

Attitude and position control of a quadcopter in a networked distributed system

Group 733 - Alejandro Alonso García, Amalie Vistoft Petersen, Andrea Victoria Tram Løvemærke, Niels Skov Vestergaard, Noelia Villarmarzo Arruñada AALBORG UNIVERSITY
DENMARK

Discussion

The network delay and sampling rate affect

the controllers' performance, however, they still

achieve the given references in simulation. Ex-

perimental results could not be presented for the

translational controllers, as it has not been pos-

sible to successfully implement the translational

controllers in due time. The design is however

deemed valid, as simulations show that it should

work in reality. The attitude controller is imple-

Department of Electronic Systems - Automation and Control Email: [aalons16] [apet13] [alavem13] [nveste12] [nvilla16] @student.aau.dk

Control Solution

Introduction

Quadcopters constitute a control challenge due to their inherent instability and coupled behavior. However, the interest for them has increased due to the multiple possibilities they offer. A linear control solution capable of stabilizing the quadcopter and controlling its position is presented by combining state space and classical control approaches. The presented results include the attitude control performance and simulations showing the behavior of the translational controllers.

System

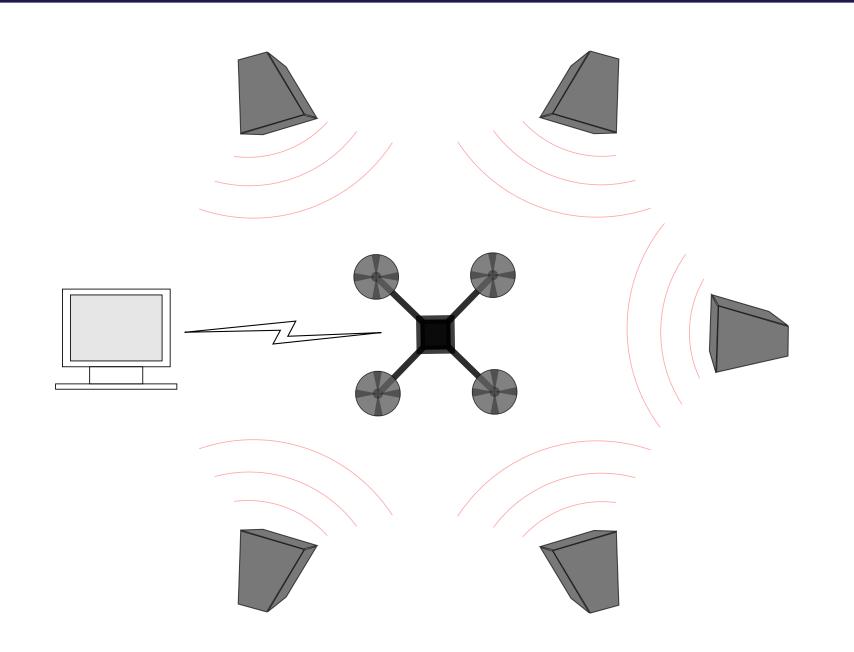


Fig. 1: The distributed system is composed by a motion tracking system connected to a computer, the quadcopter and a radio link communication between them. The network is simulated using TrueTime during the design process to ensure stability.

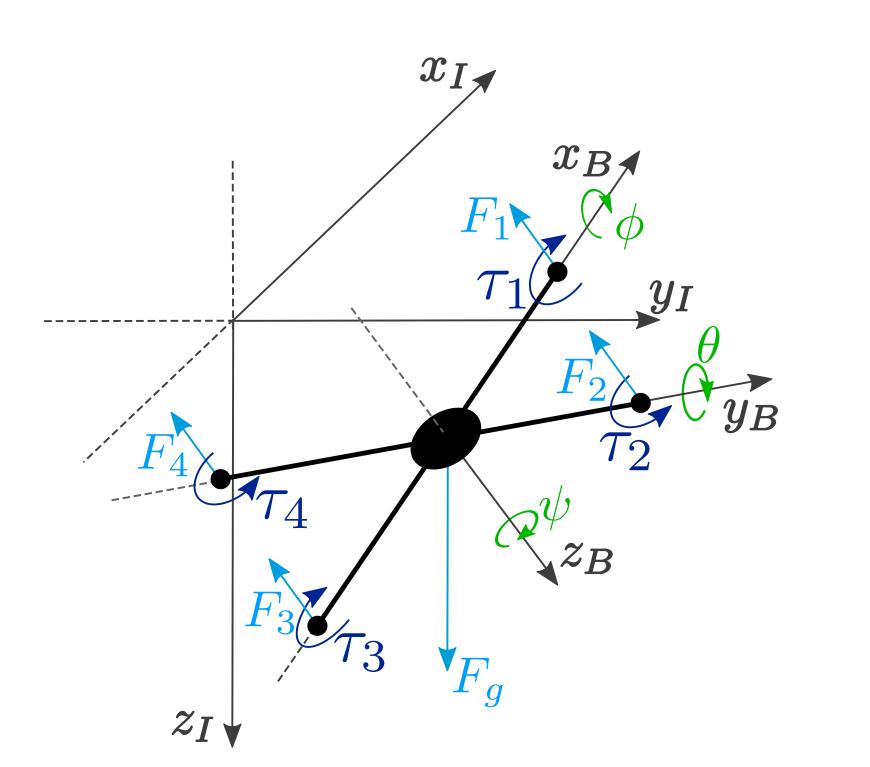


Fig. 2: Free body diagram of the quadcopter along with the inertial

and body frames used for modeling.

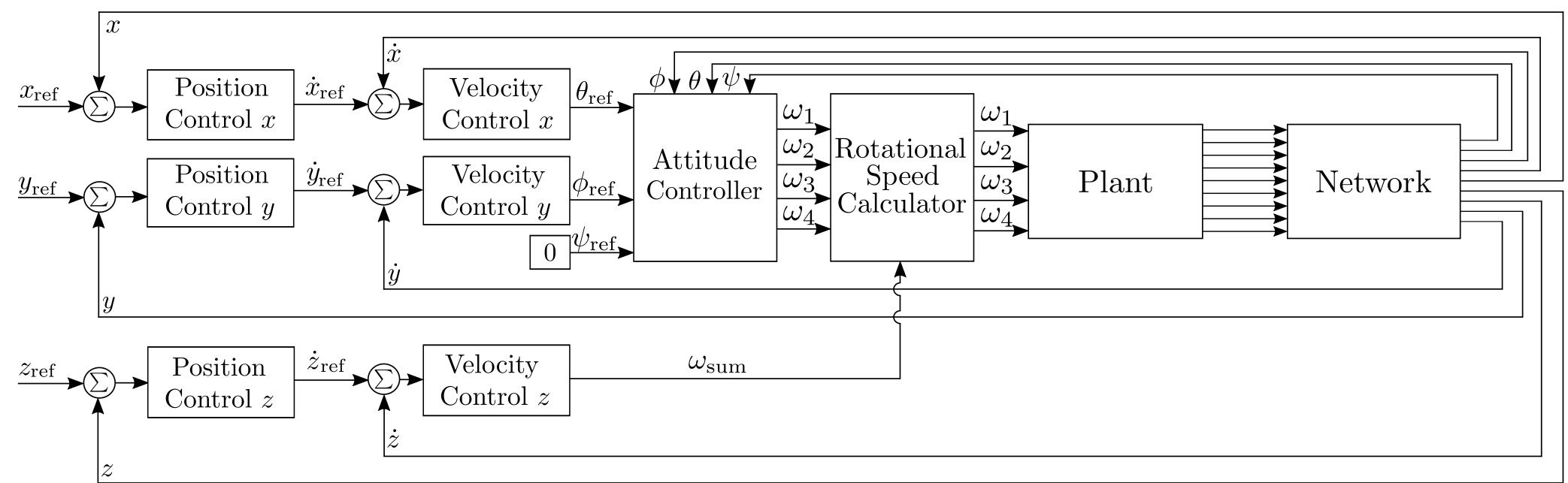


Fig. 3: Diagram of the control solution.

Attitude controller

- State feedback with integral control using LQR is designed for tracking references and handling disturbances.
- A reduced order observer is used to estimate the angular velocities.

Translational controllers

- PI controllers are used to control the velocities in order to handle input disturbances.
- The outer loops are P controllers used to control the positions.
- The bandwidths of the cascaded controllers are considered to reduce the effect of the dynamics of the inner loops in the outer loops.

Conclusion

mented and achieves the given references.

A linear control system has been designed, based upon a first principles model, to stabilize the quadcopter and control its position. The attitude controller has been designed in state space, while the translational controllers are based on classical control methods. Network effects are included in the control design to ensure stability. Simulations show that the translational controllers have been adequately designed. The attitude controller has been implemented and tested successfully.

Results

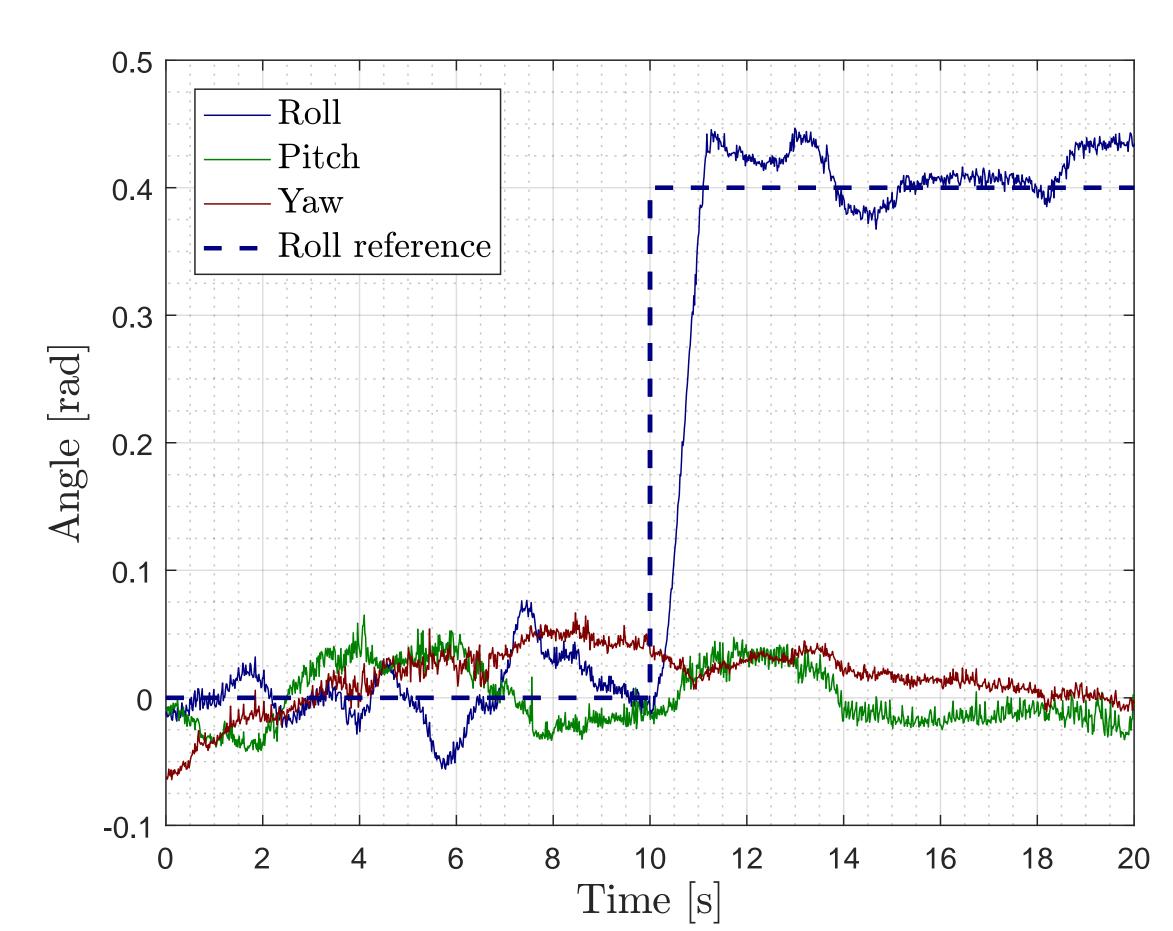


Fig. 4: Attitude control on the quadcopter. The first part of the figure shows how the angles are stabilized, then, a reference in roll of 0.4 rad is given to the controller while the other angles remain at zero.

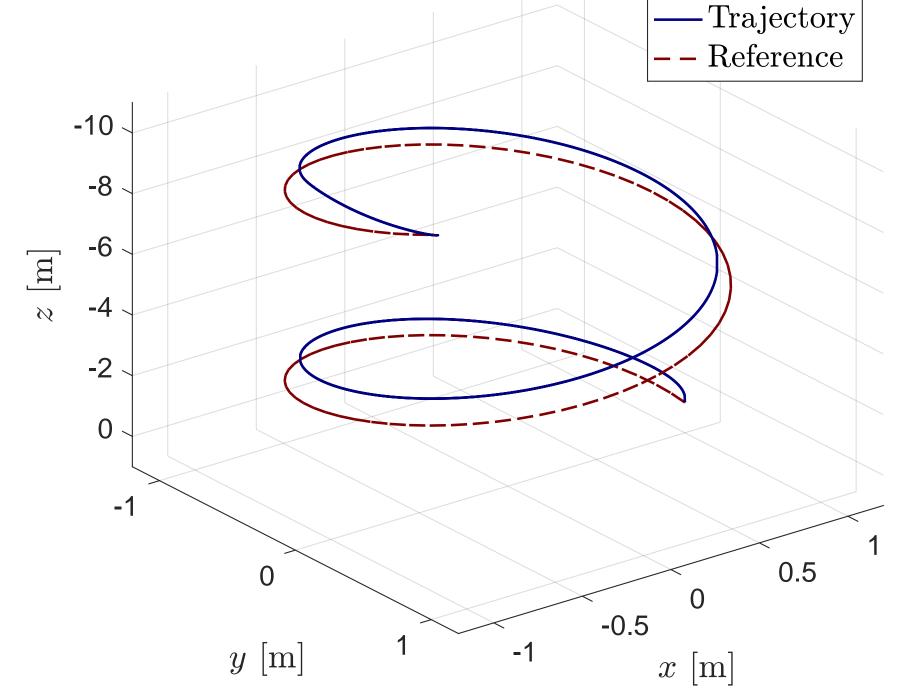


Fig. 5: The translational controllers tracking a helical trajectory. The network is included in all simulations.

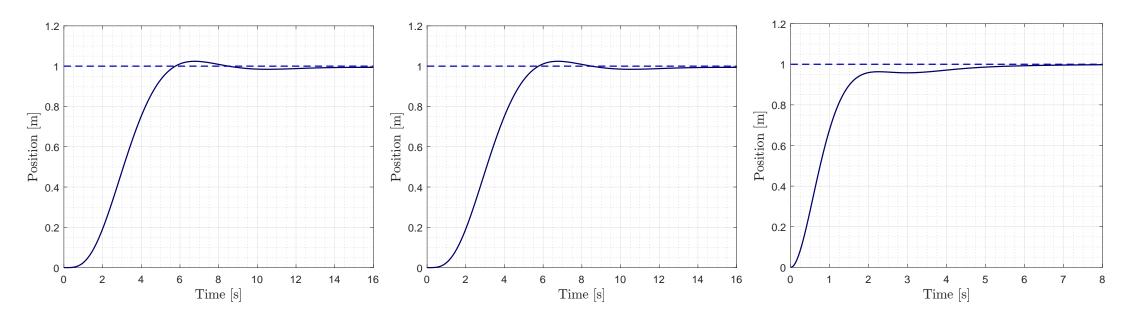


Fig. 6: Step responses of the translational position controllers in simulation.

References

Acknowledgements

Henrik Shøiler, Associate Professor, Aalborg University.