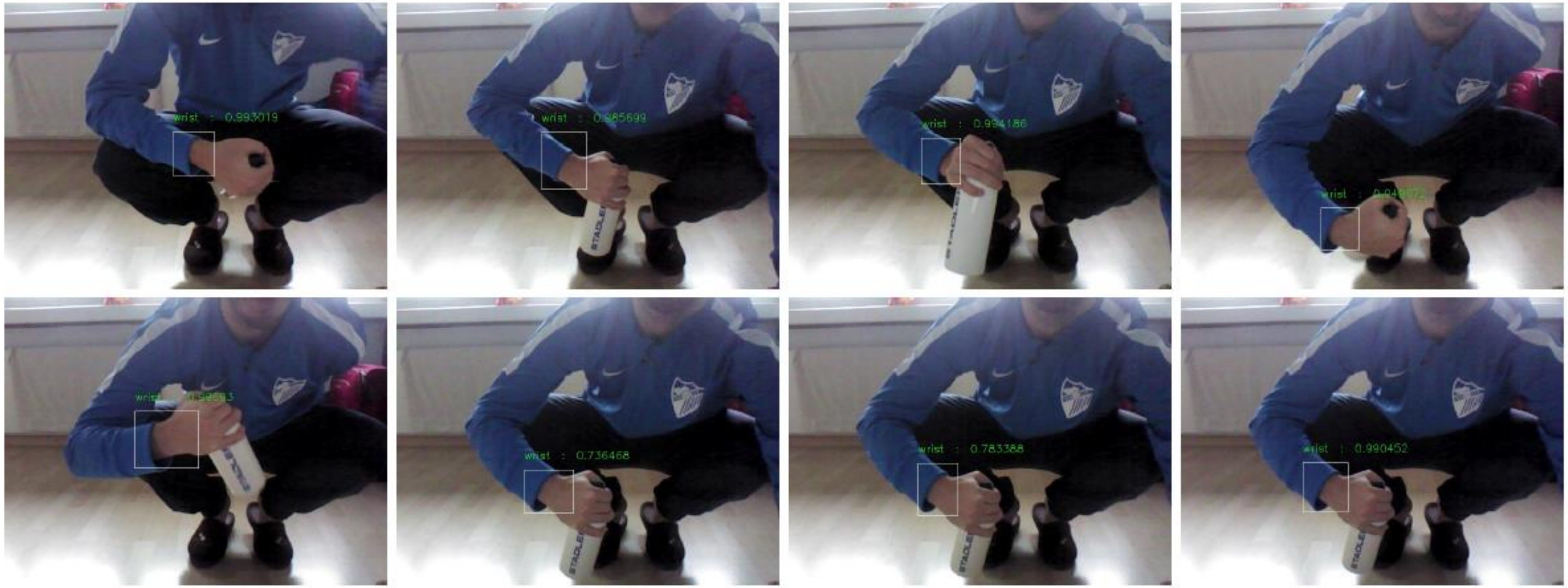
Algorithm 1 Calculation of the center of mass

```
for i= 1 to N do
    Q[i]= InverseKinematics(X[i])
    CM= CenterofMass(Q(i))
    P_Inter= Intersection(CM, Ref_Plane, X[i])
    X[i+1]= NextPoint(P_Inter, X[i], N-1)
end for
```

Algorithm 2 Trajectory generation

```
P_Inter=Intersection(CM, Ref_Plane, Goal_X)
while P_Inter != X do
    X= P_Inter
    Q= InverseKinematics(X)
    CM= CenterofMass(Q[i])
    P_Inter= Intersection(CM, Ref_Plane, Goal_X)
end while
```

8. Results: Wrist Detection I



8. Results: Wrist Detection II

Fig. 8. Localization of the wrist in two different positions, showing the pose obtained with respect to the reference system of the camera and the class score in the detection vector $[x, y, z, \mathcal{L}]$. Note that in both pictures $\mathcal{L} > 90\%$.

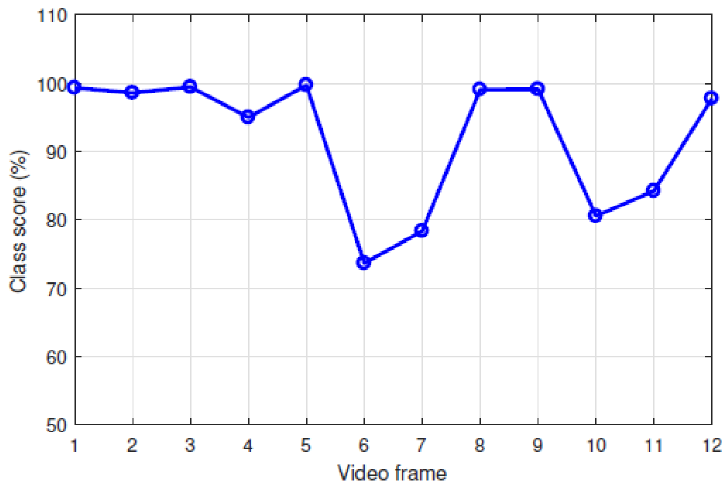


Fig. 6. Class score achieved in each frame of the sequence of images after passing through the *Faster R-CNN*.

	Wrist detected	No wrist detected
Wrist presented	521(57.13%)	391(42.87%)
No wrist presented	29(7.25%)	371(92.75%)

9. Results: Trajectory planning I

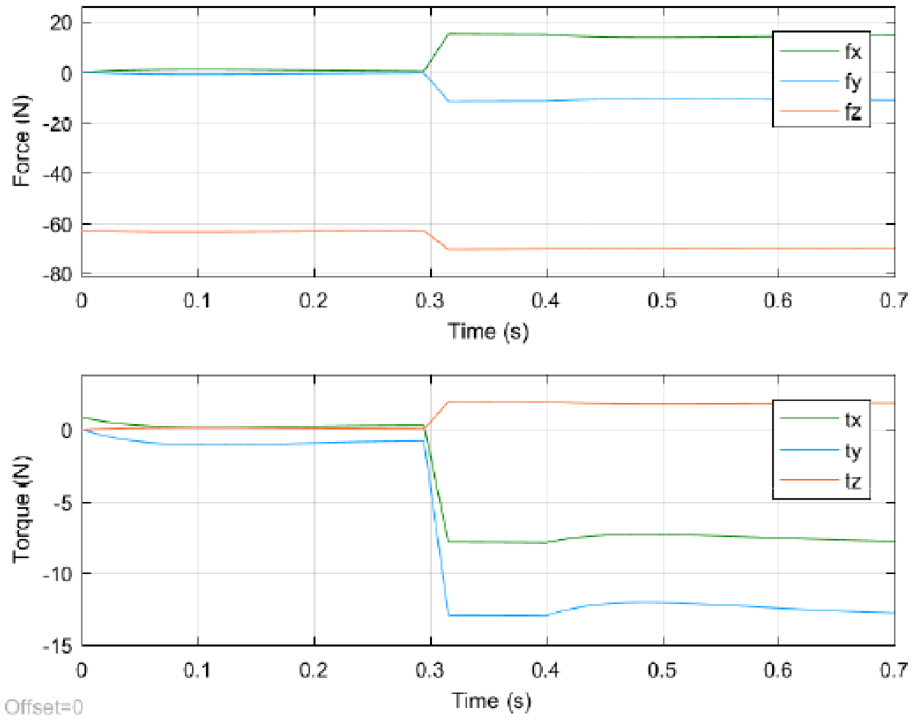


Fig. 9. Dynamic simulation of the effects of external reaction forces measured at the center of the aerial platform, with a no radial trajectory. External forces are applied for 0.1s in the opposite direction to the end effector speed, showing high-torque perturbations.

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9. Results: Trajectory planning II

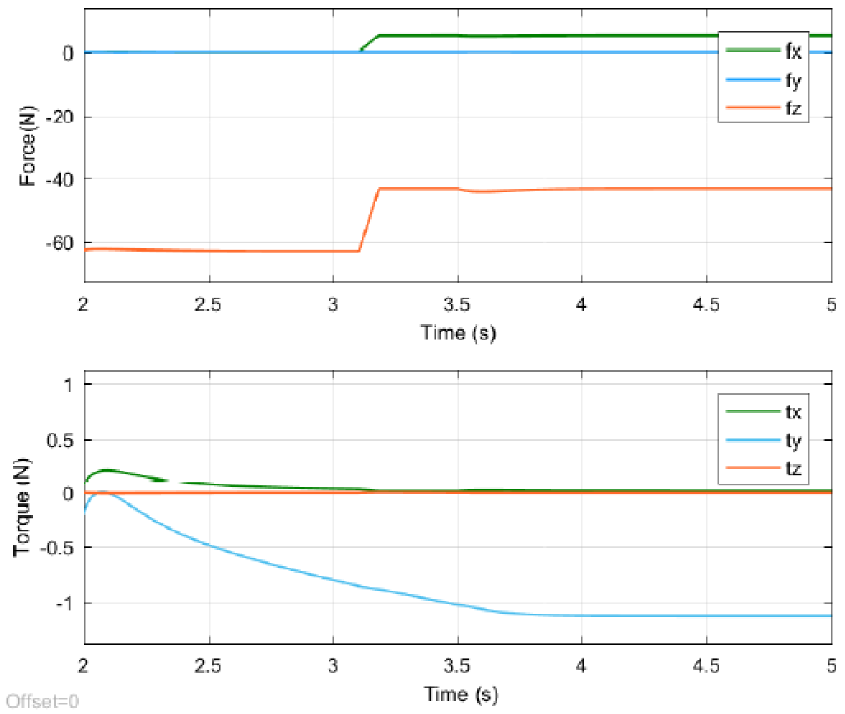

Fig. 10. Dynamic simulation of the effects of a load and external reaction forces measured at the center of the aerial platform, using the new radial trajectory method. External forces are applied for 0.1s in the opposite direction to the end effector speed and the showing negligible torque perturbations due to the external reaction force.