Daniele Mortari

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General Data

- Civil Status: Married
- Date of Birth: June 30, 1955
- Languages: Italian (native), English, and French.
- Married: T. Andreea, born in Bucharest - Romania, 1973.
- Children: Anna 2001.

Education

- 1975-1981: Attends the courses of Nuclear Engineering at the University *La Sapienza* of Rome. Attains the degree of *Dottore* by discussing a thesis on the safety of the Canadian CANDU nuclear reactors with the Nuclear Reactor Physics course, May the 28th, 1981, with marks 110/110.
- 1981-1983: Attends the two-year courses of the Aerospace Engineering School at the University *La Sapienza* of Rome, during which he starts to work, as external consultant, with the Centro di Ricerca Progetto San Marco, an International Co-operative Program for Space Research with NASA.
- 1983-1987: Attends various training and educational courses at the Goddard Space Flight Center (NASA), on the Attitude and Orbit Control Systems for the San Marco V satellite. In 1987 he attended a

training stage at Goddard on specific tasks related to data processing software algorithms for star pattern identification and attitude estimation using the Star Mapper data of the San Marco V satellite.

- 1991: Studies the problems and the operational tasks associated with the position of Range Safety Officer for the San Marco Project within the framework of a new Italian launch vehicle. Manages specifically the safety and the computation of climb trajectories of solid rocket vehicles.

Professional Experience

- 1983-1990: Consultant at the San Marco Project working on the following topics: Attitude determination, Attitude control by means of magnetic maneuvers, Spin axis drift, Orbital dynamics, and data reduction of the *Drag Balance Instrument*, the Italian experiment. For each of these items he conducts analysis and then develops the operational software for the San Marco V satellite, which carried five scientific experiments for the upper atmosphere physics analysis.

- 1985-1989: Consultant with several companies under ESA and Aeritalia contracts with relation to the following: Structural dynamics, Dynamics of docking, Eigenanalysis of numerically defective matrices (Jordan forms). Implements algorithms in the associated software.

- 1988-1989: Member of the San Marco Project staff that operationally manages the San Marco V satellite from the launch (March 25, 1988) throughout the S/C lifetime up to December 2, 1988 (re-enter), determining and controlling satellite attitude. Participates in the data reduction of the Drag Balance Instrument.

- 1989-2002: Member of the San Marco Project professional staff working on basic and applied research in astrodynamics, attitude determination, and control.

- 1990-1995: Consultant for the Computer Control System Company. He analyzes the dynamic problems of an endoscope working inside the segments of the Ariane V vehicle and implements the relevant operating software.

- 1992-2002: Assistant Professor of the Aerospace School of Engineering at the University *La Sapienza* of Rome, Italy. Researches and publishes in the following fields: attitude determination, attitude data processing, attitude dynamics, matrix and numerical analysis. Teaches in the two courses of *Space Systems* and *On-board Instrumentation* at the Aerospace School of Engineering, and in the course *Aerospace Systems* at the Faculty of Aerospace Engineering, both of the University *La Sapienza* of Rome, Italy.

- 1998-2001: Visiting Professor offering of the course of *Aerospace Systems* at the Faculty of Electronic Engineering of the University of Perugia, Italy.

- 1998-2001: Visiting Associate Professor at Department of Aerospace Engineering of Texas A&M University, College Station, TX, USA.

- 2002- Associate Professor at Department of Aerospace Engineering of Texas A&M University, College Station, TX, USA

Research Interests

- Spacecraft Attitude Estimation and Attitude Determination Systems
- Sensor Data Processing (Especially Star Identification)
- Aerospace Navigation, Dynamics, and Control
- Orbital Mechanics, Satellite Constellation Design
- Linear Algebra, Numerical Analysis.

Research Summary

- **Spacecraft Attitude Estimation**

  1. **Energy Approach Algorithm** (EAA). EAA is derived from a mathematical equivalence between the optimal attitude determination problem and the problem of finding the static equilibrium of a rigid body constrained by a set of spherical springs. Three different solutions have been found, all fully complying with the

Wahba optimality criterion. The EAA3 solution form is, approximately, as fast as QUEST.

2. **EULER-2, TRIAD-2, and EULER-n.**
   (a) **EULER-2** computes the optimal Euler axis and angle in a deterministic way, and its application is restricted to cases when $n = 2$ observed directions are available. This method is based on the attitude matrix rotation property and on a demonstrated co-planarity condition.
   (b) **TRIAD-2**. Thanks to the results obtained in EULER-2, the extension of the existing TRIAD algorithm to the optimal solution, getting TRIAD-2, has been also obtained.
   (c) **EULER-n** algorithm computes the optimal Euler axis and angle by an iterative technique. The iterative procedure, which starts from the Euler axis evaluated by EULER-2, converges to the optimal solution with a precision better than 1/1000 degree and with only one or two iterations.

3. **EULER-q** is derived from a new cost function for optimal attitude definition. The optimality criterion is derived from the Euler axis rotational property and allows a fast and reliable computation of the optimal eigenaxis. The mathematical procedure leads to the eigenanalysis of a 3×3 symmetric matrix whose eigenvector, associated with the smallest eigenvalue, is the optimal Euler axis. A simple cross vector evaluates this eigenvector and the singularity is avoided using the method of sequential rotations. Wahba optimality criterion is shown to be a little bit better than that introduced by EULER-q, which, in turn, demonstrates a clear gain in computational speed.

4. **EStimator of the Optimal Quaternion** (ESOQ) provides a closed-form solution to the problem of optimal spacecraft attitude estimation based on vectors observation, known as the Wahba problem. The algorithm first provides the closed-form expressions of a 4×4 matrix eigenvalues and then computes the eigenvector associated with the greatest of them, representing the optimal quaternion, using two different methods. The first method uses a vector cross product in a 4-D space, while the second uses an equivalent technique requiring a 3×3 nonsingular matrix inver-

sion. The resulting ESOQ algorithm does not present any singularities and allows an easy identification of the approaching of the irresolvable condition of quasi-parallel observed vectors. Accuracy and speed numerical tests demonstrate ESOQ as the fastest optimal attitude estimation algorithm to-date. This fact validates ESOQ as the most suitable algorithm when a fast-and-optimal attitude determination is required.

5. **Second EStimator of the Optimal Quaternion** (ESOQ-2). This optimal algorithm out stands for its speed. Presently it is the fastest available optimal attitude estimation algorithm. The ESOQ-2 algorithm starts from the q-method solution equation; the procedure leads to the computation of the optimal principal axis as a cross product between two row vectors of a symmetric 3×3 matrix. The optimal quaternion is then immediately computed. The introduced singularity is optimally avoided by employing only one sequential rotation. The resulting proposed algorithm is reliable, nonsingular, easy to code, and able to identify the quasi-parallel condition when the attitude computation is impossible. It has been adopted and tested by a flight experiment on-board the Space Shuttle mission STS-107. Adopted in the GSAT spacecraft mission (by ISRO Satellite Center, Bangalore, India), launched by the first Geo-Stationary Launch Vehicle (GSLV) in April 2001.

6. **Optimal Cones Intersection Technique** (OCIT). This algorithm allows to optimally estimating the direction (e.g. the spin axis) of a pointing instrument without computing the overall attitude of spacecraft. In particular OCIT-2 and OCIT-n algorithms use $n = 2$ and $n > 2$ observed vectors respectively. OCIT-2, which fully complies with the Wahba optimality criterion, optimally estimates the intersection of two cones in closed-form. OCIT-n provides the solution as a weighted sum of OCIT-2 solutions.

7. **Optimal Linear Attitude Estimation** (OLAE). This algorithm, using a Cayley Transform, establishes the relationship between the observed and reference directions with the Gibbs vector. The singularity of the Gibbs vector attitude representation is avoided by adopting one sequential rotation.

8. **Singularity Avoidance**. An algorithm to avoid singularity asso-

ciated with famous minimum element attitude parameterization, Euler angle set, has been devised. The proposed algorithm makes use of method of sequential rotation to avoid singularity associated with Euler angle set. Further, a switching algorithm is also proposed to switch between different Euler angle sets to avoid the singularity while integrating the kinematics equations corresponding to Euler angles for spacecraft motion.

- **Misalignment Estimation**

  1. **Spacecraft Spin axis**. For a spin-stabilized satellite a technique to estimate the spin axis misalignment, has been developed. The method uses the data provided by a 3-slit star mapper. This study defined the constraints (misalignment amplitude, time truncation, spin velocity) under which deriving the spin axis misalignment is possible. The method proposed was tested with the star mapper data of the San Marco 5 satellite.
  2. **Multi-FOV Star Tracker Interlock Assembly**. He developed two different methods to compute the interlock misalignment for the Multiple FOVs star tracker NavStar II and III. The first method, which evaluates the misalignment by a least-square approach, can be used if the misalignment can be considered small enough, that is, such that the star-identification process can still be performed. The second method, which can be used for any value of the interlock misalignment, implies that the star identification process can be performed for each sub-FOV. Results and tests of both the methods are shown.

- **Attitude Data Processing**

  1. **Drag Balance Instrument** (DBI). In this field he studied, by developing the relevant data reduction, the information provided by the Italian DBI experiment, which was carried on the San Marco 5 spacecraft. The DBI aim was to detect the neutral air density variations in the higher atmosphere. He has also develops the theory and the software to use the DBI as an attitude sensor. From this instrument it is possible to estimate the velocity vector direction, which can be used as an observed direction in the attitude determination problem.

2. **Acquisition and centroiding**. Two methods to speed up the acquisition and centroiding have been developed: 1) the Peak Finder (PF) which uses two integer vectors, and 2) the Run Length Encode (RLE) which uses an iterative approach applied to an adjacent star segment table and performs acquisition and centroiding simultaneously. Also for centroiding, the use of recursive functions, have been proposed. Recursive and ellipsoidal masks present centroiding accuracy gains with respect to the standard squared mask, which is more affected by the mask edge errors. Also two Gaussian Best-Fitting methods to increase centroiding accuracy have been introduced and compared versus standard Center-Of-Mass approach.

- **Star-Identification**

1. **Search Less Algorithm** (SLA). He presented two new star identification techniques, which does not use the magnitude information, for the star pattern recognition of wide field-of-view star trackers. The first is based on a best-fitting criterion and the second on a suitably devised k-vector. The proposed two star-pair-ID techniques can be regarded as general procedures, which can be included in almost all existing star-matching algorithms. The methods are able to identify and discard spikes (due to electronic noise, planets, light reflections, etc.), which demonstrate the algorithm robustness. A variation of SLA, was adopted in the "Fast Recovery Star Sensor" of the GSAT spacecraft mission (ISRO Satellite Center, Bangalore 560-017, India), launched in April 2001.
2. **Spherical-Polygon Search Algorithm** (SP-Search). He presented the SP-Search to accomplish the star pattern recognition and its extension to the recently proposed multiple field-of-view star trackers NavStar II and III which observe star fields in orthogonal directions, thus providing substantial gain in both the attitude estimation accuracy and in the operating time. The main idea of the proposed algorithm, which extensively uses the k-vector technique (a new range searching), is based on the fact that any star direction can always be expressed as a linear combination of two star directions (star pair basis) together with their vector

cross product. Using this property, which does not depend on the used system of coordinates, the problem of accessing candidate stars is then transformed into one of accessing the stars falling within a cone about a given direction. The cone observed surface is approximated herein as a spherical polygon, and its aperture is set to be h times of the star image centroiding accuracy standard deviation . Linear Error Theory is then applied for to establish an analytical approximation of h while, for fast applications, an empirical formula, is also presented. The resulting algorithm is fast and has a high probability of quickly identifying the imaged stars. This approach has the additional capability to identify and discard spurious images and it is a suitable and reliable concept to perform star pattern recognition in the most general lost-in-space case, that is, when no attitude information is available.

3. **Pyramid**. The Lost-In-Space *Pyramid* Algorithm (LISA) is a new star pattern recognition algorithm, which is based on a *Pyramid* structure of stars. This solution highly increases the capability to identify spikes (due to electronic noise, planets, light reflections, etc.). Usually, a high percentage of spikes presence puts in crisis almost all of the existing algorithms. It has been proven that the Lost-In-Space *Pyramid* Algorithm is capable to accomplish the star identification process with 4 stars and 24 spikes! This results, demonstrates that the *Pyramid* algorithm, which has been derived from an analytical approach of the star pattern recognition probability, is presently the most robust algorithm for star pattern recognition.

4. **Non-Dimensional Star Pattern Recognition**. This algorithm allows solving the *Lost-In-Space* case without the knowledge of the sensor focal length. This will be useful for star pattern recognition systems to avoid the focal length computation after lens change and as rescue program. The theory uses the *k*-vector approach and a special preparation of the star catalog.

5. **Recursive Approach**. Two novel algorithms for recursive mode star identification are presented. The first approach is derived by the Spherical Polygon Search algorithm, that accesses all the cataloged stars observed by the sensor field of view and recursively add/remove candidate cataloged stars according the pre-

dicted image motion induced by camera attitude dynamics. Star identification can be then accomplished by a star pattern matching technique which identify the observed stars in the reference catalog. The second method uses star neighborhood information and a cataloged neighborhood pointer matrix to access the star catalog. In the recursive star identification process, and under the assumption of a *slow attitude dynamics*, only the stars in the neighborhood of previously identified stars are considered for star identification in the succeeding frames.

- **Attitude Determination Systems**

1. **DBI Attitude Sensor**. Develops the theory and the software to use the DBI as an attitude sensor. From this instrument it is possible to estimate the velocity vector direction, which can be used as an observed direction in the attitude determination problem.
2. **Moon-Sun Attitude Sensor** (MSAS). The derivation that led to the MSAS is based on two facts: 1) the Moon is a gravity stabilized satellite and therefore it shows, approximately, always the same side to an Earth orbiting S/C. This implies that a Moon Reference Image (MRI) is available in the inertial reference system as a function of time and of the S/C, Sun and Moon orbital positions. 2) By comparing the MRI with the Moon Observed Image (MOI) and by a proper image processing of the MOI, it is possible to derive redundant data for attitude determination.
3. **Earth-Sun Attitude Sensor** (ESAS). The basic idea behind the MSAS, (that the Sun terminator on the Moon can provide enough information for a complete three-axis attitude computation), is extended to an Earth-observing sensor working in similar manner. This sensor is the Earth-Sun Attitude Sensor. Data processing for this type of sensor is many ways completely alike the one (more general) of the MSAS. Hence, many algorithms developed for the latter, (particularly those exploiting the knowledge of the illuminated edge of the observed body) can be adapted to the ESAS with few modifications. However, the general problems regarding the ESAS are different.

4. **Multiple FOVs Star Trackers** NavStar II and NavStar III. Texas A&M University of College Station has proposed the NavStar II sensor, which is a star tracker, which uses a mirror to deflecting half of the sensor field-of-view (FOV) to an orthogonal direction with respect to the sensor optical axis. This fact allows an optimal attitude data set for two reasons: the observed directions are the most accurate (because provided by a CCD star sensor) and the observed spatial directions are kept close to the optimal condition of being orthogonal. This solution presents the advantage of observing two star sets displaced from each other by 90 degree using only one Electro-optic system (one lens, one CCD, one electronic unit). There is obviously the additional advantage of keeping the star sensor operating using only half FOV, when the other half cannot be used because of the Sun/Earth/Moon falling within its FOV. The NavStar III star sensor has been proposed as the Italian version of StarNav II. It uses a mirror assembly deflecting 2/3 of the sensor FOV to two orthogonal directions with respect to the sensor optical axis and allows an optimal attitude data set because the spatial observed stars are kept close to the optimal condition of being orthogonal. As a result, NavStar III would achieve a substantial improvement in both the obtainable attitude accuracy (up to 30 times more accurate than a traditional star sensor) and in the operating time. This makes it quite suitable when very high attitude accuracy together with autonomous navigation is required.

5. **Compass Star Tracker**. Star trackers are the most accurate attitude sensors to perform the complete 3-axis attitude estimation of spacecraft. However, even though they are specifically designed to estimate attitude, we have demonstrated that they can also be used to estimate the local coordinates of the camera on the Earth as well as the direction of East. This requires us to align the camera with the local direction of the gravity and to have knowledge of the time that can be provided by an accurate clock. The resulting system is the Compass Star Tracker, that is, a star tracker used as a global surface navigation system. This system would certainly not substitute the Global Positioning System which, in turn, does not suffer of the limitation night-only operation and

in clear weather conditions. On the contrary, the Compass Star Tracker does not require any satellite information or other support from ground stations to be used in lieu of the traditional Global Positioning System.

- **Attitude Dynamics and Control**.

  1. **Spin rate ripple**. He developed a theoretical dynamic study for the attitude dynamics induced by thermal orbital transitions (Sun-shadow and vice versa) on a spin stabilized spacecraft carrying four cable booms with tip mass. A direct theory confirmation was obtained by applying it to the star mapper data of the San Marco 5 satellite. Within this study he presented a new mathematical best fitting technique (Optimal Best Fitting). This method compresses the abscissa axis by a proper variable change, which reduces the condition number of the matrix to be inverted; thus allowing the numerical problems characteristic of the least-square traditional method to be avoided.
  2. **Control of a Gradient Gravity Stabilized S/C**. He developed a research concerning the auxiliary magnetic control strategies for a gradient stabilized satellite. The purpose was to find an optimization technique (with respect to the noise) for uncertainty parameters systems. A non-linear control approach, based on an exact linearization via feedback, has been adopted. He developed the dynamics of a gravity gradient stabilized spacecraft, placed on a circular orbit, which used an adaptive technique to control the in-plane librations caused by the solar panels rotations.

- **Linear Algebra and Matrix Analysis**

  1. **Jordan Optimized Eigensolver** (JOE). Research and studies have been carried out for the eigenanalysis of numerically defective matrices, which led to the development of the JOE software package.
  2. ***n*-D vector cross-product**. The extension to n-D space of the vector cross product and its application to the eigenvectors computation for real, complex, and defective matrices was done.

3. **Rotation in n-D**. Generalization of the $n \times n$ proper orthogonal matrix performing the rigid rotation in the n-D space.
4. **Generalized Euler Theorem**. Found the relationship between the Orientation (General Rotation) and a minimum set of rigid rotation matrices, which constitutes the extension to n-D space of the Principal Axis Theorem (Euler Theorem).
5. **Orthogonal Matrix Decomposition**. Introduces a new decomposition for $n \times n$ proper orthogonal matrices into a product - or a sum - of planar rotation matrix set.
6. **Skew-Symmetric Matrix Decomposition**. A new decomposition for $n \times n$ skew-symmetric matrices into the sum skew-symmetric planar rotation matrix set, has been introduced.
7. **Ortho-Skew and Ortho-Sym matrices**. The Ortho-Skew and the Ortho-Sym set of matrices have been introduced. These matrices represent the extension to the n-D space of the imaginary unit. They satisfy the properties of the complex relationships, such as the Euler and the Moivre formulae.
8. **Matrix Trigonometry**. Developed the matrix trigonometry for the Ortho-Skew and the Ortho-Sym matrices.
9. **Matrix Mapping**. Introduces and completes the matrix mapping between Orthogonal, Skew-Symmetric, and Symmetric matrices which describe the Orientation in n-D spaces.

- **Numerical Analysis**

1. **k-vector**. Alternative approach to solve the *Range Searching* problem for large databases. The method, which is search-less, and instantaneous, has been widely applied to the star pattern recognition algorithms. For databases with less than 65,000 elements the speed gain with respect to the standard binary search technique is more than 50 times. The method has been modified to deal with dynamic databases.
2. **Multi-dimensional k-vector**. The extension of the k-vector to n-D databases is under study. Several different solutions are under a comparison study.

3. **Optimal Best Fitting** (OBF). OBF is a new method to perform polynomial best fitting which minimizes the condition number of the matrix to be inverted. This allows avoiding numerical problems associated with data ranging over a wide range and high degree interpolation or exponential polynomials. The optimum is achieved by replacing the independent variable with a new one, linearly correlated. The method has been extended to several best fittings, namely, those using the trigonometric functions, the Legendre orthogonal polynomials, and the Tchebychev polynomials.

- **Orbital Mechanics**

1. **Flower Constellations**. This is a novel methodology to design a set of satellite constellations which are generally characterized by repeatable ground tracks and a suitable phasing mechanism. A Flower Constellation, which can be complete or restricted, is identified by eight parameters. Five are integer parameters: the number of petals (N_p), the number of sidereal days to repeat the ground track (N_d), the number of satellites (N_s), and two integer to rule the phasing (F_n and F_d), and three are the orbit parameters equal for all satellites: the argument of perigee (ω), the orbit inclination (i), and the perigee altitude (h_p). Flower Constellations present beautiful and interesting dynamical features that allow us to explore a wide range of potential applications which include: telecommunications, Earth and deep space observation, global positioning systems, and new kind of formation flying schemes. A Flower Constellation can be re-oriented arbitrarily; however, the repeating ground track property is lost. For this project, the ad-hoc Flower Constellation Visualization and Analysis Tool (FC-VAT) software has been developed. The intellectual property by means of a Disclosure of Software, by Daniele Mortari, Matthew P. Wilkins, and Christian Bruccoleri for the FCVAT software has been signed with the Technology Licensing Office, TAMU 3369, 707 Texas Ave, College Station, TX 77843-3369 in October 15, 2003.

   (a) **Global Navigation Flower Constellation**. The Flower Constellations have the satellites following the same relative trajectory with respect to an Earth rotating reference frame.

This allows you to design an approximate uniform relative trajectory over the region of interest (which can be global) and uniformly distribute in time the satellites along the relative trajectory. Based on this idea, a new constellation of 30 satellites is here proposed, designed, and compared with the existing GPS and GLONASS constellation and the proposed European Galileo constellation. The proposed solution presents better characteristics in terms of attitude and position errors.

   (b) **Sun-Synchronous Flower Constellations**. Within the general theory of the Flower Constellations, it has been proposed a set of constellations whose relative trajectory follows the Sun. The resulting constellations are called Sun-Synchronous Flower Constellations.

2. **Multi Sun-Synchronous orbits**. These orbits represents the generalization of the Sun-Synchronous orbits. The Multi Sun-Synchronous Orbits (MSSO) are built such that the relative trajectory, with respect to a rotating reference frame having one axis constantly aligned with the Earth-Sun direction, constitutes a closed loop repeating trajectory. Among all the possible choice of this rotating reference frame, the reference frame having the has one axis aligned along with the ecliptic pole plays an important role.

3. **Shifting Sun-Synchronous Constellations**: In this constellation, after every orbit period, the constellation is shifted by a constant angle, such that the constellation appears identical with respect to the Sun direction.

4. **Two Way Orbits**. Some compatible orbits, having odd number of petals, having the relative trajectory with the property of being retrograde and prograde over a long parte of the ground track. It is possible to build special *Two-Way Constellations* that have, simultaneously, one spacecraft being prograde (at apogee) and one spacecraft being retrograde (at perigee).

5. **Reconnaissance problem**. This problem (observation of discrete sites of interest) is classic in remote sensing and has several important military applications. The goal of this study is to design a repeated Earth relative trajectory (resonant orbit) so that

all the assigned sites will be visited within a given time period. The objective is to find the best satellite orbit that achieves this mission. In a general case, a single satellite may not found to achieve the mission and hence a constellation of satellites will be used and optimization process will then look for the minimum number of satellites that achieves the mission and the best orbit for each.

- **Aerospace Navigation**

  1. **Differential Image Navigation**: The Differential Image Technique is a new technique to perform proximity navigation and/or docking/landing with an object whose shape and dynamics are known within a non negligible uncertainty. Our challenge is that the spacecraft carries a fixed single digital camera only, and that the control system, during the critical phase of landing/docking, takes all the decisions based on the information contained in subtracting subsequent pictures. This results into a novel and passive vision-based technology to perform proximity navigation. In particular, we will show how to estimate the rotational dynamic and how to design the control maneuvers sequence to land onto an asteroid.

Teaching Experience in Engineering

1. *Sistemi Aerospaziali* 1992-1998. (Prof. C. Arduini). Part: Attitude dynamics, Estimation, Stability and Control, Dynamics of flexible structures, space environment, and space systems architecture. Aerospace School of Engineering of University *La Sapienza* of Rome, Italy.

2. *Strumenti di Bordo* 1995-1997. (Prof. L. Iess). Part: Attitude parameterization, sensors, actuators, estimation, and data processing. Aerospace School of Engineering of University *La Sapienza* of Rome, Italy.

3. *Sistemi Aerospaziali* 1996-1998. (Prof. C. Ulivieri). Part: Astrodynamics, Rigid Body Dynamics and stability, Attitude Parameterization, Error, Determination, Sensors, Space environment, and Space

Systems architecture. Dipartimento di Ingegneria Elettronica ed Informatica, Facoltà di Ingegneria, Università di Perugia, Italy.

4. *Attitude Estimation* (2000). Prepared for the industry Officine Galileo of Alenia Spazio, Firenze, Italy.

5. *Le Matrici di Rotazione nella Determinazione e Descrizione dell'Orientamento dei Veicoli Spaziali* (2001). Prepared as a doctorate course of *Metodi e Modelli Matematici per le Scienze Applicate*, Facoltà di Ingegneria, University *La Sapienza* of Rome, Italy.

6. *Sistemi Aerospaziali* (1998-2002). Dipartimento di Ingegneria Elettronica ed Informatica, Facoltà di Ingegneria, Università di Perugia, Italy.

7. AERO-423 *Space Technology I*, Fall 2002, Fall 2003, Spring 2004. Department of Aerospace Engineering. Texas A&M University, College Station, TX.

8. AERO-489 *Attitude Determination*, Spring 2003, Department of Aerospace Engineering, Texas A&M University, College Station, TX.

9. AERO-689 *Spacecraft Attitude Determination*, Spring 2004. Department of Aerospace Engineering. Texas A&M University, College Station, TX.

Theses and Dissertations

1. Dr Emilio Francesco Morandini, Ph.D. Advisor, *Sensori ed Algoritmi per la Determinazione Puntuale dell'Assetto in Campo Spaziale*, Università degli Studi *La Sapienza* di Roma, Scuola di Ingegneria Aerospaziale. 1993/1994.

2. Alessandro Sigalot, M.S. Principal Advisor, *Problemi di Determinazione d'Assetto di Satelliti Artificiali e Identificazione di Stelle con Sensori Stellari*, Università degli Studi *La Sapienza* di Roma, Facoltà di Fisica. 1995/1996.

3. Davide Paciulli, M.S. Principal Advisor, *Analisi ed Algoritmi per l'Elaborazione Dati di un Sensore Luni-Solare*, Università degli Studi di Perugia, Facoltà di Ingegneria, Corso di Laurea in Ingegneria Elettronica. 1996/1997.

4. Michela Angelucci, M.S. Principal Advisor, *Sensori Stellari a Campi di Vista Multipli: Identificazione Stellare e Disallineamento*, Università degli Studi *La Sapienza* di Roma, Facoltà di Ingegneria, Corso di Laurea in Ingegneria Aerospaziale. 1998/1999.

5. Dr Gwanghyeok Ju, Ph.D. External Advisor, *Autonomous Star Sensing, Pattern Recognition, and Attitude Determination for Spacecraft: An Analytical and Experimental Study.* Department of Aerospace Engineering. Texas A&M University, May 2001.

6. Amit Sanyal, M.S. External Advisor, *Research, which includes a Theoretical Study on Rotation in Higher Dimensions and Attitude Estimation for Star Sensors.* Texas A&M University, Department of Aerospace Engineering. June 2001.

7. Mauro Bellezza, M.S. Principal Advisor, *Problematiche di Elaborazione Dati e di Sistema per le Prove a Terra di un Sensore Luni-Solare*, Università degli Studi di Perugia, Facoltà di Ingegneria, Corso di Laurea in Ingegneria Elettronica. June 2001.

8. Aurora Ntumba, M.S. Principal Advisor, *Identificazione Stellare per il Sensore d'Assetto a Tre Campi di Vista StarNav III*, Università degli Studi di Perugia, Facoltà di Ingegneria, Corso di Laurea in Ingegneria Elettronica. September 2001.

9. Silvia Sangiorgi, M.S. Principal Advisor, *ASTRIUM Internship: Unusual behaviour study of the TWTAs, Travelling Wave Tube Amplifiers, Embarked in ASTRIUM Telecommunications Satellites*, Università degli Studi di Perugia, Facoltà di Ingegneria, Corso di Laurea in Ingegneria Elettronica. January 2002.

10. Serena La Rosa, M.S. Principal Advisor, *Sviluppo di un Sistema Autonomo di Identificazione Stellare*, Università degli Studi di Perugia, Facoltà di Ingegneria, Corso di Laurea in Ingegneria Elettronica. March 2002.

11. Christian Bruccoleri, M.S. Principal Advisor, *Elaborazione di Immagini Stellari per la Navigazione Aerospaziale*, Università degli Studi *La Sapienza* di Roma, Corso di Laurea in Ingegneria Informatica, Facoltà di Ingegneria. March 2002.

12. Dr. Malak A. Samaan, Ph.D. Co-Advisor, *Research on Multiple FOVs Star Sensor Data Processing.* Department of Aerospace Engineering, Texas A&M University. June 2003.

13. Dr. Keun Joo Park, Ph.D. Principal Advisor, *GPS Receiver Self Survey and Attitude Determination Using Pseudolite Signals.* Department of Aerospace Engineering, Texas A&M University. May 2004.

14. Matthew Paul Wilkins, Graduate Ph.D. student, Principal Advisor, Department of Aerospace Engineering, Texas A&M University. (Expected graduation Summer 2004).

15. Abdelkhalik, Ossama Omar, Graduate Ph.D. student, Principal Advisor. Department of Aerospace Engineering, Texas A&M University. (Entering fourth and last year).

16. Bruccoleri, Christian, Graduate Ph.D. student, Principal Advisor. Department of Aerospace Engineering, Texas A&M University. (Entering third year).

Invited Seminars

1. *San Marco Project and Space Research at the University of Rome*, Invited plenary session talk at the Fourth International Symposium on Automatic Control and Computer Science (SACCS' 93), Iasi, Romania, October 29-30, 1993.

2. *The Moon-Sun and the Earth-Sun Attitude Sensors*, Flight Dynamics Division of the Goddard Space Flight Center (NASA), Greenbelt, MD, January 22, 1997, Invited by Dr F. Landis Markley and Dr Julie Deutschmann.

3. *The Moon-Sun and the Earth-Sun Attitude Sensors*, System Sciences Division of the Computer Science Corporation of Lanham-Seabrook, MD. June 13, 1997, Invited by Dr Dipak Oza and Dr Murty Challa.

4. *Recently Proposed Sensors and Algorithms for Spacecraft Attitude Determination*, Department of Aerospace and Mechanics Engineering, University of Minnesota, Minneapolis, MN, July 10, 1997, Invited by Prof. Yiyuan J. Zhao.

5. *New Algorithms and Sensors for Attitude Determination*, Mathematics Department of the Naval Postgraduate School, Monterey, CA, November 30, 1998, Invited by Prof. Guillermo Owen and Prof. Beny Neta.

6. *New Algorithms and Sensors for Attitude Determination*, Department of Aerospace Engineering, Texas A&M University, College Station, TX, December 7, 1998, Invited by Prof. John L. Junkins.

7. *From Planar to General Rotation in the n-D Spaces*, Department of Aerospace Engineering, Texas A&M University, College Station, TX, September 14, 2000, Invited by Prof. John L. Junkins.

8. *Ortho-Skew and Ortho-Sym Matrices: the Extension of the Imaginary Unit to n-D Spaces*, Department of Aerospace Engineering, Texas A&M University, College Station, TX, September 14, 2000. (invited by Prof. John L. Junkins).

9. *From Planar to General Rotation in the n-D Spaces*, Department of Aerospace Engineering, University of Texas, Austin, TX, September 15, 2000, Invited by Prof. Maruthi Akella.

10. *From Planar to General Rotation in the n-D Spaces*, Instituto de Sistemas e Robotica, Instituto Superior Tecnico of Lisbon Technical University, Portugal, May 3, 2001, Invited by Prof. Pedro U. Lima.

11. *General One-to-One Mapping Among Orientation Matrices*, Department of Aerospace Engineering, Texas A&M University, College Station, TX, March 7, 2002, Invited by Prof. Ramesh Talreja and Prof. John L. Junkins.

12. ESOQ: *From Theory to Application*, Department of Aerospace Engineering, Texas A&M University, College Station, TX, March 7, 2002, Invited by Prof. Ramesh Talreja and Prof. John L. Junkins.

13. *Conformal Mapping among Orthogonal, Symmetric, and Skew-Symmetric Matrices*, AERO 681 Seminar Series, Department of Aerospace Engineering, Texas A&M University, College Station, TX, February 4, 2003 at 4:00pm.

14. *ANNA: a Slide Presentation*, Circolo Italiano, Texas A&M University, College Station, TX, March 19, 2003 at 19:30pm.

15. *The Flower Constellations*, AIAA Learn and Lunch Speech, NASA's Johnson Space Center, Houston, TX, June 11, 2003 at 11:00pm.

16. *The Flower Constellations*, Aerospace and Ocean Engineering Department of the Virginia Polytechnic Institute and State University, Blacksburg, VA, September 21, 2003 at 04:00pm.

17. *The Flower Constellations*, College of Architecture, Texas A&M University, College Station, TX, November 25, 2003 at 11:00pm.

18. *The Flower Constellation Set*, NASA's Jet Propulsion Laboratory, Pasadena, CA, January 15, 2004 at 11:00am.

19. *Secondary Paths in Flower Constellations*, Algebra and Combinatorics Seminar, Department of Mathematics, Texas A&M University, College Station, TX, January 30, 2004 at 03:00pm.

Funded Projects

1. PI. *Feasibility Study of the Moon-Sun and the Earth-Sun Attitude Sensors: Algorithm Development*
   Sponsor: Italian Space Agency
   Amount: Lire 173M (about $86.5K)
   Dates: One year contract, completed by May 31, 2000.

2. PI. *Feasibility Study of the Moon-Sun and the Earth-Sun Attitude Sensors: Ground Tests*
   Sponsor: Italian Space Agency
   Amount: Lire 150M (about $75K)
   Dates: One year contract completed by May 31, 2001.

3. PI. *Feasibility Study of the Multiple FOVs Star Tracker NavStar III*
   Sponsor: Italian Space Agency
   Amount: Lire 100M (about $50K)
   Dates: Six month contract completed by September 30, 2001.

4. PI. *Design of an Elegant Breadboard for the Multiple FOVs Star Tracker NavStar III*
   Sponsor: Italian Space Agency
   Amount: Lire 90M (about $45K)
   Dates: One year contract completed by August 13, 2002.

5. Co-I. *Solar Sail Diagnostic Package*
   PI: Richard Pappa (LaRC)
   Sponsor: NASA Langley
   Amount: $500K
   Dates: 06/03-06/05
   Note: After acceptance, ITAR has been risen from TRL 2-3 to TRL 6. The PI stepped down, because US citizenship became required.

6. In addition to the above projects in which Dr. Mortari has been the sole Principal Investigator, Dr. Mortari has served as a co- investigator or visiting researcher for several projects over the past ten years at the San Marco Project and for three years at Texas A&M University; the total budgets for these projects are several million dollars. In collaboration with Prof. J.L. Junkins and Prof. T. Pollock at Texas A&M on the StarNav project, the methods developed for star pattern recognition have been adopted for the EO-3 mission (a $130M spacecraft to be launched in 2005), and a pending patent has been commercialized.

Present and Pending Projects

7. Co-I. *Mission Planning Studies for Near-Earth Asteroids*
   PI: John L. Junkins (TAMU)
   Sponsor: Science Applications International Corporation
   Amount: $25K
   Dates: 2/1/04 - 8/31/04
   Status: Approved for funding, under negotiation.

8. PI. *n-D k-vector Range Searching and Applications*,
   Sponsor: National Science Foundation
   NSF 04-500, IIS Information and Data Management,
   Amount: $420,080.00,
   Dates: June 1, 2004 - May 31, 2007, (1.50 mo/yr)
   Status: Pending.

9. PI. *Flower Constellations for Earth Observations*
   Sponsor: Earth Science Division, JPL-NASA
   Amount: $107,965.00,
   Date: June 1, 2004 - May 31, 2005 (1.50 mo/yr)
   Status: In preparation.

Professional Societies

- American Astronautical Society: Member, 1992 - present.
- American Institute of Aeronautics and Astronautics: Member, 1994 - present.
- Phi Beta Delta, Honorary Association, Member, October 2002 - present.
- Sigma Xi, The Scientific Research Society. Full Member, January 2003 - present.

Professional Societies Activities

- Associate Editor of the AAS *Journal of the Astronautical Sciences*
- Reviewer of the AIAA *Journal of Guidance, Control, and Dynamics*, since 1997.
- Reviewer of the AAS *Journal of the Astronautical Sciences*, since 1998.
- Reviewer of the *Acta Astronautica*, since 2004.
- Session Chair of *Attitude Determination II* at the AIAA/AAS Astrodynamics Specialist Conference, San Diego, CA, July 29-31, 1996.
- Invited paper at the Third International Conference on Non Linear Problems in Aeronautics and Astronautics, ICNPAA-2000, Daytona Beach, FL, May 10-12, 2000.
- Session Chair at the Third International Conference on Non Linear Problems in Aeronautics and Astronautics, ICNPAA-2000, Daytona Beach, FL, May 10-12, 2000.
- Co-Organizer of the 2003 AAS John L. Junkins Astrodynamics Symposium, Texas A&M University, College Station, TX, May 23-24, 2003.
- Session Chair of the 2003 AAS John L. Junkins Astrodynamics Symposium, Texas A&M University, College Station, TX, May 23-24, 2003.
- Guest-Editor of the Special Issue: The John L. Junkins Astrodynamics Symposium of the *Journal of the Astronautical Sciences*.

- Program Committee member for the 6th International Conference on Dynamics and Control of Systems and Structures in Space 2004, Riomaggiore, Italy, 18-22 July, 2004.

- Organizing Committee Member for the International Conference on Dynamics and Control of Systems and Structures in Space 2004, Riomaggiore, Italy, 18-22 July, 2004.

Consulting

- The Charles Stark Draper Laboratory, Inc., Cambridge, MA. The Pyramid and the ESOQ2 algorithms have been adapted to the Stellar Inertial Compass for the JPL New Millennium Program ST6. Pyramid solves the the Star Identification problem in the *Lost-in-Space* case and ESOQ2 optimally estimates the spacecraft attitude from vector observations, respectively.

- Massachusetts Institute of Technology, Cambridge, MA. The successfully application of Pyramid by Draper Labs. has convinced the MIT Center for Space Research, to adopt Pyramid for the High Energy Transient Explorer (HETE) spacecraft. Pyramid became operative on HETE since July 2002. Pyramid will also be used on the HETE2 and on the GIFTS missions.

Honors

- NASA Group Achievement Award (1981) for activities related to Spacecraft Attitude Determination and Control of the San Marco Spacecraft.

Patents

- Junkins, J.L., Pollock T.C., and Mortari, D. *Multiple Field of View Optical Imaging System and Method*, U.S. Patent Pending No. 60/239,559, January 29, 2001.

- Disclosure of Software by Daniele Mortari, Matthew P. Wilkins, and Christian Bruccoleri for *The Flower Constellation Visualization and Analysis Tool* (FCVAT) with the Technology Licensing Office, TAMU

3369, 707 Texas Ave, College Station, TX 77843-3369. October 15, 2003.

- TBD in the immediate future. Patent for the algorithm which find all the admissible locations in a given orbit for satellites belonging to the same assigned relative trajectory with respect to an Earth rotating reference frame. The patent will be submitted through the Technology Licensing Office, TAMU 3369, 707 Texas Ave, College Station, TX 77843-3369.

List of Publications

Textbooks

1. *The John L. Junkins Astrodynamics Symposium*, Srinivas Rao Vadali and Daniele Mortari, Eds. American Astronautical Society, San Diego, 2003 Paperback: 542 pp., illus. ISBN 0877035067. Advances in the Astronautical Sciences, Vol. 115.

2. Mortari, D. *Attitude Determination and Star Navigation*, in preparation (Status: 70% done, about 350 pages). To be submitted to the AIAA Educational Series.

3. Mortari, D. *Spacecraft Orbit and Attitude Dynamics: "Space Magic"*, in preparation (Status: 55% done, about 250 pages). To be submitted to College Publishers.

4. *The Journal of the Astronautical Sciences*, Special Issue: The John L. Junkins Astrodynamics Symposium, Srinivas Rao Vadali and Daniele Mortari, Eds. American Astronautical Society. To appear.

Archival Publications (peer reviewed journal articles)

1. A.M. Nobili, D. Bramanti, G. Catastini, E. Polacco, A. Milani, L. Anselmo, M. Andrenucci, S. Marcuccio, A. Genovese, G. Genta, E. Brusa, C. Del Prete, D. Bassani, G. Vannaroni, M. Dobrowolny, E. Melchioni, C. Arduini, U. Ponzi, F. Curti, G. Laneve, D. Mortari, M. Parisse, F. Cabiati, E. Rossi, A. Sosso, G. Zago, S. Monaco, G. Gori Giorgi, S. Battilotti, L. D'Antonio, and, G. Amicucci, "Galileo Galilei Flight Experiment on the Equivalence Principle with Field Emission Electric Propulsion," *Journal of the Astronautical Sciences*, Vol. 43, No. 3, July-September 1995, pp. 219-242.

2. Mortari, D. "EULER-2 and EULER-n Algorithms for Attitude Determination from Vector Observations," *Space Technology*, Vol. 16, Nos. 5/6, 1996, pp. 317-321.

3. Mortari, D. "Modelli Matematici per la Determinazione d'Assetto di Satelliti Artificiali," *Atti del Centro Ricerche Aerospaziali, Nuova Serie*, No. 6, March 1996.

4. Mortari, D. "Riduzione dei Dati di Sensori d'Assetto," *Atti del Centro Ricerche Aerospaziali, Nuova Serie*, No. 7, October 1996.

5. Mortari, D. "Energy Approach Algorithm for Attitude Determination from Vector Observations," *Journal of the Astronautical Sciences*, Vol. 45, No. 1, pp. 41-55, 1997.

6. Mortari, D. "Search-Less Algorithm for Star Pattern Recognition," *Journal of the Astronautical Sciences*, Vol. 45, No. 2, April-June 1997, pp. 179-194.

7. Mortari, D. "ESOQ: A Closed-Form Solution to the Wahba Problem," *Journal of the Astronautical Sciences*, Vol. 45, No. 2, April-June 1997, pp. 195-204.

8. Mortari, D. "n-D Cross Product and its Application to Matrix Eigenanalysis," *Journal of Guidance, Control, and Dynamics*, Vol. 20, No. 3, May-June 1997, pp. 509-515.

9. Mortari, D. "Moon-Sun Attitude Sensor," *Journal of Spacecraft and Rockets*, Vol. 34, No. 3, May-June 1997, pp. 360-364.

10. Mortari, D. "EULER-q Algorithm for Attitude Determination from Vector Observations," *Journal of Guidance, Control, and Dynamics*, Vol. 21, No. 2, March-April 1998, pp. 328-334.

11. Mortari, D. "Second Estimator of the Optimal Quaternion," *Journal of Guidance, Control, and Dynamics*, Vol. 23, No. 5, Sept.-Oct. 2000, pp. 885-888.

12. Markley, L.F., and Mortari, D. "Quaternion Attitude Estimation Using Vector Observations," *Journal of the Astronautical Sciences*, Special Issue: The Richard H. Battin Astrodynamics Symposium, Vol. 48, No. 2/3, April-September, 2000, pp. 359-380.

13. Mortari, D. "On the Rigid Rotation Concept in n-D Spaces," *Journal of the Astronautical Sciences*, Vol. 49, No. 3, July-September 2001.

14. Mortari, D. Wilkins, M., and Bruccoleri, C. "The Flower Constellations," Accepted in the *Journal of the Astronautical Sciences*, Special Issue: The John L. Junkins Astrodynamics Symposium, 2003.

15. Mortari, D. "Ortho-Skew and Ortho-Sym Matrix Trigonometry," Accepted in the *Journal of the Astronautical Sciences*, Special Issue: The John L. Junkins Astrodynamics Symposium, 2003.

Submitted and in Preparation

16. Mortari, D., Samaan, M.A., Bruccoleri, C., and Junkins, J.L. "The *Pyramid* Star Pattern Recognition Algorithm," Submitted to the ION *Journal of Navigation.*

17. Samaan, M.A., Mortari, D., and Junkins, J.L. "Non Dimensional Star Identification for Un-Calibrated Star Cameras," Submitted to the AAS *Journal of the Astronautical Sciences.*

18. Park, K., Wilkins, M., Bruccoleri, C., and Mortari, D. "Uniformly Distributed Flower Constellation Design Study for Global Navigation System," Submitted to the ION *Journal of Navigation.*

19. Samaan, M.A., Mortari, D., and Junkins, J.L. "Recursive Mode Star Identification Algorithms," Submitted to the IEEE *Transactions on Aerospace and Electronic Systems.*

20. Mortari, D., Rojas, J.M., and Junkins, J.L. "Attitude and Position Estimation from Vector Observations," Submitted to the AIAA *Journal of Guidance, Dynamics, and Control.*

21. Samaan, M.A., Mortari, D., and Junkins, J.L. "Compass Star Tracker for GPS Applications," Submitted to the ION *Journal of Navigation.*

22. Wilkins, M., Bruccoleri, C., and Mortari, D. "Constellation Design Using Flower Constellations," Submitted to the AIAA *Journal of Guidance, Dynamics, and Control*

23. Singla, P., Mortari, D., and Junkins, J.L. "How to Avoid Singularity for Euler Angle Set?," Submitted to the AIAA *Journal of Guidance, Dynamics, and Control.*

24. Mortari, D., and Singla, P. "Ambiguity Resolution and Optimal Solution of Cones Intersection Technique," To be submitted to the IEEE *Transactions on Aerospace and Electronic Systems.*

25. Katake, A., Mortari, D., and Junkins, J.L. "Dual Field-of-View Star Tracker StarNav II Data Processing," To be submitted to *Sensor Review.*

26. Bruccoleri, C., Wilkins, P.M., and Mortari, D. "Use of Star Trackers for Space Surveillance," To be submitted to *Sensor Review.*

27. Park K.J., Bruccoleri, C., and Mortari, D. "Moon-Sun Sensor Data Processing," To be submitted to *Sensor Review.*

28. Mortari, D. and Junkins, J.L. "An Analytical Approach to Star Identification," To be submitted to the AIAA *Journal of Guidance, Dynamics, and Control.*

29. Mortari, D. and Rojas, M. "Conformal Mapping among Orthogonal, Symmetric, and Skew-Symmetric Matrices," To be submitted to the *Journal of Linear Algebra.*

Conference Papers and Proceedings Publications (abstract or extended abstract refereed)

1. Arduini, C., and Mortari, D. J.O.E.: "Jordan Optimized Eigensolver: A Step Toward a Numerical Jordan Form Analyzer for Control and Interactive Thermo-Structural-Dynamic Applications," Proc. International Conference Spacecraft Structures and Mechanical Testing, October 19-21, 1988, Noordwijk, The Netherlands, pp. 461-465.

2. Arduini, C., Laneve, G., Mortari, D., and Parisse, M. "Numerical Treatment of the Thermo-Structural-Dynamic Problems: The Interpolation Techniques," Proc. International Conference Spacecraft Structure and Mechanical Testing, October 19-21, 1988, Noordwijk, The Netherlands, pp. 219-224.

3. Arduini, C., Laneve, G., Mortari, D., and De Micco, A. "A Model of Perturbed of the Spinning Motion of the San Marco Fifth Spacecraft," AGARD Conference Proceeding, No. 489, November 13-16, 1989.

4. Arduini, C., Baiocco, P., Mortari, D., and Parisse, M. "A Quasi Adaptive Magnetic Damping Strategy for Gravity Gradient Stabilized Spacecraft," Paper 92-0031 of the 43rd International Astronautical Federation Congress, August 28 - September 5, 1992, Washington D.C.

5. Arduini, C., Mortari, D., Curti, F., and Baiocco, P. “A Noise Optimized Non Linear Reference Model Control for High Precision Pointing in Space with Uncertain Parameters,” AA in ICS International Workshop on Advanced Approaches in Industrial Control Systems, Prague, May 18-20, 1993.

6. Curti, F., Mortari, D., Parisse, M., and Arduini, C. “A New Technique with Adaptive Observer for Controlling a Flexible Spacecraft under Gravity Gradient,” Fourth International Symposium on Automatic Control and Computer Science, October 29-30, 1993, Iasi, Romania.

7. Mortari, D., Arduini, C., Ambrogini, E., and Virno Lamberti, R. “San Marco Project and Space Research at the University of Rome, Plenary Session,” Fourth International Symposium on Automatic Control and Computer Science (SACCS' 93), October 29-30, 1993, Iasi, Romania.

8. Mortari, D., and Arduini, C. “Attitude Dynamics Induced by the Thermal Transition on a Spin Stabilized Cable Boom System,” Advances in the Astronautical Sciences, Vol. 87, Pt. I, pp. 53-65. Paper 94-104 of the 4th Annual AIAA/AAS Space Flight Mechanics Meeting, Cocoa Beach, FL, February 14-16, 1994.

9. A.M. Nobili, D. Bramanti, G. Catastini, E. Polacco, A. Milani, L. Anselmo, M. Andrenucci, S. Marcuccio, A. Genovese, G. Genta, E. Brusa, C. Del Prete, D. Bassani, G. Vannaroni, M. Dobrowolny, E. Melchioni, C. Arduini, U. Ponzi, F. Curti, G. Laneve, D. Mortari, M. Parisse, F. Cabiati, E. Rossi, A. Sosso, G. Zago, S. Monaco, G. Gori Giorgi, S. Battilotti, L. D'Antonio, and, G. Amicucci, “Galileo Galilei Flight Experiment on the Equivalence Principle with Field Emission Electric Propulsion,” Proceeding of Forum on Small and Medium Size Italian Scientific Satellites, E. Antonello Ed., Centro Stampa Area di Ricerca del CNR di Milano, 1994, pp. 19-29.

10. Mortari, D., and Arduini, C. “3-Slit Star Mapper Data Processing for the Spin Axis Misalignment Determination,” Paper of the 2nd ESA International Conference on Guidance, Navigation and Control Systems, ESTEC, Noordwijk, April 12-15, 1994, (ESA WPP-071), pp. 463-470.

11. Mortari, D. “Energy Approach Algorithm for Attitude Determination from Vector Observations,” Advances in the Astronautical Sciences,

Vol. 89, Pt. I, pp. 773-784. Paper 95-207 of the 5th Annual AIAA/AAS Space Flight Mechanics Meeting, Albuquerque, NM, February 13-16, 1995.

12. Mortari, D. "EULER-2 and EULER-n Algorithms for Attitude Determination from Vector Observations," Paper T2-9 of the IFAC Conference on Intelligent Autonomous Control in Aerospace, IACA' 95, August 14-16, 1995, Beijing, China, pp. 213-218.

13. Mortari, D. "A Fast On-Board Autonomous Attitude Determination System based on a new Star-ID Technique for a Wide FOV Star Tracker," Advances in the Astronautical Sciences, Vol. 93, Pt. II, pp. 893-903. Paper 96-158 of the Sixth Annual AIAA/AAS Space Flight Mechanics Meeting, Austin, TX, February 11-15, 1996.

14. Mortari, D. "EULER-q Algorithm for Attitude Determination from Vector Observations," Advances in the Astronautical Sciences, Vol. 93, Pt. II, pp. 1009-1020. Paper 96-173 of the 6th Annual AIAA/AAS Space Flight Mechanics Meeting, Austin, TX, February 11-15, 1996.

15. Mortari, D. "Moon-Sun Attitude Sensor," Paper 96-3618 of the AIAA/AAS Astrodynamics Specialists Conference, San Diego, CA, July 29-31, 1996.

16. Mortari, D. "n-D Cross Product and Its Application to Matrix Eigenanalysis," Paper 96-3619 of the AIAA/AAS Astrodynamics Specialists Conference, San Diego, CA, July 29-31, 1996.

17. Curti, F., and Mortari, D. "Study on Optimal Filtering for Attitude Determination Applied to the Moon-Sun Attitude Sensor," Advances in the Astronautical Sciences, Vol. 95, Pt. II, pp. 803-816. Paper 97-166 of the 7th Annual AIAA/AAS Space Flight Mechanics Meeting, Huntsville, AL, February 10-12, 1997.

18. Mortari, D. "ESOQ-2 Single-Point Algorithm for Fast Optimal Spacecraft Attitude Determination," Advances in the Astronautical Sciences, Vol. 95, Pt. II, pp. 817-826. Paper 97-167 of the 7th Annual AIAA/AAS Space Flight Mechanics Meeting, Huntsville, AL, February 10-12, 1997.

19. Laneve, G., and Mortari, D. "Performance Assessment of the Moon-Sun Attitude Sensor," Advances in the Astronautical Sciences, Vol. 95,

Pt. II, pp. 839-850. Paper 97-169 of the 7th Annual AIAA/AAS Space Flight Mechanics Meeting, Huntsville, AL, February 10-12, 1997.

20. Mortari, D. "Optimal Cones Intersection Techniques for Attitude Pointing Error Evaluation," Advances in the Astronautical Sciences, Vol. 97, Pt. I, pp. 949-962. Paper 97-661 of the AAS/AIAA Astrodynamics Conference, Sun Valley, ID, August 4-7, 1997.

21. Mortari, D. "Range Limits of Attitude Determination Accuracy," Advances in the Astronautical Sciences, Vol. 97, Pt. I, pp. 167-178. Paper 97-611 of the AAS/AIAA Astrodynamics Conference, Sun Valley, ID, August 4-7, 1997.

22. Mortari, D., and Paciulli, D. "Il Sensore d'Assetto Luni-Solare: Elaborazione dei Dati per una Precisa Determinazione di Assetto," Atti del XIV Congresso Nazionale della AIDAA, Napoli, October 20-24, 1997, Vol. II, pp. 603-612.

23. Mortari, D. "Optimal Best-Fitting of Numerical Data," Advances in the Astronautical Sciences, Vol. 99, Pt. II, pp. 1509-1518. Paper AAS 98-206 of the 8th Annual AIAA/AAS Space Flight Mechanics Meeting, Monterey, CA. February 9-11, 1998.

24. Mortari, D., Pollock, T.C., and Junkins, J.L. "Towards the Most Accurate Attitude Determination System Using Star Trackers," Advances in the Astronautical Sciences, Vol. 99, Pt. II, pp. 839-850. Paper AAS 98-159 of the 8th Annual AIAA/AAS Space Flight Mechanics Meeting, Monterey, CA. February 9-11, 1998.

25. Mortari, D., and Angelucci, M. "Star Pattern Recognition and Mirror Assembly Misalignment for DIGISTAR II and III Star Sensors," Advances in the Astronautical Sciences, Vol. 102, Pt. II, pp. 1175-1184. Paper AAS 99-182 of the 9th Annual AAS/AIAA Space Flight Mechanics Meeting, Breckenridge, CO, February 7-10, 1999.

26. Mortari, D. "SP-Search: A New Algorithm for Star Pattern Recognition," Advances in the Astronautical Sciences, Vol. 102, Pt. II, pp. 1165-1174. Paper AAS 99-181 of the 9th Annual AAS/AIAA Space Flight Mechanics Meeting, Breckenridge, CO, February 7-10, 1999.

27. Mortari, D., and Neta, B. "Optimal Best-Fitting of Numerical Data: Part II," Advances in the Astronautical Sciences, Vol. 102, Pt. II, pp. 1185-1200. Paper AAS 99-183 of the 9th Annual AIAA/AAS Space Flight Mechanics Meeting, Breckenridge, CO, February 7-10, 1999.

28. Markley, L.F., and Mortari, D. "How to Compute Attitude from Vector Observations," Paper 99-427 of the AAS/AIAA Astrodynamics Specialist Conference, Girdwood, AK, August 15-19, 1999.

29. Mortari, D., and Junkins, L.J. "SP-Search Star Pattern Recognition for Multiple Fields of View Star Trackers," Paper 99-437 of the AAS/AIAA Astrodynamics Specialist Conference, Girdwood, AK, August 15-19, 1999.

30. Mortari, D., and Gigli, S. "Earth-Sun Attitude Sensor: Hardware Design and Ground Tests," Paper 99-438 of the AAS/AIAA Astrodynamics Specialist Conference, Girdwood, AK, August 15-19, 1999.

31. Mortari, D., and Neta, B. "k-vector Range Searching Techniques," 10th Annual AIAA/AAS Space Flight Mechanics Meeting. Paper AAS 00-128, Clearwater, FL. January 23-26, 2000.

32. Mortari, D., Markley, L.F., and Junkins, L.J. "Optimal Linear Attitude Estimator," 10th Annual AIAA/AAS Space Flight Mechanics Meeting. Paper No. AAS 00-129, Clearwater, FL. January 23-26, 2000.

33. Mortari, D., Angelucci, M., and Markley, L.F. "Singularity and Attitude Estimation," 10th Annual AIAA/AAS Space Flight Mechanics Meeting. Paper No. AAS 00-130, Clearwaters, FL. January 23-26, 2000.

34. Mortari, D. "On the Rigid Rotation Concept in the n-D Spaces: Part I," Invited paper of the Third International Conference on Non Linear Problems in Aeronautics and Astronautics, ICNPAA-2000, Daytona Beach, FL, May 10-12, 2000. Proceeding of ICNPAA - 2000, Vol. 2, pp. 480-496.

35. Mortari, D. "On the Rigid Rotation Concept in the n-D Spaces: Part II," Invited paper of the Third International Conference on Non Linear Problems in Aeronautics and Astronautics, ICNPAA-2000, Daytona

Beach, FL, May 10-12, 2000. Proceeding of ICNPAA - 2000, Vol. 2, pp. 497-504.

36. Ju, G., Kim, Y.H., Pollock, C.T., Junkins, L.J., Juang, N.J., and Mortari, D. "Lost-In-Space: A Star Pattern Recognition and Attitude Estimation Approach for the Case of No A Priori Attitude Information," 23rd Annual AAS Guidance and Control Conference. Paper No. AAS 00-004, Breckenridge, CO. February 2-6, 2000.

37. Markley, L.F., and Mortari, D. "New Developments in Quaternion Estimation from Vector Observations," Richard H. Battin Astrodynamics Symposium Conference. Paper AAS 00-266, Texas A&M University, College Station, TX, March 20-21, 2000, Vol. 106, pp. 373-393.

38. Mortari, D., Junkins, L.J., and Samaan, M.A. "Lost-In-Space Pyramid Algorithm for Robust Star Pattern Recognition," Paper of the 2001 AAS Guidance and Control Conference, Breckenridge, CO, February 10-12, 2001.

39. Samaan, M.A., Mortari, D., and Junkins, L.J. "Recursive Mode Star Identification Algorithms," AAS/AIAA Space Flight Mechanics Meeting Santa Barbara, California 11-14 February, 2001.

40. Mortari, D., and Romoli, A. "Novità Ottiche ed Algoritmiche del Sensore Stellare NavStar III," Workshop ASI - La Scienza e la Tecnologia sulla Stazione Spaziale Internazionale - Torino, May 16-18, 2001.

41. Kim H.Y., Junkins, L.J., and Mortari, D. "A New Star Pattern Recognition Method: Star Pair Axis and Image Template Matrix Method," 2001 Core Technologies for Space Systems Conference. November 28-30, 2001, Colorado Springs, CO.

42. Samaan, M.A., Mortari, D., Pollock, T.C., and Junkins, L.J. "Predictive Centroiding for Single and Multiple FOVs Star Trackers," Paper AAS 02-103 presented at the AAS/AIAA Space Flight Mechanics Meeting, San Antonio, TX, 27-31 January, 2002.

43. Mortari, D., and Romoli, A. "NavStar III: A Three Fields Of View Star Tracker," 2002 IEEE Aerospace Conference, Big Sky, MT, March 9-16, 2002.

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