RESUMÉ

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Abhijit Das

Objective: A research oriented career (PhD) in Control system applications

Research Experience:

Position	*Sponsor*	*Project Title*	*Duration*
Junior Project Assistant	**Defense Research Lab, India** *http://mod.nic.in/*	Non-Classical Approaches to Autopilot Design in Tactical Aerospace Vehicles	2003-2005
Junior Project Assistant	**Aeronautics Research And Development Board** *http://www.drdo.com/boards/ardb*	Development and assessment of modern multivariable control design paradigms for aerospace applications	2005-2006
Junior Project Assistant	**Aeronautical Development Establishment, Bangalore, India** *http://www.drdo.com/*	Development and testing of real time algorithms for fault tolerance of aerospace applications	2006-Present

Publications:

Published:

I. Abhijit Das, Tanushree Garai, Siddhartha Mukhopadhyay and Amit Patra, "*Feedback Linearization for a Nonlinear Skid-To-Turn Missile Model*", Proceedings of the First India Annual Conference, IEEE INDICON, p: 314-317, 20-22 Dec, 2004.

II. Abhijit Das, Tanushree Garai, Ranajit Das, Siddhartha Mukhopadhyay and Amit Patra, *"Autopilot Design via Feedback Linearization for a Nonlinear Skid-To-Turn Missile"*, National Conference for Control and Dynamical Systems, Indian Institute of Technology, Mumbai, Jan.2005.

III. Abhijit Das, Ranajit Das, Siddhartha Mukhopadhyay and Amit Patra, "*Nonlinear Autopilot and Observer design for a Surface-To-Surface, Skid-To-Turn Missile"*, Proceedings of the Second India Annual Conference, IEEE INDICON, p: 304-308, 11-13 Dec. 2005.

IV. Abhijit Das, Ranajit Das, Siddhartha Mukhopadhyay and Amit Patra, "*Sliding Mode controller along with Feedback linearization for a Nonlinear Missile Model"*, 1st International Symposium on Systems and Control in Aerospace and Astronautics, ISSCAA 2006 Jan. 19-21, 2006, p: 952-956, Harbin, China.

V. Abhijit Das, Ranajit Das, Siddhartha Mukhopadhyay and Amit Patra, "*Robust 3-axes Autopilot for a Tactical Aerospace Vehicle"*, Proceedings of IEEE region 10 international conference, TENCON, Hong Kong, 14-17 November 2006.

VI. Abhijit Das, Ranajit Das, Siddhartha Mukhopadhyay and Amit Patra, "*Robust Autopilot for a Short Range Skid-To-Turn Homing Missile"*, To appear in IEEE International Conference on Industrial Technology, 15-17th December, 2006, Mumbai , India

VII. Abhijit Das, Ranajit Das, Siddhartha Mukhopadhyay and Amit Patra, "Robust Nonlinear Design of Three Axes Missile Autopilot via Feedback Linearization", Proceedings of National Systems Conference, 2-4 November 2006, Goa, India

VIII. Abhijit Das, Ranajit Das, Siddhartha Mukhopadhyay and Amit Patra, "A Practical Approach to Estimate States of an Aerospace Vehicle", Proceedings of National Systems Conference, 2-4 November 2006, Goa, India

IX. Ranajit Das, Abhijit Das, Siddhartha Mukhopadhyay and R. N. Bhattacherjee, "Nonlinear Design of 3-axis Autopilot for a Tactical Aerospace Vehicle", Proceedings of Advances in Control and Optimization of Dynamical Systems (ACCODS), 2-4 February 2007, Bangalore, India

Accepted:

X. Abhijit Das, Ranajit Das, Siddhartha Mukhopadhyay and Amit Patra, "*Robust Feedback Linearization in Application to a STT Missile Model"*, 2006 IEEE International Symposium on Industrial Electronics ISIE'06, 9-13 July 2006, Canada

Journal *(*to be communicated to IEEE transaction of Aerospace Electronics*)*:

XI. Abhijit Das, Ranajit Das, Siddhartha Mukhopadhyay and Amit Patra, *"A New Robust nonlinear design of 3-axes autopilot for a tactical aerospace vehicle"*.

Reviewed:

I. E. Mekheal, M. I. El-Singaby and A. Khalil, "*Robust Controller Design Using H_∞ Loop-Shaping and Method of Inequalities*" 2006 IEEE International Symposium on Industrial Electronics ISIE'06, 9-13 July 2006, Canada

Qualifications:

Degree/ Certificate	Institute/ School	University/ Board	Year	CGPA/ %
MS (by research)	**IIT Kharagpur, W.B. (India).**	IIT Kharagpur, W.B. (India).	2006	**8.48** (up to thesis submission)
BE (Electrical Engineering)	**Bengal Engineering College (Shibpur)**	Bengal Engineering College (University)	2003	**78.4%**
Higher Secondary (10+2)	**Atulmoni Polytechnic HS School**	West Bengal Council of Higher Secondary Education	1998	**87.0%**
Madhyamik Examination (10^{th})	**Aryya Bidyapith High School**	West Bengal Board of Secondary Education	1996	**85.33%**

Professional Memberships:

- Lifetime Member, *System Society of India*
- Student Member*, IEEE*

Achievements and Awards:

- Stood First in Higher Secondary Examination in **Kharagpur** Zone
- Stood First in West Bengal Science Academy Examination
- Received award for West Bengal Talent Search Examination
- Received certificate on the course entitled ***Non-linear Problems in Aerospace Vehicle Dynamics*** ,IIT Bombay January 24 – 25, 2005

Activities:

- ***Seminar Secretary for Electrical Engineering Society,*** *2001-03.* Active participation in management of various seminar responsibilities for the local chapter of **Electrical engineering Society,** including, **Blood donation camp** and **Tech Fests**.

- ***Selected for the best actor in a Bengali Play at the undergraduate (B.E.) level***.

Computer Skills:

***Programming Languages*:**

- C++
- FORTRAN 90
- ***Assembly Language Programming*:** Intel 8085 and 8086

***Libraries and Tools*:**

- MATLAB 5.3, 6.0, 6.5 and 7.2 -SIMULINK and Control Systems Toolbox
- Latex
- Adobe Suite
- Macromedia Suite
- Latex
- Maple
- Mathematica
- Microsoft Visual Studio
- Microsoft Office XP and 2000

***Operating Systems*:**

- LINUX 6.0, 8.2, Fedora, SUSE Enterprise Edition 8, Red Hat Enterprise Edition 3.
- Windows 2000/ 2003 server/ XP/ 98.

Relevant Courses Undertaken:

At the MS Level:

- Nonlinear Control System
- Linear Control Theory
- Optimal Control
- Estimation of Signals and Systems
- Differential Geometry
- Fault Tolerant Control
- Embedded Systems

At the BE Level:

- **Artificial Intelligence**
- 8085 and 8086 microprocessors
- Control Systems Engineering (I & II)
- Industrial Instrumentation
- Digital Electronics
- Analog Electronics
- Machine Drives and Power Electronics

Projects:

MS PROJECT-1:

Non-Classical Approaches to Autopilot Design in Tactical Aerospace Vehicles

Objective:

The objective here was to design a multivariable non-linear autopilot for a Skid-To-Turn missile and to prove its improved performance over the conventional three-loop autopilot. The autopilot was desired to meet the following:

1. Decoupled "Pitch-Yaw-Roll" channels for the missile so as to maintain the missile performance in terms of miss distance, angle of attack, impact angle etc.
2. Restricted "Fin saturation", especially, for high maneuverability and high angle of attack zones.

***Brief Overview of the project*:**

Conventional missile autopilots are designed using the classical methodologies of linear control concept. In most of the cases autopilot design has been studied in frequency domain and the plant is linearized around some fixed operating points. But these conventional approaches suffer from the problem of coupling between pitch, yaw and roll channels as well as the instability caused by the aerodynamic uncertainties. Specially, these problems are more prominent in cases of high angle-of-attack or high maneuverability zones. In the last decade, the design of missile autopilots have been extensively studied using modern gain scheduling techniques, robust control, feedback linearization, sliding mode technique, singular perturbation like techniques etc. But in most of the cases detailed simulation study in terms of decoupling of *pitch-yaw-roll* channels to avoid *fin* and *gimbal* angle saturations have not been done.

This project aims at overcoming these difficulties using multivariable control technique. Specifically, exact input-output (I/O) feedback linearization has been applied, thereby, facilitating the I/O dynamic characteristics of the pitch yaw and roll channels to become linear and decoupled at the same time. More importantly, the missile dynamics becomes independent of flight conditions such as the missile velocity and the air density. In this project the superiority of the new nonlinear autopilot over the traditional one has been addressed through realistic simulation results. Moreover robust I/O linearization technique has been adopted to tackle the aerodynamic uncertainties in the system. In this study sliding mode technique has been introduced to design a linear controller for the inner rate loop of the system. The outer loop design has been carried out based on conventional linear gain scheduling approach. The remaining part of the project deals with a nonlinear *Luenberger observer* for estimating the unmeasured states which is essential for computing nonlinear feedback.

Project Status:

The improved performance of the newly designed autopilot has been proved over the existing traditional *(Three loop autopilot)* one and I am proud to say that my work has been appreciated to a great extent in Defense Research Lab, India. In this work the following have been achieved as per industrial criterion:

I. Roll rate has been minimized to a great extent even in the high angle of attack or in the high maneuvering.
II. The almost perfect decoupling between the three axes has been proved.
III. The unmeasured states of the system are being computed by a nonlinear Luenberger observer.
IV. The proof of internal stability (zero dynamics) has been shown thorough a realistic simulation result.

MS PROJECT-2:

Development and Assessment of Modern Multivariable Control Design Paradigms for Aerospace Applications

Objective:

The main objective is to find new multivariable approaches for designing autopilots for aerospace vehicles such as LCA (Light Combat Aircraft), Missiles. The newly designed autopilot should meet the following requirements:

1. The autopilot should be robust with respect to aerodynamic uncertainties and all sorts of disturbances.
2. Autopilots should be designed considering the flexibility in the missile dynamics.
3. Fault estimations and adaptive fault tolerant strategies are to be investigated.

Brief Overview and Status of the project:

In this project I have investigated the Linear Matrix Inequality (LMI) approach to H_∞ control applied to a realistic surface-to-surface skid-to-turn missile model. As the direct application of H_∞ control strategies to a complicated nonlinear plant is not so simple, I have used this approach to design the inner rate loop of the missile. To do so firstly I have linearized the nonlinear plant using the same input-output linearization. And then to tolerate the uncertainties due to aerodynamic coefficients and wind disturbances a robust controller has been adopted with H_∞ design methodologies. The whole problem has been formulated based on mixed sensitivity approach where different weighting functions have been introduced to achieve robustness and performance criterions simultaneously. An elaborate study has been done considering all sorts of possible disturbance cases with different flight conditions.

Another approach of designing robust autopilot has been investigated through model reference control strategy. In that case, the conventional input-output linearization technique has been used to achieve robust performance. The robustness of the autopilot has been proved in a realistic test bed with different flight conditions. The all simulations have been carried out with 20-150% tolerance of the aerodynamic coefficients. More investigations such as time scale separation of the faster inner loop and slower outer loop dynamics etc are in progress.

CURRENT PROJECT:

Development and testing of real time algorithms for fault tolerance of aerospace applications

Objective:

The performance of the Electro Hydraulic Actuator used in mission-critical systems, like aerospace vehicles, is extremely important. The failure of the actuator system is almost sure to lead to a catastrophic mission failure. Some of these failures can be tolerated with redundancy in some components. Interestingly, it turns out that there is significant scope of introducing Fault Tolerance in the actuator system with real time Fault Detection and Isolation (FDI) algorithms. So, it is important to investigate methodology that improves the performance, reliability of the actuator to meet the mission objectives. As the actual model of the EH actuator is a hybrid one, to formulate a continuous nonlinear state space model, "sgn" function blocks and "saturation" blocks have been approximated through sigmoid function. In the next step different nonlinear estimation methodologies have been tested on the system to estimate states as well as parameters.

Undergraduate Project:

Fuzzy Control of an Inverted Pendulum

A two-dimensional problem has been considered where the pendulum moves only in the plane of the paper. The inverted pendulum is unstable in that it may fall over any time unless a suitable control force is applied. The Pendulum model has been assumed to be linear considering a negligible angle of deviation of the pendulum rod with respect to the vertical reference position. A pole-placement controller (LSVF) has been designed to obtain the state trajectories of the system. The simulation results seem to be much realistic as the mass of the pendulum rod, friction in between the cart wheel and the sliding surface etc. has been taken into account in the system model. After that, based on these state trajectories it was possible to form the rule base of the proposed fuzzy controller. The MATLAB simulation was done to show the comparative performance of fuzzy controller with LSVF.

Personal Profile:

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References:

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Declaration:

I hereby declare that I take the full responsibility of the authenticity of the above mentioned information.

(Abhijit Das)