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## RESEARCH: ACCOMPLISHMENTS AND GOALS

*My Philosophy of Life*  
*While there is a will there is a way*

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*Synopsis* — Research in astrodynamics, anthromathematics, security technologies, economodynamics and mathematical physics, introduced 10 new branches of mathematics (anthromathematics, astromathematics, anthrotopology, condensed-matter mathematics, antroalgebra, anthrogeometry, anthrodynamics, anthroimaging, sport mathematics and astro-anthromathematics), published papers in ISI Impact Factor Journals, Research-Productivity Allowance awarded by Higher Education Commission, aerospace, health care and security technologies impacted by research, referee of ISI Impact Factor Journals, Editor-in-Chief of Karachi University Journal of Science, convener of Dean's Research Projects Evaluation Committee, conducted training programs for researchers, organized motivating programs for future researchers.

**Philosophy** To capitalize on the strengths of mathematics, having the power of generalization and the power of application, to formulate and to propose “smart” solutions, which enhance man's quality of life by converting them into commercial products, services and processes, which are comfortable, economical, environmentally friendly and safe.

- © National Curriculum Revision Committee
- ® Higher Education Commission, Govt. of Pakistan
- § National Testing Service Pakistan <http://www.nts.org>
- # American Institute of Aeronautics and Astronautics
- ‡ International Brain Research Organization
- ‡ The Abdus Salam International Center for Theoretical Physics, Trieste, Italy
- ‡ The Early Talent Research Participation Program

- ¶ Transparency International Pakistan
- \* Anthromathematics Group <http://anthromath.uok.edu.pk>
- § Department of Mathematics <http://math.uok.edu.pk>
- ‡ National Growth and Developmental Standards for the Pakistani Children <http://ngds.uok.edu.pk>
- € United States (of America)
- ¶ University of Karachi, Karachi <http://www.uok.edu.pk>

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<b>MAIN EQUIPMENTS</b> <i>Constructed in our Lab</i> Moiré-Fringe-Recording System Dotted-Rasterstereography-Recording System Enhanced-Anthropometry Instruments	<b>SUPPORTING EQUIPMENTS</b> <i>Purchased</i> Measuring Tools Computing Systems Still-Recording System Video-Recording System Multi-Media-Projection System
<b>SOFTWARES</b> <i>Developed in our Lab</i> Moiré-Fringe-Analysis System Dotted-Rasterstereography-Face-Recognition Software SOFTGROWTH (Growth-and-Obesity Roadmaps)	<b>RESEARCH GRANTS</b> <i>Awarded and Utilized</i> SSUET Research Grant Dean's Research Grant <i>Project (under preparation)</i> National ICT Fund Higher Education Commission

**Description of research resources**

**Methodology** A Nobel laureate was asked, "What is the key to your success?" He replied, "I know what I am doing, in depth, and know a little bit about other disciplines". This strategy of complete knowledge of the problem at hand and knowledge of the associated fields is to be applied to bring out efficient, elegant and innovative solutions to problems challenging the mankind in the third millennium, using the techniques of mathematics. Modeling of system, environment and sources of error to be done using mathematical tools, fine-tuning to be done through simulations and test runs, followed by validation through field trials.

**Accomplishments** Mathematical models of the human brain (involving matrices of the order of  $10^{16} \times 10^{16}$ ), which could not be processed by the fastest supercomputers available in the world), the human spinal column (presented the idea of treating the spinal column as a 3-dimensional problem, formulated 3-D static and dynamic models), the human heart (introduced cardiac-coördinate mesh, treated heart as a system of standing waves), the growth of children (developed methods to generate detailed growth pro-files) and the planetary orbits (introduced the elliptic-astrodynamical-coördinate mesh, formulated equation of motion in this mesh) were developed. 3-D optical imaging and image processing (moiré fringe topography, rasterstereography) systems were set up and studied to generate 3-D coördinates and curvatures of a test object. In particular, postures and gaits of children were studied and procedures devised to simultaneously project moiré and raster grids on a moving object and decode information about 3-D coördinates and curvatures through selective optical filtering. In addition, moiré fringe topography was combined with the edge-based algorithm to study 3-D motion. Normally, the edge-based algorithm would be able to handle only 2-D motion.

Other important accomplishments include proposing a face-recognition system employing dynamic-biometric patterns, in particular, edge-based rasterstereography, defining determinant of a general tensor, proposing extended symmetries in special relativity, studying behavior of massive particles near velocity of light, deriving Dirac's relativistic equation starting from the energy operator in rest frame, formulating control laws (the extended-cross-product steering, the normal-component-cross-product steering, the dot-product steering, the normal-component-dot-product steering, the ellipse-orientation steering), devising guidance schemes (the Lambert scheme with correction for cross-range error, the inverse-Lambert scheme, the inverse-Q system, the multi-stage-Q system) and applying concepts of precedence and influence graphs to clinical medicine. In the area of foundations of mathematical physics, mathematical formulation of sixth paradigm of physics was given.

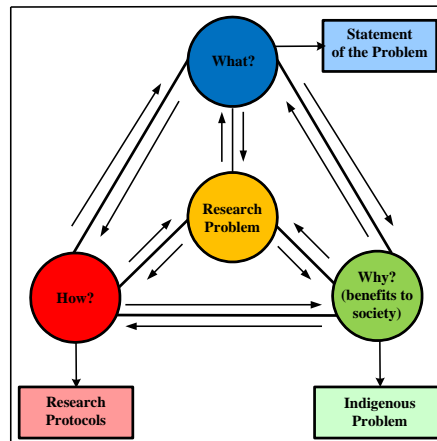
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**The anatomy of an indigenous research problem**

(<http://www.ngds-ku.org/Presentations/Research-Teaching-ComDev.pdf>)

**Accomplishments (continued)** More recent work focuses on proposing mathematical solutions for US-Childhood-Obesity Problem. **The First-Generation Solution** was proposed on September 4, 2013, **the Second-Generation Solution** on September 4, 2014, **the Third-Generation Solution** on July 1, 2015 and **the Fourth-Generation Solution** on February 13, 2016. Mathematical criteria for classifying build of a child (small, medium and big), nutritional-status classification (acute malnutrition, over-nutrition, under-nutrition, energy-channelization I-III), concept of pseudo gain of height/mass (physical gain but drop in percentile), mathematical index to classifying obesity/wasting, tallness/stunting as well as mathematical index to determine severity of acute malnutrition (all of them expressed as percentages) were proposed. In addition, laws of econodynamics were proposed, corruption was modeled using mathematical tools and smart-intelligent power introduced to resolve state conflicts.

185 papers (175 as solo, first or corresponding author out of which 48 in peer-reviewed journals; 137 in conferences), some of them published in *Biological Cybernetics (Springer)* [ISI Impact Factor (2015) = 1.611], *Journal of Biological Physics (Springer)* [ISI Impact Factor (2015) = 1.394], *Chinese Journal of Physics* [ISI Impact Factor (2015) = 0.464] as well as *Matrix and Tensor Quarterly (Tensor Society of Great Britain)*. Eleven (11) new branches of mathematics were introduced during the course of my research.

**New branches of mathematics introduced by the researcher**

#	Name of Branch	Date Introduced	First Mention
1	Anthromathematics	March 22, 2010	<a href="http://www.ngds-ku.org/Presentations/Firdous.pdf">http://www.ngds-ku.org/Presentations/Firdous.pdf</a>
2	Astromathematics	October 8, 2012	<a href="http://www.ngds-ku.org/Presentations/ISPA.pdf">http://www.ngds-ku.org/Presentations/ISPA.pdf</a>
3	Anthrotopology	December 27, 2012	<a href="http://www.ngds-ku.org/Presentations/BZU1.pdf">http://www.ngds-ku.org/Presentations/BZU1.pdf</a>
4	Condensed-Matter Mathematics	December 28, 2012	<a href="http://www.ngds-ku.org/Presentations/BZU.pdf">http://www.ngds-ku.org/Presentations/BZU.pdf</a>
5	Anthroalgebra	April 10, 2013	<a href="http://www.ngds-ku.org/Presentations/AMTM.pdf">http://www.ngds-ku.org/Presentations/AMTM.pdf</a>
6	Anthrogeometry	April 10, 2013	<a href="http://www.ngds-ku.org/Presentations/AMTM.pdf">http://www.ngds-ku.org/Presentations/AMTM.pdf</a>
7	Anthrodynamics	April 10, 2013	<a href="http://www.ngds-ku.org/Presentations/AMTM.pdf">http://www.ngds-ku.org/Presentations/AMTM.pdf</a>
8	Anthroimaging	September 5, 2013	<a href="http://www.ngds-ku.org/Presentations/Scan.pdf">http://www.ngds-ku.org/Presentations/Scan.pdf</a>
9	Sport Mathematics <sup>3</sup>	May 17, 2014	<a href="http://www.ngds-ku.org/Presentations/Sport_Mathematics.pdf">http://www.ngds-ku.org/Presentations/Sport_Mathematics.pdf</a>
10	Astro-Anthromathematics	December 29, 2015	<a href="http://www.ngds-ku.org/Presentations/Childhood-Obesity.pdf">http://www.ngds-ku.org/Presentations/Childhood-Obesity.pdf</a>
11	Astro-Anthrodynamics	May 01, 2016	<a href="http://www.ngds-ku.org/Papers/J44.pdf">http://www.ngds-ku.org/Papers/J44.pdf</a>

<sup>3</sup>Schutz (1980) delineates a field of sports studies named as ‘sport mathematics’ and lists topics of study using tools of mathematical analysis. He puts forward arguments, which support the identification of mathematics and sport as a sub-discipline within sports studies. However, sport mathematics as a formal subject, with a well-defined ‘Program of Studies’, was put forward in 2014.

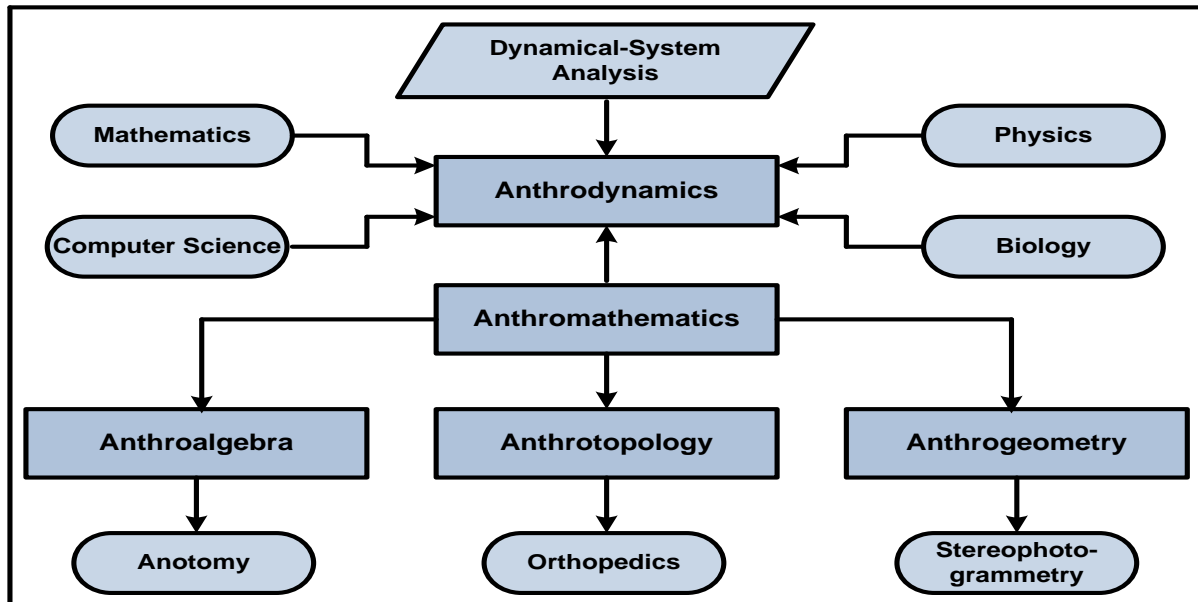
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The building blocks of anthrodynamics

**Impact on Technologies** *Aerospace Industry*  
The new control laws proposed and the guidance schemes developed could be used to design efficient and effective space missions as well as passenger aircrafts traveling partly in space in the ballistic orbits. Technological benefits include:

- a) Reduction in travel time — comfort
- b) Reduction in fuel consumption (most of the flight shall be in the ballistic phase, consuming no fuel), which would be passed on to customer as reduction in ticket price — economical/environmentally friendly
- c) Reduction in engine noise (most of the flight shall be in the ballistic phase, during which the engines would not be operating) — comfort
- d) Absence of turbulence (most of the flight shall be in the ballistic phase in space) — comfort
- e) Since engines are not required in the ballistic phase, there would be a reduced risk of engine failure — safety

#### *Health-Care Industry*

The model of growth of children could predict a boy's or a girl's adult height and adult weight as well as suggest control measures to achieve the desired height and weight at a tender age. Using the ideas of mathematics and physics, efficient and effective techniques for determination of height and weight are developed, tested and implemented as part of the NGDS Pilot Project (<http://ngds-ku.org>). 3-D models of the spinal column have given new dimensions to detection, documentation, follow up and treatment of scoliosis. Simultaneous recording using moiré fringe topography and rasterstereography could be used in kinesiology and biomechanics to assess movement of spine. They could, also, be used to improve gymnastic performance. Edge-based moiré could be used to quantify movement of lips with applications in speech analysis.

#### *Security Technologies*

The multi-level screening system proposed in my paper **Pattern Recognition using Moiré Fringe Topography and Rasterstereography**, may form the basis of a highly specific, cardless identification system, employing biometric identifiers, which could be used in place of identity cards or passports.

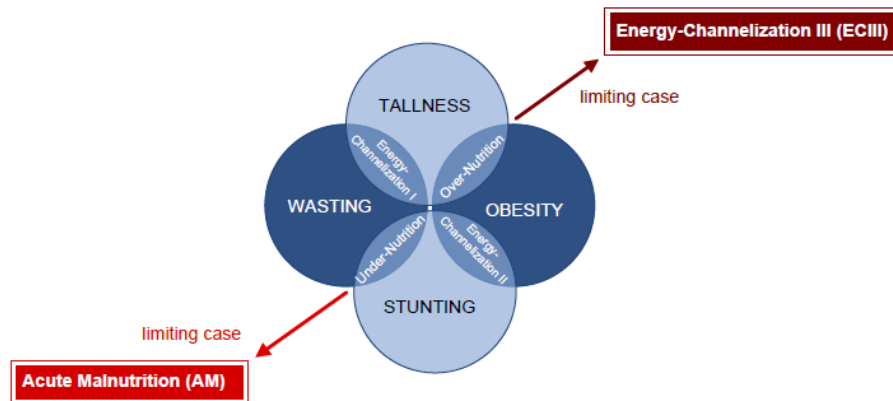
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### Nutrition and energy-channelization

**Honors** Research-Productivity Allowance awarded by Higher Education Commission (2003), nominated for the King Faisal International Prize in Science (Mathematics) 2010 by University of Karachi, referee of *Astrophysics and Space Science (Springer)* [ISI Impact Factor (2015) = 1.678], *Clinical Biomechanics (Elsavier)* [ISI Impact Factor (2015) = 1.636], *Acta Paediatrica* [ISI Impact factor (2015) = 1.647], *Optics and Laser Technology (Elsavier)* [ISI Impact factor (2015) = 1.879], *Pakistan Journal of Scientific and Industrial Research*, *Journal of Chinese Institute of Engineers* and *Proceedings of the Pakistan Academy of Sciences*, Editor-in-Chief of *Karachi University Journal of Science* (2015-to date).

**Goals** During the coming years I would like to continue working in the areas of mathematical modeling, mathematical physics (devising methods to deal with nonlinear systems, constructing minkowski-type metric for curved spacetime, generalizing principle of equivalence) and control theory (formulating new control laws), with applications in the fields of biomathematics, bioinformatics and astrodynamics. Further, I would try to establish liaison with local industry, in order to get adequate funding for the projects and be able to understand needs of the society we are a part of.

**Research Policy** Research-Project-Evaluation Committee, Dean, Faculty of Science, FY 2007-2012, Member; FY 2015-present, Convener

**Training Programs for Researchers** *Research Methodology I*  
Graduate Studies Course (for MS/PhD students), Office of Dean, Faculty of Science, University of Karachi, Second Semester 2009 (Course Faculty)  
[http://www.ngds-ku.org/DFS/ASR701\\_09.pdf](http://www.ngds-ku.org/DFS/ASR701_09.pdf)  
*Research Methodology II*  
Graduate Studies Course (for MPhil/PhD students), Office of Dean, Faculty of Science, University of Karachi, First Semester 2009 (Course Coördinator)  
<http://www.ngds-ku.org/DFS/ASR702.htm>  
*Technical Aspects of Preparing a Research Proposal*  
Presentation, Workshop on Preparing Research Proposals, Office of Dean, Faculty of Science, University of Karachi, August 16, 2008 (Coördinator of the Workshop)  
<http://www.ngds-ku.org/DFS/DFS01.htm>  
*Research Methodology*  
Graduate Studies Course (for MPhil/PhD students), Faculty of Arts, University of Karachi, November 21-24, 2007 (Course Faculty)  
*Research-Proposal Writing*  
Research Seminar, Department of Mathematics, University of Karachi, February 11, 2006

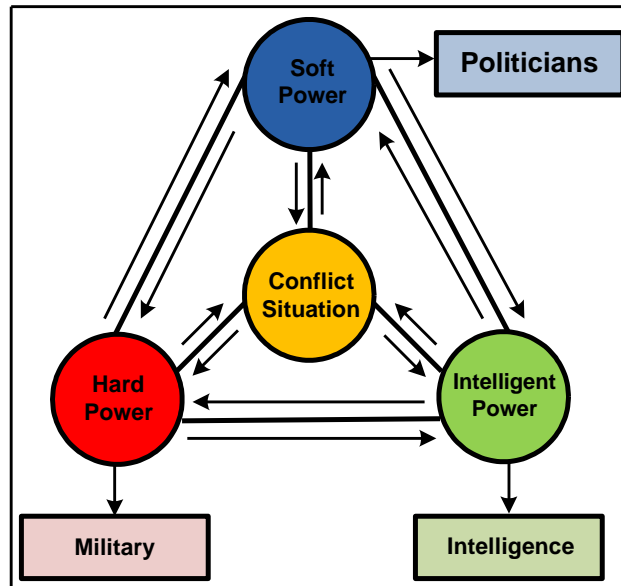
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**Ingredients of smart-intelligent power**

- Motivational Programs for Future Researchers**
- The Undergraduate Student Research Participation Program*  
Students oriented towards research by requiring them to prepare proposals dealing with practical problems, employing mathematical techniques, one student from the Aga Khan University Medical College did his research elective, some students co-authored papers, 1988-2010 (Program Coördinator)
  - Research-Proposal Writing*  
Lecture in Course on Research Methodology, Masters in Economics and Finance, University of Karachi, April 23, 2009
  - Talent-Farming Scheme*  
Summer School for BSc and MSc students, HEC Regional Center, Karachi, July 12-20, 2004 (Faculty)
  - The NGDS Student Internships*  
A subproject of the NGDS Pilot Project  
Pre-University Students participate in the ongoing research programs of University of Karachi, 2002-2010 (Program Coördinator)  
[http://www.ngds-ku.org/ngds\\_URL/subprojects.htm#Internships](http://www.ngds-ku.org/ngds_URL/subprojects.htm#Internships)
  - The Early Talent Research Participation Program*  
A subproject of the NGDS Pilot Project  
High-School Students are introduced to the ongoing research programs of University of Karachi, 2002-2010 (Program Coördinator)  
[http://www.ngds-ku.org/ngds\\_URL/subprojects.htm#ETRPP](http://www.ngds-ku.org/ngds_URL/subprojects.htm#ETRPP)

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