# Novelty Assessment Report

**Paper**: Special Unitary Parameterized Estimators of Rotation

**PDF URL**: https://openreview.net/pdf?id=VaS6xcDrTb

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## Abstract

This paper revisits the topic of rotation estimation through the lens of special unitary matrices. We begin by reformulating Wahba's problem using $SU(2)$ to derive multiple solutions that yield linear constraints on corresponding quaternion parameters. We then explore applications of these constraints by formulating efficient methods for related problems. Finally, from this theoretical foundation, we propose two novel continuous representations for learning rotations in neural networks. Extensive experiments validate the effectiveness of the proposed methods.



## Core Task Landscape

This paper addresses: **Rotation Estimation and Learning in Neural Networks**

A total of **50 papers** were analyzed and organized into a taxonomy with **25 categories**.

### Taxonomy Overview

The research landscape has been organized into the following main categories:

- **Rotation Equivariance and Invariance in Network Architectures**
- **Rotation Representation and Parameterization for Learning**
- **Rotation-Based Self-Supervised Learning**
- **6D Pose Estimation for Objects and Spacecraft**
- **Relative Camera Pose and Rotation Estimation**
- **Image Orientation and Rotation Correction**
- **Rotation Estimation in Specialized Application Domains**
- **Rotation Robustness and Training Dynamics**
- **Multi-Task Learning and Specialized Network Architectures**
- **Theoretical Foundations of Rotation Learning**

### Complete Taxonomy Tree

- Rotation Estimation and Learning in Neural Networks Survey Taxonomy
- Rotation Equivariance and Invariance in Network Architectures
  - Steerable and Equivariant Convolutional Filters (4 papers)
  - [1] Learning steerable filters for rotation equivariant cnns (Weiler, 2018) View paper
  - [12] Rotation equivariant vector field networks (Marcos, 2017) View paper
  - [25] Rotation-invariant convolutional neural networks for galaxy morphology prediction (Dieleman, 2015) View paper
  - [42] Rotation invariant local binary convolution neural networks (Xin Zhang, 2017) View paper
  - Rotation-Invariant Point Cloud and 3D Convolutions (2 papers)
  - [3] Rotation-invariant 3D convolutional neural networks for 6D object pose estimation (Zhizhong Chen, 2025) View paper
  - [7] Rotation invariant convolutions for 3d point clouds deep learning (Zhiyuan Zhang, 2019) View paper
  - Equivariant Graph Neural Networks (6 papers)
  - [11] Rotation Invariant Graph Neural Networks using Spin Convolutions (Shuaibi, 2021) View paper
  - [23] Multi-scale rotation-equivariant graph neural networks for unsteady Eulerian fluid dynamics (Mario Lino, 2022) View paper
  - [33] On the Expressive Power of Geometric Graph Neural Networks (Cohen, 2023) View paper
  - [34] E(n) Equivariant Topological Neural Networks (Battiloro, 2024) View paper
  - [38] HEGN: Hierarchical Equivariant Graph Neural Network for 9DoF Point Cloud Registration (Adam Misik, 2024) View paper
  - [41] Rotation-equivariant graph neural networks for learning glassy liquids representations (Francesco Saverio Pezzicoli, 2022) View paper
- Rotation Representation and Parameterization for Learning
  - Continuity and Topological Properties of Rotation Representations (1 papers)
  - [2] On the continuity of rotation representations in neural networks (Yi Zhou, 2019) View paper
  - Orthogonalization and Matrix-Based Rotation Learning (2 papers)
  - [6] Learning unorthogonalized matrices for rotation estimation (Gu, 2023) View paper
  - [37] An analysis of svd for deep rotation estimation (Jake Levinson, 2020) View paper
  - Special Unitary and Quaternion Parameterizations ★ (2 papers)
  - [0] Special Unitary Parameterized Estimators of Rotation (Anon et al., 2026) View paper
  - [35] Algebraically rigorous quaternion framework for the neural network pose estimation problem (Chen Lin, 2023) View paper
  - Frequency-Domain and Harmonic Rotation Representations (1 papers)
  - [13] 3D equivariant pose regression via direct Wigner-D harmonics prediction (Minsu Cho, 2024) View paper

- Rotation-Based Self-Supervised Learning
    - Image Rotation Prediction for Representation Learning (2 papers)
    - [8] Unsupervised representation learning by predicting image rotations (Gidaris, 2018) View paper
    - [9] Image enhanced rotation prediction for self-supervised learning (Sekitoshi Kanai, 2021) View paper
    - Video Rotation Prediction for Spatiotemporal Learning (1 papers)
    - [29] Self-supervised spatiotemporal feature learning via video rotation prediction (Jing, 2018) View paper
    - Rotation Feature Decoupling and Invariance Learning (2 papers)
    - [4] Self-supervised representation learning by rotation feature decoupling (Zeyu Feng, 2019) View paper
    - [17] Equivariant spatio-temporal self-supervision for lidar object detection (Deepti Hegde, 2024) View paper
    - Rotation Prediction for Model Evaluation and Robustness (1 papers)
    - [45] What does rotation prediction tell us about classifier accuracy under varying testing environments? (Deng, 2021) View paper
- 6D Pose Estimation for Objects and Spacecraft
    - Spacecraft Pose Estimation from Monocular Vision (3 papers)
    - [5] Deep learning for spacecraft pose estimation from photorealistic rendering (Pedro F. ProenÃ§a, 2020) View paper
    - [10] Neural network-based pose estimation for noncooperative spacecraft rendezvous (Simone Dâ□□Amico, 2020) View paper
    - [30] Non-cooperative Satellite Rotation Estimation Based on Monocular Vision (Jie He, 2024) View paper
    - Point Cloud-Based 6D Pose Estimation (2 papers)
    - [40] Pose estimation of point sets using residual MLP in intelligent transportation infrastructure (Yujie Li, 2023) View paper
    - [48] 6d object pose regression via supervised learning on point clouds (Ge Gao, 2020) View paper
    - Viewpoint Encoding and Unseen Object Pose Estimation (2 papers)
    - [24] Efficient encoding and aligning viewpoints for 6D pose estimation of unseen industrial parts (Jiatong Xu, 2024) View paper
    - [31] On Representation of 3D Rotation in the Context of Deep Learning (GajdoÅ¡ech, 2024) View paper
- Relative Camera Pose and Rotation Estimation (2 papers)
    - [22] Relative Camera Pose Estimation Using Convolutional Neural Networks (Iaroslav Melekhov, 2017) View paper
    - [27] Extreme rotation estimation using dense correlation volumes (Cai, 2021) View paper
- Image Orientation and Rotation Correction (2 papers)
    - [28] Image orientation estimation with convolutional networks (Alexey Dosovitskiy, 2015) View paper
    - [32] Deep rotation correction without angle prior (Lang Nie, 2023) View paper
- Rotation Estimation in Specialized Application Domains
    - Rotation in Robotics and Localization (2 papers)
    - [36] Joint hand detection and rotation estimation using CNN (Xiao-ming Deng, 2017) View paper
    - [47] Rotation-Invariant LiDAR-based Localization Method Based on Feature Pyramid and Vector Neural Network (Gengxuan Tian, 2024) View paper
    - Rotation in Remote Sensing and Aerial Imagery (1 papers)
    - [18] Remote Sensing Rotation Image Detection Based on Deep Learning (å□¨, 2024) View paper
    - Rotation in Physical Simulation and Scientific Computing (1 papers)
    - [20] Unsupervised protein-ligand binding energy prediction via neural euler's rotation equation (Jin, 2023) View paper
    - Rotation in Industrial Monitoring and Specialized Detection (5 papers)
    - [14] Analyzing the rotation trajectory in table tennis using deep learning (Li, 2023) View paper
    - [19] Convolutional neural network based fault detection for rotating machinery (Olivier Janssens, 2016) View paper
    - [21] Predicting Space Debris Rotation Using the Debris Rotation Prediction Network (DRPN) (Sagar Mankari, 2025) View paper
    - [26] Real-time barcode detection and classification using deep learning (Daniel Kold Hansen, 2017) View paper
    - [50] Moment-rotation estimation of steel rack connection using extreme learning machine (M. Shariati, 2019) View paper
- Rotation Robustness and Training Dynamics
    - Rotation Robustness in Pose Estimation and Classification (1 papers)
    - [46] Robust human pose estimation for rotation via self-supervised learning (Kimin Yun, 2020) View paper
    - Weight Decay and Rotational Equilibrium in Training (1 papers)
    - [39] Rotational Equilibrium: How Weight Decay Balances Learning Across Neural Networks (Kosson, 2023) View paper
    - Binary Neural Networks with Rotation Considerations (1 papers)
    - [43] Rotated binary neural network (Lin, 2020) View paper
- Multi-Task Learning and Specialized Network Architectures (3 papers)
    - [15] Contrastive generative self-supervised learning for 3d medical image segmentation (Lichun Zhang, 2024) View paper
    - [16] Automating multi-task learning on optical neural networks with weight sharing and physical rotation (Shanglin Zhou, 2025) View paper
    - [44] Neural Network-Based Ambiguity Resolution for Precise Attitude Estimation With GNSS Sensors (Raul de Celis, 2024) View paper
- Theoretical Foundations of Rotation Learning (1 papers)
    - [49] Deep Neural Networks for Rotation-Invariance Approximation and Learning (Charles K. Chui, 2019) View paper

## Narrative

Core task: rotation estimation and learning in neural networks. The field encompasses diverse approaches to handling rotational transformations in deep learning, organized into several major branches. One branch focuses on rotation equivariance and invariance, where architectures such as Steerable Filters[1] and Vector Field Networks[12] build in geometric symmetries to ensure consistent behavior under rotation. Another branch addresses rotation representation and parameterization, exploring continuous representations like Rotation Continuity[2] and specialized parameterizations including quaternions and special unitary groups. Additional branches cover rotation-based self-supervised learning (e.g., Predicting Image Rotations[8]), 6D pose estimation for objects and spacecraft (Spacecraft Pose Rendering[5], Spacecraft Rendezvous Pose[10]), relative camera pose estimation (Relative Camera Pose[22]), and specialized applications ranging from remote sensing to machinery fault diagnosis. Theoretical foundations and training dynamics form yet another branch, examining how networks learn and represent rotational structure.

Within the representation and parameterization branch, a particularly active line of work explores trade-offs between continuity, computational efficiency, and geometric fidelity. Some methods favor matrix-based representations analyzed through SVD Rotation Analysis[37] or address challenges with Unorthogonalized Matrices[6], while others adopt quaternion frameworks as in Quaternion Framework Pose[35]. SUPER[0] situates itself within the special unitary and quaternion parameterizations cluster, emphasizing structured algebraic representations that respect the manifold geometry of rotation groups. This contrasts with approaches like Rotation

Continuity[2], which prioritize smooth, continuous mappings for gradient-based optimization, and differs from works such as Neural Euler Rotation[20] that explore alternative angle-based parameterizations. The choice of representation remains an open question, balancing mathematical elegance, learning stability, and downstream task performance across the diverse application domains represented in this taxonomy.

## Related Works in Same Category

The following **1 sibling papers** share the same taxonomy leaf node with the original paper:

### 1. Algebraically rigorous quaternion framework for the neural network pose estimation problem

**Authors**: Chen Lin, Andrew J. Hanson, Sonya M. Hanson | **Year/Venue**: 2023 • IEEE International Conference on Computer Vision | **URL**: View paper

#### Abstract

The 3D pose estimation problem - aligning pairs of noisy 3D point clouds - is a problem with a wide variety of real-world applications. Here we focus on the use of quaternion-based neural network approaches to this problem and apparent anomalies that have arisen in previous efforts to resolve them. In addressing these anomalies, we draw heavily from the extensive literature on closed-form methods to solve this problem. We suggest that the major concerns that have been put forward could be resolv...

#### Relationship Analysis

Both papers belong to the Special Unitary and Quaternion Parameterizations category, focusing on algebraically rigorous frameworks for rotation representation using quaternions and special unitary matrices in neural networks. They overlap in addressing the quaternion double-cover problem and utilizing Wahba's problem formulations for rotation estimation. However, the original paper derives novel continuous representations (2-vec and QuadMobius) from special unitary matrix constraints and provides comprehensive solutions across stereographic and 3D formulations, while the candidate paper specifically focuses on resolving anomalies in quaternion-based neural network training through multi-valued training targets derived from Bar-Itzhack's rotation-to-quaternion map.

## Contributions Analysis

This paper presents **3 main contributions**, each analyzed against relevant prior work:

### Contribution 1: Multiple solutions to Wahba's problem via SU(2) yielding linear quaternion constraints

**Description**: The authors reformulate Wahba's problem using special unitary matrices SU(2) and derive multiple solutions (stereographic plane, 3D sphere, and Möbius approximation) that produce linear constraints on quaternion parameters, enabling efficient rotation estimation.

This contribution was assessed against **10 related papers** from the literature. Papers with potential prior art are analyzed in detail with textual evidence; others receive brief assessments.

#### 1. Quaternion attitude estimation using vector observations

**URL**: View paper

**Brief Assessment**

Quaternion Vector Observations[56] focuses on unified notation and algorithms for solving Wahba's problem, but does not demonstrate prior work on the specific SU(2) reformulation approach or the derivation of linear quaternion constraints through stereographic plane, 3D sphere, and Möbius approximation solutions.

#### 2. Experimental analysis of quaternion-based attitude estimation algorithms

**URL**: View paper

**Brief Assessment**

The candidate paper (Quaternion Attitude Analysis[60]) focuses on experimental analysis of quaternion-based attitude estimation algorithms. No full text context is provided for this candidate, preventing any comparison of technical approaches or assessment of whether it addresses SU(2) formulations or linear quaternion constraints for Wahba's problem.

#### 3. Attitude Estimation Algorithm Based on Quaternion Descriptor Kalman Filter

**URL**: View paper

**Brief Assessment**

Quaternion Descriptor Kalman[55] focuses on attitude estimation using Kalman filtering with quaternion descriptors, not on reformulating Wahba's problem through SU(2) matrices or deriving linear quaternion constraints from multiple solution approaches (stereographic plane, 3D sphere, Möbius approximation).

#### 4. Generalized linear quaternion complementary filter for attitude estimation from multisensor observations: An optimization approach

**URL**: View paper

**Brief Assessment**

Linear Quaternion Filter[57] focuses on complementary filter design for attitude estimation using gradient descent optimization on quaternion representations, not on reformulating Wahba's problem through SU(2) matrices or deriving multiple solution forms (stereographic plane, 3D sphere, Möbius approximation) that yield linear constraints on quaternion parameters.

#### 5. Bingham policy parameterization for 3d rotations in reinforcement learning

**URL**: View paper

**Brief Assessment**

Bingham Policy Parameterization[52] focuses on policy parameterization for reinforcement learning using the Bingham distribution, not on deriving multiple solutions to Wahba's problem via SU(2) with linear quaternion constraints.

#### 6. Multisensor attitude estimation: fundamental concepts and applications

**URL**: View paper

**Brief Assessment**

Multisensor Attitude Estimation[58] is a historical overview and textbook on attitude estimation methods. It does not present novel solutions to Wahba's problem using SU(2) or derive linear quaternion constraints as technical contributions.

### 7. Research on algorithms for multiâvector attitude determination

**URL**: View paper

**Brief Assessment**

Multivector Attitude Determination[53] is a survey paper reviewing existing algorithms (QUEST, SVD, FOAM, FLAE) for Wahba's problem. It does not present SU(2)-based formulations or derive linear quaternion constraints, focusing instead on traditional quaternion and matrix methods.

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### 8. A Closed-form Solution to the Wahba Problem for Pairwise Similar Quaternions

**URL**: View paper

**Brief Assessment**

Wahba Problem Solution[54] focuses on a closed-form solution for the special case of two vector observations using quaternion similarity and Sylvester equations, not on SU(2) reformulations or multiple solution methods yielding linear constraints on quaternion parameters.

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### 9. Attitude estimation of aircraft based on quaternion SRCKF-SLAM algorithm

**URL**: View paper

**Brief Assessment**

Quaternion SRCKF SLAM[59] focuses on applying square root cubature Kalman filtering to attitude estimation in agricultural drone navigation, not on deriving multiple solutions to Wahba's problem using SU(2) matrices or establishing linear quaternion constraints for rotation estimation.

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### 10. Fast linear quaternion attitude estimator using vector observations

**URL**: View paper

**Brief Assessment**

Quaternion Attitude Estimator[51] focuses on solving Wahba's problem through pseudo-inverse matrices and eigenvalue decomposition, not through SU(2) reformulation or stereographic projections as in the original paper.

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## Contribution 2: Two novel continuous representations for learning rotations in neural networks

**Description**: The authors introduce two new rotation representations for neural networks: 2-vec (a 6D representation based on optimal two-point rotation) and QuadMobius (a 16D representation based on Möbius transformations), both designed to improve rotation learning compared to existing methods.

This contribution was assessed against **10 related papers** from the literature. Papers with potential prior art are analyzed in detail with textual evidence; others receive brief assessments.

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### 1. Harmonic networks: Deep translation and rotation equivariance

**URL**: View paper

**Brief Assessment**

Harmonic Networks[74] focuses on circular harmonics for rotation equivariance in CNNs, not on continuous rotation representations for general neural network learning as proposed in the original paper's 2-vec and QuadMobius methods.

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### 2. Rotation-invariant feature learning via convolutional neural network with cyclic polar coordinates convolutional layer

**URL**: View paper

**Brief Assessment**

Cyclic Polar Coordinates[73] focuses on rotation-invariant feature learning through polar coordinate transformations for image classification, not on continuous rotation representations (like 2-vec or QuadMobius) for direct rotation estimation in neural networks.

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### 3. Smooth, exact rotational symmetrization for deep learning on point clouds

**URL**: View paper

**Brief Assessment**

Smooth Rotational Symmetrization[71] focuses on enforcing rotational equivariance for point cloud models through coordinate system ensembles, not on developing continuous rotation representations for neural network learning. The paper addresses symmetrization of existing architectures rather than proposing new rotation parameterizations like 2-vec or QuadMobius.

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### 4. Scene Representation Networks: Continuous 3D-Structure-Aware Neural Scene Representations

**URL**: View paper

**Brief Assessment**

Scene Representation Networks[76] focuses on continuous 3D scene representations for novel view synthesis and geometry learning, not on rotation parameterizations for neural networks. The paper does not address rotation representation learning.

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### 5. On the continuity of rotation representations in neural networks

**URL**: View paper

**Prior Art Analysis**

Rotation Continuity[2] demonstrates that continuous rotation representations for neural networks were proposed prior to the original paper's submission. The candidate paper presents a 6D representation based on Gram-Schmidt orthogonalization and a 5D representation using stereographic projection, both designed to address discontinuities in rotation learning. These representations were developed to solve the same fundamental problem: creating continuous mappings from representation space to rotation space that avoid the discontinuities present in quaternions and Euler angles. The candidate paper provides extensive theoretical analysis proving that 3D rotations require at least 5 dimensions for continuous representation, and validates these representations empirically on multiple tasks including pose estimation and inverse kinematics.

**Evidence**

Evidence 1 - **Rationale**: Both papers explicitly state they are proposing continuous representations for learning rotations in neural networks. The candidate paper demonstrates prior work establishing that quaternions and Euler angles are discontinuous, and proposes 5D and 6D continuous alternatives. - **Original**: this paper revisits the topic of rotation estimation through the lens of special unitary matrices. we begin by reformulating wahba's problem using su (2) to derive multiple solutions that yield linear constraints on corresponding quaternion parameters. we then explore applications of these constrain... - **Candidate**: in this paper , we advance a definition of a continuous representation, which can be helpful for training deep neural networks. w e relate this to topological concepts such as homeomorphism and embedding. w e then investigate what are continuous and discontinuous representations for 2d, 3d, and n-dim...

Evidence 2 - **Rationale**: The candidate paper explicitly presents a 6D continuous representation for 3D rotations using Gram-Schmidt orthogonalization, which the original paper acknowledges as prior work (zhou et al. 2019) when describing their 2-vec method. - **Original**: 2-vec the first is based on our formula for the optimal rotation from two unweighted observations and is denoted 2-vec. similar to the gram-schmidt map in zhou et al. (2019), 2-vec interprets a 6d output vector from a model as target 3d x and y axes (denoted bx, by). unlike the gram-schmidt method w... - **Candidate**: 6d representation for the 3d rotations: for the 3d rotations, case 3 gives us a 6d representation. the generalized cross product for bn in equation (7) simply reduces to the ordinary cross product b1 x b2. w e give the detailed equations in section b in the supplemental document. w e specifically not...

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### 6. Interpretable Rotation-Equivariant Quaternion Neural Networks for 3D Point Cloud Processing

**URL**: View paper

**Brief Assessment**

Quaternion Point Cloud[70] focuses on rotation-equivariant quaternion neural networks for 3D point cloud processing, not on continuous rotation representations for general neural network learning as in the original paper's 2-vec and QuadMobius methods.

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### 7. Topological Neural Networks go Persistent, Equivariant, and Continuous

**URL**: View paper

**Brief Assessment**

Persistent Topological Networks[75] focuses on topological neural networks for higher-order relational data and persistent homology descriptors, not on continuous rotation representations for neural network learning.

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### 8. SHE-MTJ based ReLU-maxÂ pooling functions for on-chip training of neural networks

**URL**: View paper

**Brief Assessment**

SHE-MTJ ReLU[77] focuses on spintronic hardware implementations of ReLU and max-pooling activation functions for neural networks, not on rotation representations or rotation learning methods.

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### 9. A multi-scale deep neural networks for early fault diagnosis in rolling ball bearings

**URL**: View paper

**Brief Assessment**

Multiscale Bearing Fault[72] focuses on fault diagnosis in rolling ball bearings using multiscale deep neural networks for mechanical engineering applications, not on rotation representations for neural network learning in computer vision or robotics contexts.

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### 10. Generalizing convolutional neural networks for equivariance to lie groups on arbitrary continuous data

**URL**: View paper

**Brief Assessment**

Lie Group Equivariance[69] focuses on equivariant convolutional architectures for general Lie groups on continuous spatial data, not specifically on rotation representations for neural network learning. The paper addresses group convolutions and equivariance properties rather than proposing novel rotation parameterizations like 2-vec or QuadMobius.

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## Contribution 3: Efficient methods for rotation estimation problems using linear quaternion constraints

**Description**: The authors develop efficient optimization methods leveraging their linear quaternion constraints for various rotation estimation tasks, including residual-based optimization, constrained optimization with axis priors, and closed-form solutions for the two-point case of Wahba's problem.

This contribution was assessed against **10 related papers** from the literature. Papers with potential prior art are analyzed in detail with textual evidence; others receive brief assessments.

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### 1. Attitude determination from vector observations: Quaternion estimation

**URL**: View paper

**Brief Assessment**

Quaternion Vector Determination[64] focuses on recursive Kalman filtering for quaternion estimation from vector observations, not on developing efficient optimization methods using linear quaternion constraints for various rotation estimation tasks as in the original paper.

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### 2. Depth-based efficient PnP: a rapid and accurate method for camera pose estimation

**URL**: View paper

**Brief Assessment**

Depth PnP[63] focuses on camera pose estimation (PnP problems) using depth information, not on developing general efficient optimization methods for rotation estimation using quaternion constraints as in the original paper.

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### 3. Analytical quaternion-based bias estimation algorithm for fast and accurate stationary gyro-compassing

**URL**: View paper

**Brief Assessment**

Quaternion Gyro Compassing[61] focuses on gyroscope bias estimation for stationary alignment in inertial navigation systems, not general rotation estimation optimization methods using quaternion constraints.

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### 4. An extended Kalman filter for quaternion-based orientation estimation using MARG sensors

**URL**: View paper

**Brief Assessment**

Extended Kalman MARG[65] focuses on real-time orientation estimation using MARG sensors with Kalman filtering, not on developing efficient optimization methods for general rotation estimation tasks using linear quaternion constraints.

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### 5. Comparing the Performance of Quaternion, Rotation Matrix, and Euler Angles Based Attitude PID Controllers for Quadrotors

**URL**: View paper

**Brief Assessment**

Quaternion PID Controllers[68] focuses on attitude control strategies for quadrotors using different rotation representations (quaternions, rotation matrices, Euler angles) for PID controller implementation, not on developing efficient optimization methods for rotation estimation problems using linear quaternion constraints.

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### 6. A linear Kalman filter for MARG orientation estimation using the algebraic quaternion algorithm

**URL**: View paper

**Brief Assessment**

Linear Kalman Quaternion[66] focuses on real-time orientation estimation from inertial sensors (angular rate, acceleration, magnetic field) using a linear Kalman filter with quaternion representation. The original paper addresses general rotation estimation problems with novel linear quaternion constraints derived from special unitary matrices, including solutions to Wahba's problem and various optimization methods. These are fundamentally different problem domains and methodological approaches.

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### 7. Fast linear quaternion attitude estimator using vector observations

**URL**: View paper

**Prior Art Analysis**

Quaternion Attitude Estimator[51] demonstrates that linear quaternion constraints for rotation estimation were developed prior to the original paper. The candidate paper presents a linear approach to Wahba's problem that establishes linear constraints on quaternion parameters through pseudo-inverse matrices, enabling efficient rotation estimation. The candidate explicitly derives linear quaternion constraints and applies them to various rotation estimation scenarios including residual-based optimization and closed-form solutions for the two-point case, which directly overlaps with the original paper's claimed contributions.

**Evidence**

Evidence 1 - **Rationale**: Both papers claim to develop linear approaches to rotation estimation using quaternion constraints. The candidate paper explicitly states its contribution as deriving a linear approach with quaternion constraints, predating the original paper's similar claim. - **Original**: Our previous general solutions are notably distinct from other methods as they allow for the principled construction of linear constraints (eqs. (11) and (18)) on quaternion parameters. We discuss some applications and desirable properties of these results. - **Candidate**: based on (17), it is able to find one reasonable solution to the system. identically, the solution belongs to the optimal quaternion of the wahba's problem. following such motivation, this paper mainly contributes on the issues below: 1) the linear approach to (17) is derived, where pseudoinverse mat...

Evidence 2 - **Rationale**: Both papers derive linear constraints on quaternion parameters for efficient rotation estimation. The candidate paper's equation (44) establishes a linear constraint system similar to the original paper's equations (11) and (18). - **Original**: while wahba's problem admits a direct solution, many related rotation estimation tasks require iterative methods. these often involve repeatedly evaluating per-observation losses for a candidate quaternion. examples include alternative loss functions like the absolute chordal metric ( l1 distance) o... - **Candidate**: expand the equation with transpose operation, we obtain pt 1 ht x + pt 2 ht y + pt 3 ht z -q = 0 ⇔(w -i)q = 0 (44) where w's elements are given by w1,1 = hx1 + hy2 + hz3 w1,2 = -hy3 + hz2 w1,3 = -hz1 + hx3 w1,4 = -hx2 + hy1

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### 8. A general framework for constrained convex quaternion optimization

**URL**: View paper

**Brief Assessment**

Constrained Quaternion Optimization[67] focuses on general convex quaternion optimization with widely affine constraints, not specifically on rotation estimation problems or Wahba's problem formulations.

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### 9. An Observation Model From Linear Interpolation for Quaternion-Based Attitude Estimation

**URL**: View paper

**Brief Assessment**

Linear Interpolation Observation[62] focuses on attitude estimation using Kalman filters with MARG sensors and linear interpolation between QUEST and FQA algorithms, not on developing efficient optimization methods leveraging linear quaternion constraints for various rotation estimation tasks.

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### 10. Algebraically rigorous quaternion framework for the neural network pose estimation problem

**URL**: View paper

**Brief Assessment**

Quaternion Framework Pose[35] focuses on neural network pose estimation using quaternion theory and multi-valued training targets, not on developing efficient optimization methods leveraging linear quaternion constraints for various rotation estimation tasks.

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## Appendix: Text Similarity Detection

No high-similarity text segments were detected across any compared papers.

## References


- [0] Special Unitary Parameterized Estimators of Rotation View paper
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