Quadrotor Modeling And Control

J.Z. Ma

Quadrotor Modeling And Control:

Modeling and Control Simulation for Autonomous Quadrotor Idris Eko Putro,2011-03 The use of Quadrotor UAVs has been widely well known It has capability to hover vertical take off and landing VTOL with having less complexity in vehicle dynamics compared with small helicopter It is basically an unstable system and exhibits nonlinear behavior This book describes the development of nonlinear model of quadrotor dynamics derived from Newton Euler formulation and presented under Matlab Simulink environment The Model is equipped by Stability Augmentation System SAS to maintain the quadrotor level flight attitude stability The autonomous mission for this vehicle is fixed for trajectory following LQR Optimal control was chosen to accomplish this mission **Dynamic Modeling and Control of a Quadrotor Using Linear and Nonlinear Approaches** Heba talla Mohamed Nabil Elkholy,American University in Cairo. School of Engineering Interdisciplinary Program,2014 Abstract With the huge advancements in miniature sensors actuators and processors depending mainly on the Micro and Nano Electro Mechanical Systems MEMS NEMS many researches are now focusing on developing miniature flying vehicles to be used in both research and commercial applications This thesis work presents a detailed mathematical model for a Vertical Takeo ff and Landing VTOL type Unmanned Aerial Vehicle UAV known as the quadrotor The nonlinear dynamic model of the quadrotor is formulated using the Newton Euler method the formulated model is detailed including aerodynamic effects and rotor dynamics that are omitted in many literature The motion of the quadrotor can be divided into two subsystems a rotational subsystem attitude and heading and a translational subsystem altitude and x and y motion Although the quadrotor is a 6 DOF underactuated system the derived rotational subsystem is fully actuated while the translational subsystem is underactuated The derivation of the mathematical model is followed by the development of four control approaches to control the altitude attitude heading and position of the quadrotor in space The fi rst approach is based on the linear Proportional Derivative Integral PID controller The second control approach is based on the nonlinear Sliding Mode Controller SMC The third developed controller is a nonlinear Backstepping controller while the fourth is a Gain Scheduling based PID controller The parameters and gains of the forementioned controllers were tuned using Genetic Algorithm GA technique to improve the systems dynamic response Simulation based experiments were conducted to evaluate and compare the performance of the four developed control techniques in terms of dynamic performance stability and the effect of possible disturbances **Modeling and Control of a Quadrotor in a Wind Field** Nguyen Khoi Tran,2016 In recent years there has been a surge of interest in the use of small unmanned air vehicles UAVs for various civilian and military applications Many of the proposed applications are outdoor and may include environments with high wind The relatively small size of quadrotors means that wind gusts can destabilize the quadrotor if the on board flight controller is not equipped to deal with wind effects This work investigates the ability of a quadrotor to maneuver in a wind field and develops a method to cope with wind disturbances A dynamic model of a quadrotor is presented to model its motion The quadrotor

model includes a wind effect model to quantify the effect of wind on the dynamics of a quadrotor A proportional integral derivative PID controller is shown as a baseline controller typically used on quadrotors A LQR controller is then shown as an alternative to a PID controller These two controllers are compared in a simulation environment using the wind effect model and simulated wind disturbances Both controllers are found to have similar performance in a wind field though the LQR controller is found to be easier to tune These experiments were then repeated using the AscTec Pelican quadrotor platform in an indoor environment A feedforward controller was developed which uses the wind effect model and a custom onboard wind sensor to generate control inputs that oppose the disturbance forces and moments In simulation the feedforward controller was effective in improving control performance while experimentally the feedforward control was not effective due to wind sensing errors **Robot Motion and Control 2007** Krzysztof R. Kozlowski,2007-06-01 Robot Motion Control 2007 presents very recent results in robot motion and control Forty one short papers have been chosen from those presented at the sixth International Workshop on Robot Motion and Control held in Poland in June 2007 The authors of these papers have been carefully selected and represent leading institutions in this field **Modeling and Control of a Quadrotor with Dynamic Inertia** Jared D. A. Becker,2013 As the support and technology for unmanned vehicles has increased so have the possible applications for Unmanned Aerial Vehicles UAVs From military intelligence gathering missions to civilian search and rescue missions the demand for highly capable UAVs is high Drawing inspiration from biological examples such as the hawkmoth this research investigates the use of dynamic inertia as a control mechanism for small quadrotor helicopters Using Lagrangian mechanics a nonlinear 3D model and a nonlinear 2D model are developed for a quadrotor with dynamic inertia modeled as an actuated pendulum mounted beneath the vehicle Designing a linear quadratic controller for a linearization of the system about the hovering flight condition and applying this controller to the nonlinear model results in a stabilizing dynamic inertia controller capable of adequate trajectory tracking for a simple desired trajectory Additional simulations also show that the linear controller has favorable robustness properties to compensate for modeling errors and nonlinearities **Artificial Neural Networks for Engineering Applications** Alma Y Alanis,Nancy Arana-Daniel,Carlos Lopez-Franco,2019-02-13 Artificial Neural Networks for Engineering Applications presents current trends for the solution of complex engineering problems that cannot be solved through conventional methods The proposed methodologies can be applied to modeling pattern recognition classification forecasting estimation and more Readers will find different methodologies to solve various problems including complex nonlinear systems cellular computational networks waste water treatment attack detection on cyber physical systems control of UAVs biomechanical and biomedical systems time series forecasting biofuels and more Besides the real time implementations the book contains all the theory required to use the proposed methodologies for different applications **Instruments, Measurement, Electronics and Information Engineering** J.Z. Ma,2013-08-08 Selected peer reviewed papers from the 2013 International Conference on Precision

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Proceedings of the 2nd International Conference on Electronic Engineering and Renewable Energy Systems Bekkay Hajji,Adel Mellit,Giuseppe Marco Tina,Abdelhamid Rabhi,Jerome Launay,Salah Eddine Naimi,2020-08-14 This book includes papers presented at the Second International Conference on Electronic Engineering and Renewable Energy ICEERE 2020 which focus on the application of artificial intelligence techniques emerging technology and the Internet of things in electrical and renewable energy systems including hybrid systems micro grids networking smart health applications smart grid mechatronics and electric vehicles It particularly focuses on new renewable energy technologies for agricultural and rural areas to promote the development of the Euro Mediterranean region Given its scope the book is of interest to graduate students researchers and practicing engineers working in the fields of electronic engineering and renewable energy

Applied Computer Sciences in Engineering Juan Carlos Figueroa-García,Eduyn Ramiro López-Santana,José Luis Villa-Ramírez,Roberto Ferro-Escobar,2017-09-13 This book constitutes the refereed proceedings of the Forth Workshop onEngineering Applications WEA 2017 held in Cartagena Colombia inSeptember 2017 The 59 revised full papers presented were carefully reviewed and selectedfrom156 submissions The papers are organized in topical sections such as computerscience computational intelligence simulation systems internet of things fuzzy sets and systems power systems logistics and operations management miscellaneous applications **Vibration Engineering and Technology of Machinery** José Manoel Balthazar,2021-03-03 This volume gathers the latest advances innovations and applications in the field of vibration and technology of machinery as presented by leading international researchers and engineers at the XV International Conference on Vibration Engineering and Technology of Machinery VETOMAC held in Curitiba Brazil on November 10 15 2019 Topics include concepts and methods in dynamics dynamics of mechanical and structural systems dynamics and control condition monitoring machinery and structural dynamics rotor dynamics experimental techniques finite element model updating industrial case studies vibration control and energy harvesting and MEMS The contributions which were selected through a rigorous international peer review process share exciting ideas that will spur novel research directions and foster new multidisciplinary collaborations *Modeling and Optimization of the Aerospace, Robotics, Mechatronics, Machines-Tools, Mechanical Engineering and Human Motricity Fields* Adrian Olaru,2014-06-30 Selected peer reviewed papers from the 9th International Conference on Modeling and Optimization of the Aerospace Robotics Mechatronics Machines Tools Mechanical Engineering and Human Motricity Fields OPTIROB 2014 June 26 29 2014 Mangalia Romania *Convergent Cognitive Information Technologies* Vladimir Sukhomlin,Elena Zubareva,2020-01-31 This book constitutes the refereed proceedings of the Third International Conference on Convergent Cognitive Information Technologies Convergent 2018 held in Moscow Russia in December 2018 The 26 revised full papers and 9 short papers were carefully reviewed and selected from 147 submissions The papers of this volume are organized in topical sections on

theoretical questions of computer science computational mathematics computer science and cognitive information technologies cognitive information technologies in control systems big data and applications the Internet of Things IoT standards communication and information technologies network applications smart cities standards cognitive information technologies and their applications cognitive information technologies in the digital economics digital transformation of transport   Applied Mechanics and Mechatronics II František Trebuňa,2015-11-30 Special topic volume with invited peer reviewed papers only   **International Integrated Engineering Summit 2014** Al Emran Ismail,Amir Khalid,Aziman Madun,Ahmad Kueh Beng Hong,Fariza Mohamad,Hamidon Salleh,Kamaruddin Ambak,Mohammad Kamil Abdullah,Mohd Azlis Sani Md Jalil,Mohd Ezree Abdullah,Mohd Fahrul Hassan,Mohd Halim Irwan Ibrahim,Mohd Khairul bin Ahmad,Nan Mad Sahar,Nik Hisyamudin Muhd Nor,Nor Aiziz Yusoff,Norwati Jamaluddin,Norzila Othman,Radin Maya Saphira Radin Mohamed,Saidin Wahab,Saiful Azhar Ahmad Tajudin,Saifulnizan Jamian,Chin Fhong Soon,Wan Mahani Hafizah Wan Mahmud,Mohd Zainizan Sahdan,2015-07-15 Selected peer reviewed papers from the 1st International Integrated Engineering Summit IIES 2014 December 1 4 2014 Batu Pahat Malaysia   Proceedings of the ASME Dynamic Systems and Control Division ,2006   *Manufacturing Science and Technology, ICMST2011* Wu Fan,2011-11-22 Selected peer reviewed papers from the 2011 International Conference on Manufacturing Science and Technology ICMST 2011 September 16 18 2011 Singapore   **Modeling, Design, and Control of Multiple Quadrotors** Abdullah E. Altawaitan,2019 In the last few decades with the revolution of availability of low cost microelectronics which allow fast and complex computations to be performed on board there has been increasing attention to aerial vehicles especially rotary wing vehicles This is because of their ability to vertically takeoff and land VTOL which make them appropriate for urban environments where no runways are needed Quadrotors took considerable attention in research and development due to their symmetric body which makes them simpler to model and control compared to other configurations One contribution of this work is the design of a new open source based Quadrotor platform for research This platform is compatible with both HTC Vive Tracking System HVTS and OptiTrack Motion Capture System Robot Operating System ROS and MAVLINK communication protocol The thesis examined both nonlinear and linear modeling of a 6 DOF rigid body quadrotor s dynamics along with actuator dynamics Nonlinear linear models are used to develop control laws for both low level and high level hierarchical control structures Both HVTS and OptiTrack were used to demonstrate path following for single and multiple quadrotors Hardware and simulation data are compared In short this work establishes a foundation for future work on formation flight of multi quadrotor   Modeling and Neural Control of Quadrotor Helicopter Yasir Amir Khan Niazi,2010-08 Quadrotor is a rotorcraft with four vertically oriented propellers Two of the propellers spin in clockwise direction and the other two in the counter clockwise direction For a Quadrotor Helicopter a stabilizing controller is always needed In this book Artificial Neural Networks based Control Methodology to stabilize the a Quadrotor Helicopoter has been explained Firstly a mathematical model of Quadrotor is

developed A simplified approach is adopted using momentum theory where the gyroscopic effect and air friction on machine s body has been neglected resulting in a simplified model which is useful in designing a controller to stabilize the machine in hover state The proposed model is nonlinear since the rotor dynamics are function of square of motor inputs In the controller designing Direct Inverse Neural Network Control methodology is employed For that matter 16 8 4 MLP 16 16 4 MLP and 16 64 4 MLP are used to control the Quadrotor plant There performance is compared using simulation results Direct Inverse Control using 16 64 4 MLP gives the best performance amongst all the other considered **Dynamic Modeling and Robust Nonlinear Control of Unmanned Quadrotor Vehicle** Amr Mohamed Elhennawy,2018 Abstract It is not easy to control a quadrotor due to its highly nonlinear dynamics variable coupling and model uncertainties The underactuation property of the quadrotor also poses another degree of complexity to the model due to the limited availability of control techniques that can be applied to underactuated systems This thesis presents the development of mathematical modeling control techniques simulation and real time testing on a developed quadrotor as an unmanned aerial vehicle Modeling of the dynamic system of a quadrotor including the motor dynamics is carried out using Newton Euler mechanics and state space representation is obtained Using this model a second order Sliding Mode Control SMC is developed as a nonlinear robust control technique For the SMC development quadrotor system is divided into two subsystems One represents the fully actuated degrees of freedom and the other one represents the underactuated degrees of freedom The aim of the proposed flight controller is to achieve asymptotic position and attitude tracking of the two subsystems by driving the tracking errors to zero to achieve the required tracking performance Tackling of chattering problem associated with SMC is introduced Using the developed mathematical model and the developed two control techniques as linear and nonlinear approaches the Proportional plus Derivative PD and SMC simulation testing is conducted with and without the presence of external disturbances representing weight variation Multiple simulations testing are performed to ensure the adequacy of the proposed control techniques using MATLAB and Simulink Detailed discussion on the results of each control technique and comparison are presented with elaborate consideration of the robustness against weight variation The simulation results demonstrate the ability of the SMC to drive the vehicle to stability and achieve the desired performance characteristics Finally hardware design of a quadrotor has been developed and implemented with considerations on the hardware challenges are presented Results of real time ght tests using the two developed control techniques are presented and compared with that of the simulation results and it shows reliable performance of the nonlinear robust SMC controller Flight tests results came consistent with the simulation results in terms of tracking performance robustness and actuators e orts Hardships in the implementation are mentioned and recommendations and future work are proposed Journal of Aircraft ,2009

Unveiling the Energy of Verbal Artistry: An Psychological Sojourn through **Quadrotor Modeling And Control**

In some sort of inundated with displays and the cacophony of fast conversation, the profound energy and emotional resonance of verbal beauty usually diminish in to obscurity, eclipsed by the constant onslaught of noise and distractions. Yet, nestled within the lyrical pages of **Quadrotor Modeling And Control**, a captivating perform of fictional brilliance that impulses with fresh feelings, lies an unforgettable journey waiting to be embarked upon. Written with a virtuoso wordsmith, that exciting opus guides visitors on a psychological odyssey, softly revealing the latent possible and profound impact stuck within the intricate web of language. Within the heart-wrenching expanse of the evocative examination, we shall embark upon an introspective exploration of the book is key styles, dissect their interesting writing design, and immerse ourselves in the indelible impression it leaves upon the depths of readers souls.

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