

## CV of Shiran A. Nanayakkara

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### Education

Completed most of the requirements towards a PhD in Mechanical Engineering at Lehigh University in Bethlehem, PA, U.S.A. in year 1988.

Major Field of Studies: Kinematics, Dynamics and Control of Mechanical Systems with emphasis on applications in the field of **Robotics**.

Dissertation Topic: Synthesis of Spatial Linkages; Grade Point Average: 4.0/4.0

Masters: University of Texas at Austin, TX, U.S.A. May 1984

Major Field of Study: Kinematics, Dynamics and Control of Mechanical Systems with emphasis on applications in **Vibrations** and Modelling of Physical Systems.

Thesis: Transmission of Vibrations in Fluid Filled Piping Systems; Grade Point Average: 4.0/4.0

Bachelors: University of Moratuwa, Sri Lanka, February 1980, Bachelor of Science in Mechanical Engineering with First Class Honors

Average Grade: 77.4% (70% = A). Ranked first in a class of 30 Mechanical Engineering students and second in a batch of 125 engineering students of all majors.

### Teaching Experience

I have taught undergraduates at four (04) Sri Lankan universities and students preparing for IESL Part II and Part III examinations. I also taught undergraduates at University of Texas at Austin and at University of Nevada at Reno in USA. I taught NDT students at University of Moratuwa before that program was transferred out of the Faculty of Engineering.

Teaching at University of Moratuwa:

Final Part II subject: Mechanics and Controls (Control Systems half of the module) from 1980 to 1981.

Final Part I subject: Engineering Mechanics (only course work assignments and tutorial classes) from 1980 to 1981.

Final Part II subject: Mechanics and Controls (Mechanics of Machines half of the module) from 1997 to 1999.

Final Part I subject: Engineering Mechanics (60% of the module) from 1998 to 2002.

Final Part I subject: Design of Machine Elements (60% of the module) from 2000 to 2002

Final Part II subject: Machine Design (50% of the module) from 2000 to 2003.

Coordinated the practical portion of the Level 1, Semester 2 subject: Applied Mechanics (Dynamics) in year 2001 when this subject was taught for the first time.

Level 1 June Term subject: Design Project (30% of the module) from 2001 to 2007.

ME207 Machine Elements and Innovative Design (50% of the module) from 2002 to 2004 and in year 2006.

ME2142 Machine Elements and Innovative Design and ME2153/ME2080 Design of Machine Elements (60% of module in both subjects) from 2011 to 2018. Taught 50% of the module in 2020.

ME209 / ME2090 / ME2092 Mechanics of Machines I (complete module) from 2002 to 2019.

ME304 / ME305 / ME3052 Machine Design & Project (40% of the module) from 2002 to 2008 and from 2013 to 2015.

ME3260 Mechatronic System Design Project (40% of the module) from year 2018 to 2020. My contributions were focused mainly on the machine design aspect and the mathematical modelling aspect of the design projects.

ME303 / ME3030 / ME3032 / ME2050 Mechanics of Machines II. Taught 40% of the module from year 2002 to 2006. Taught the complete module from year 2007 to 2018 except in year 2012. Taught 60% of the module from 2019 to 2020.

The NDT second year subject: Mechanics of Machines from 1980 to 1981 and from 1997 to 2000. I taught the complete module except in year 1997 when I taught only 50% of the module.

An NDT first year subject related to Engineering Mechanics (complete module) during year 1997.

Teaching at the Institution of Engineers, Sri Lanka (IESL):

The IESL Part II subject: Dynamics Systems (80% of the module) from 1997 to 1998.

The IESL Part III subject: Machine Design (complete module) from 2012 to 2014.

Teaching at University of Ruhuna, Faculty of Engineering:

ME4306 Mechanics of Machines (complete module).

ME5310 Theory of Machines (complete module). Both subjects were taught from 2003 to 2007.

Teaching at Kotelawala Defense Academy (KDA):

Third year subject: Transmissions (complete module) from 1997 to 1998.

Third year subject: Mechanics of Machines (complete module) from 1998 to 2005.

Teaching at Ocean University:

MaE 406 Machine Design (complete module) from 2014 to 2020.

Teaching at Foreign Universities:

Teaching Assistant, University of Nevada at Reno, USA, in spring 1985. Taught an undergraduate laboratory class in Computer Aided Design.

Teaching Assistant, University of Texas at Austin, USA for five (05) semesters. Taught a senior laboratory class in Dynamic Systems and Controls, a senior laboratory class in Robotics, a discussion section (i.e. a tutorial class) in a sophomore level course in Kinematics and Dynamics of Mechanical Systems and a freshman Computer Graphics class.

### **Final year Undergraduate Projects which were supervised**

#### At University of Moratuwa:

In year 1997 / 1998: A mathematical model to synthesize a Spatial Four Bar Linkage and develop software to design such linkages.

Intake 03 (2006 / 2007): (3 projects)

Cinnamon Rubbing Device, An Automated Machine to Load a Coconut Husk Chopping Machine, An Automated Coir Dust Briquette Making Machine.

Intake 04 (2007 / 2008): (4 projects)

A Safe Coir Manufacturing Machine (Coir Mill), An Automated Device to Load a Coir Manufacturing Machine, A Geo Textile Weaving Machine, A Coir Strip Making Machine.

Intake 05 (2008 / 2009): (3 projects)

An Improved Coir Mill, An Improved Geo Textile Weaving Machine, An Improved Coir Strip Making Machine

Intake 06 (2009 / 2010): (2 projects)

An Improved Cinnamon Rubbing Machine, An Alternative Design of a Geo Textile Weaving Machine

Intake 07 (2010 / 2011): (3 projects)

Automation of a Commonly Found Operation in the Brush and Broom Industry, Design of a Waste Bio Mass Fired Drier for Timber Seasoning, Design of an Automated Device to Comb and Clean Raw Coir

Intake 08 (2011-2013): (2 projects)

Design and Fabricate a Completely Automated Bristle Fiber Production System, Design and Fabricate an Automated Fabric Laying Machine Suitable for the Local Apparel Manufacturing Industry.

Intake 09 (2013 / 2014): (1 project)

A Low Cost Automated Device to Remove Husk Chips from Coir.

Intake 15 (2019 / 2020): (1 project)

Design and Development of a Multifunctional Patient Monitoring Platform. I was the co-supervisor of this project which won the “Mobil Award for the Best Mechanical Engineering Final Year Project” out of a total of 32 final year projects in Mechanical Engineering.

Many of the final year projects that are mentioned above were funded by external sources. All the final year projects, which I supervised from intake 03 to intake 05 were provided with IRQUE funds to the tune of LKR. 100,000/= per project. Due to limitations in IRQUE funding, the projects of intake 06 were provided with less money per project.

At the Kotelawala Defense Academy:

A Hydraulically Powered System to Elevate a Naval Gun, in year 2000.

An Automated System to Load a 120 mm Mortar Tube, in year 2001.

An Automated System to Load a 130 mm Artillery Gun, in year 2002.

Sources of external funding for some of the projects that are mentioned above:

Sri Lanka Inventors Commission; LKR 120,000/= in year 2006.

Sri Lanka Inventors Commission; LKR 1,250,000/= in year 2007 / 2008.

Ministry of Industrial Development; approximately LKR 1,500,000/= in year 2008.

Ministry of Industry and Commerce; 47% of the requested project budget of LKR 1,250,000/=

From June 2007 to December 2015, **I funded these projects with more than LKR 3,000,000/= (more than three million rupees) of personal funds.**

Intellectual property potential of the projects mentioned above:

I intend to apply for two (02) patents based on innovative ideas from the project: Design and Fabricate an Automated Fabric Laying Machine Suitable for the Local Apparel Manufacturing Industry. I also intend to apply for a patent on innovative ideas from the project: An Improved Geo Textile Weaving Machine. The coir sector advisory committee of the Ministry of Industry and Commerce, which consisted of many members from industry advocated further funding and development of this project. Several other projects have the potential to produce patentable intellectual properties. But, they need further development.

I was also involved in the following innovative design and development projects outside University of Moratuwa.

An Improved System to Elevate a 20 mm Naval Gun mounted on Fast Attack Crafts (FAC) of the Sri Lanka Navy; from 1997 to 1999.

A method to lift a UHF repeater to a height of 200 m above ground to enable FACs to communicate; from 2002 to 2003.

An underwater barrier suitable for the Trincomalee Navy base in year 2006.

Consultant to the Industrial Development Board (IDB) Katubedda, from year 2006 to 2007. Was involved in designing and improving machinery developed by the IDB for local cottage industries.

Was the examiner in the City and Guilds Post Graduate Diploma in Mechanical Engineering (Level 7) examination in the subject: Mechanical Engineering Design that was conducted in year 2015.

## **Research Experience**

Mechanical Engineer - Fastman, Inc., Bethlehem, PA, USA which is a small high technology Research and Development company funded by Small Business Innovative Research contracts from the U.S. federal government; from March 1989 to February 1991. These research efforts were funded by grants from the US Navy, National Science Foundation and the Advanced Research Projects Agency (ARPA).

- Perfected a Least Squares Method to determine linkage parameter errors in robots and proved the validity of the method used based on Coordinate Measuring Machine measurements of robot hand position and orientation (pose). The mathematical technique which had been developed only for cases with two nominally parallel link axes was extended to a robot with three nominally parallel link axes which required the solution of a much more complicated kinematics problem. The identified linkage parameter errors were used to calibrate the robot and improve its accuracy. The robot calibration technique which used measurements of robot hand poses was extended to work on measurements of linear distance, to a specific point on the robot hand.
- Carried out modeling of Electro-Mechanical Systems used in laser interferometry based sensors and carried out computer simulations of the response of these physical systems. Also developed algorithms to control the temperature, etc. of these systems.
- Designed a mechanical coupler for laser beams.
- Computer implemented Wavelet Transform algorithms, and produced examples of the application of the Wavelet Transform. Also computer implemented similar but less powerful transforms such as the Fast Fourier Transform, Wigner, and Choi-Williams Transform for purposes of comparison with the Wavelet Transform.

Research Assistant - Department of Mechanical Engineering and the Institute for Robotics, Lehigh University, Bethlehem, PA, U.S.A. from August 1985 till August 1988. These research efforts were funded by State of Pennsylvania Ben Franklin Partnership research grants.

- Developed a least squares method to determine linkage parameter errors in open kinematic chains such as robots with one pair of nominally parallel linkage axes.
- Developed a kinematic algorithm to measure the end effector pose of a robot using a non-tactile sensor and wrote the sensor software in the C programming language.
- Derived a dynamic parameter identification algorithm for robotic linkages based on the Euler - Lagrange equations.

- Developed a complete model of the dynamic performance of robotic systems. The effects of link flexibility on the dynamic performance of the robot was studied using the assumed modes method. Carried out a survey of testing methods that can be used to evaluate the dynamic performance of a robot.
- Developed algorithms for the synthesis of spatial linkages. Methods of synthesizing both open and closed kinematic linkages were examined. The technique used for synthesis of 3-dimensional linkages was an extension of the robot calibration research applied to designing specialized robots for specific motions.
- Carried out a survey of suitable robots to implement water jet cutting of the body panels of the V22 Osprey aircraft under development by Boeing Vertol (Boeing Helicopter Company) in Ridley Park, PA, USA in year 1987. This aircraft, which had rotors that can tilt had body panels, which were made out of carbon fiber composites.

Project Assistant - Computer Integrated Manufacturing Laboratory, Lehigh University, Bethlehem, PA, U.S.A. in year 1991.

- Carried out CAD modeling and Mechanical Design of machine parts.

Research Assistant - Department of Mechanical Engineering, University of Texas at Austin, U.S.A. This research project was funded by the Office of the Director of Defense Research and Engineering, David W. Taylor Naval Ship Research and Development Centre of the US Navy.

- Analyzed vibrations in fluid filled piping systems using a wave theory approach. The resulting technique was computationally efficient and compared favorably with results from both experiments and finite element analysis models.

## **Publications**

Nanayakkara, S., and N.D. Perreira, "Wave Propagation and Attenuation in Piping Systems," **Journal of Vibration, Acoustics, Stress, and Reliability in Design**. Transactions of the American Society of Mechanical Engineers, Vo1.108, No.4, October 1986, pp. 441-446.

Nanayakkara, S., and N.D. Perreira, "A Least Squares Technique to Determine Linkage Parameter and Pair Variable Errors in Open Kinematic Chains," **Presented at the SIAM Conference on Geometric modeling and Robotics**, Albany, New York, July 15 - 18, 1985.

Perreira N.D., and S. Nanayakkara, "Structure Borne Sound Transmission in Fluid Filled Piping Systems," Final Report to the David W. Taylor Naval Ship Research and Development Centre, Contract No. N61533-82-M-2373, December 1983.

Nanayakkara S., and N.D. Perreira, "Structure Borne Sound Transmission in Fluid Filled Piping System Elbows," **Proceedings of the 11<sup>th</sup> International Congress on Acoustics (ICA)**, Lyons, France, July 19-27, 1983.

Nanayakkara, S., and N.D. Perreira, "Structure Borne Sound Transmission in Fluid Filled Piping Systems," **Proceedings of the 104<sup>th</sup> meeting of the Acoustical Society of America**, Orlando, Florida, Nov. 9-12, 1982, Paper No. HH5.

**Academic Honors:**

Tuition Scholarship, Lehigh University, Bethlehem, PA, U.S.A. 1985-86.

Xebec Fellowship, University of Nevada at Reno, U.S.A. 1984-85.

Received a half time assistantship, University of Texas at Austin, U.S.A. 1981-84.

Was placed first in order of merit among Mechanical Engineering graduates in the batch which graduated in 1980.

Placed first in order of merit in Sri Lanka among all students in the mathematics stream at the GCE (Advanced Level) examination held in April 1974 and was awarded the Brook Bond Scholarship.

I hereby certify that the information provided herewith is true to the best of my knowledge and take responsibility for the contents.

Shiran A. Nanayakkara