iHuman3D: Intelligent Human Body 3D Reconstruction using a Single Flying Camera

Supplemental Material

ACM Reference format:
. 2018. iHuman3D: Intelligent Human Body 3D Reconstruction using a Single Flying Camera. In *Proceedings of 2018 ACM Multimedia Conference, Seoul, Republic of Korea, October 22–26, 2018 (MM '18),* 2 pages.
https://doi.org/10.1145/3240508.3240600

1 SYSTEM SETUP

This section provides more details about the used hardware and software components in our *iHuman3D* system. The following Fig. 1 shows the platform of flying camera in the *iHuman3D* system and its three main layers.

- The bottom layer is the execute & sensor layer, which consists of the on-board sensors only accessed by the middle hardware abstraction layer (HAL).
- In the middle layer, we utilize two kinds of products from DJI. The ***DJI A3***[1] works as the flight controller, while ***DJI Guidance***[2] works as the navigation component. These two components connect each other with CAN ports, while they can communicate with the highest layer through the series port using DJI SDK.
- The top layer is the algorithm layer. It is programmable and related to all the on-board algorithms. The ***Intel NUC***[3] works as the on-board computing unit, and the ***ASUS Xtion*** acquires the RGBD data of the scene. Based on the NBV Commands from ourGAME-based active view planning module, the ***PID Controller*** calculates the PID parameters for UAV control, which is executed on the ***Intel NUC***.

The SDK supported by DJI is utilized to communicate between the highest programmable layer and the middle HAL layer. All the velocities including the three axises velocities and the three angular velocities (roll, yaw and yaw) can be set from ***Intel NUC*** to ***DJI A3***. Without velocity setting, the drone will stay hovering. On the other hand, we can collect the flight states from ***DJI A3*** to ***Intel NUC***, including all the sensor data, the current altitude, the current velocities of the drone, etc.

Based on the acquired states of the flying camera and current next best view (NBV) command, we utilize the PID controllers run on the ***Intel NUC*** to directly tune the three linear velocities (along three axises) and the three angular velocities of the aerial robot platform, without an additional feedback controller for trajectory tracking on the aerial robot platform. More details about the PID controllers for the task of active view planning are provided in the following supplemental material.

MM '18, October 22–26, 2018, Seoul, Republic of Korea

ACM ISBN 978-1-4503-5665-7/18/10…$15.00
https://doi.org/10.1145/3240508.3240600

2 FLYING CAMERA CONTROL

This section elaborates the control for the execution of the flying camera towards current desired view point. Recall that the NBV command includes the 3-DOF vector $\mathbf{v} = (r, \theta, l)$, and a robot yaw angle θ representing the desired view location along the three XYZ axises and the yaw angle in volume coordinate frame of the flying camera. By utilizing the transform matrix $\mathbf{T}_{v2w} = \mathbf{T}_{w2v}{}^{-1}$, we can transform the desired volume view to world coordinate $\mathbf{W}$, The PID controllers are utilized to turn the desired view $\mathbf{W}^*$ into the desired linear and angular velocities. Firstly, current corresponding state of the flying camera $\mathbf{W}_{cur} = (x_{cur}, y_{cur}, z_{cur})$ is extracted from DJI A3. Then the error between the measurement and the desired values is formulated as:

$$Err = (Err_x, Err_y, Err_z, Err_\theta) = \mathbf{W}_{cur} - \mathbf{W}^*, \tag{1}$$

which is applied to the PID controllers to tune the velocities of the flying camera. For our iHuman3D system, two different PID controllers are applied to the linear and angular velocities respectively.

2.1 PID controller for the linear velocities

The target of this controller is to ensure that the flying camera reaches the desired location stably by tuning the three linear velocities along the XYZ axes. Taking the Z axis for example, we use the following formulation to calculate the desired linear velocity V_z along the Z axis of the camera coordinate system:

$$V_z = K_p \times Err_z - K_d \times \frac{\partial Err_z}{\partial t}, \tag{2}$$

where the K_p is the proportional coefficient, the K_d is the derivative coefficient. During all the experiments of our *iHuman3D* system, K_p is 2.6 and K_d is 0.12 for the Z axis

The calculation of the linear velocities of the X and Y axes is similar to Eqn. 2, only with different proportional and derivative coefiňĄcients according to the maneuverabilityof the flying camera. For the linear velocity V_x along the X axis, the proportional and derivative coefiňĄcients are set to be 1.5 and 0.1, respectively. For the linear velocity V_y along the Y axis, the proportional and derivative coefiňĄcients are set to be 1.0 and 0.02, respectively. The final velocity is alsotruncated to be no larger than 1.0 m/s for safety guarantee.

2.2 PID controller for the angular velocities

The target of this controller is to ensure that the flying camera maintains a specific view angle in the desired location. Recall that

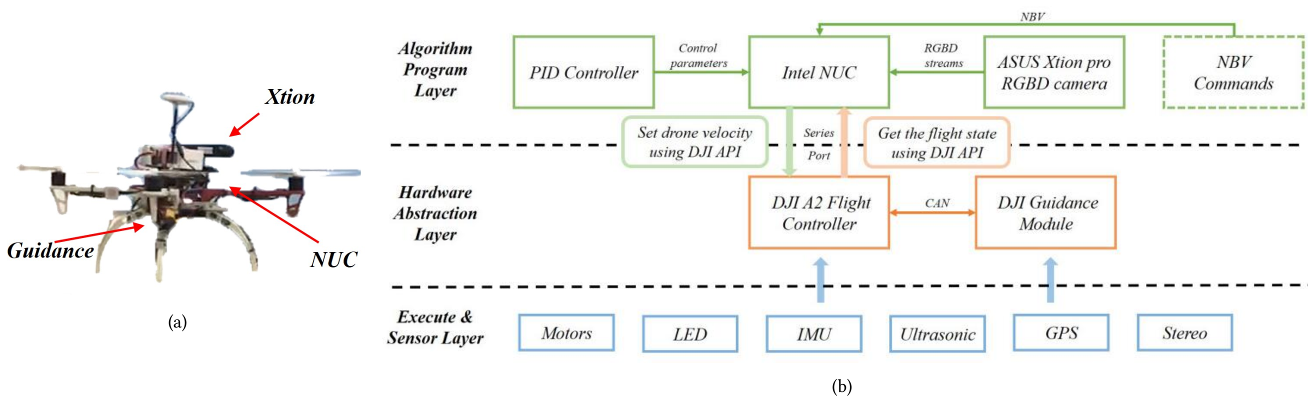

Figure 1: The layered illustration of the UAV platform in our *iHuman3D* system.

the roll and pitch angular velocity are set to be zero, and thus only the yaw angular velocity is controlled by this PID controller. Based on the error Err_θ calculated from Eqn. 1, we use the following formulation to tune the yaw angular velocity:

$$W_{yaw} = K_p \times Err_\theta - K_d \times \frac{\partial Err_\theta}{\partial t}. \quad (3)$$

To improve the stability of the flying camera during tuning the yaw angular velocity, the proportional and derivative coefficients are piecewisely deïňĄned as follows:

$$(K_p, K_d) = \begin{cases} (2.4, 0.2) & if\ \mathbf{abs}(Err_\theta) \geq 25^o \\ (1.2, 0.05) & otherwise \end{cases} \quad (4)$$

In addition, the final angular velocity is also truncated to be no larger than 90 degrees/s for safety guarantee.

REFERENCES

[1] DJI. 2016. DJI A3. https://www.dji.com/a3/. (2016).
[2] DJI. 2016. DJI Guidance. https://www.dji.com/guidance/. (2016).
[3] Intel. 2016. NUC5i7RYH Mini PC. http://www.intel.com/content/www/us/en/nuc/nuc-kit-nuc5i7ryh/. (2016).