An Approach for Computing the Euclidean Motions on the Base of Measurement Data

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Abstract. Here it is shown that by coordinating any three non-collinear points in the dynamic and the inertial Cartesian frames, measured through different technical devices, it is possible to develop via the so-called vector-parameter (known also as Rodrigues or Gibbs vector) both numerical and analytical algorithms for computing the position and orientation of the rigid body in the three-dimensional Euclidean space. This study can be viewed also as an example of interesting application of the SO(3) group representations to practical problems.

Keywords: SO(3) group, parameterizations of rotation motions, spacecraft dynamics, mechanisms, robotics, biomechanics
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INTRODUCTION

The way of describing the motions of bodies in the inertial space using a rotating and translating of a noninertial frame of reference (see [1]-[12], etc.), called also the movable dynamic frame, is very important in many areas like vehicle and spacecraft dynamics, mechanisms, robotics and biomechanics, etc. [14], [15], [16]. Recently, a lot of efforts have been made in order to include also the flexibility of bodies in parallel with that one established within rigid body dynamics. In this study a method of computing the position and orientation of the movable Cartesian frame with respect to the Cartesian inertial frame, which have been coordinated in both frames, is presented and verified using three non-collinear points. The orientation is obtained through vector-parameters which are elements of a Lie group with a nice and clear composition law. An analytical procedure for solving this problem is successfully realized. In order that the transformation SO(3) matrix between the above frames be found, a number of different sets of parameters can be used. These sets of parameters are quite different according to the physical interpretation, the presence of singularities, the use of trigonometric or purely algebraic functions, the number of accompanying constraint equations, etc. In this aspect, because of the complex composition law of the standard parameterizations of SO(3) group by Eulerian or Bryant angles, quaternions, Cayley-Klein parameters, and etc., the present work aims to present a set of parameters for finite rotations and translations through a set of parameters having easy physical interpretation, see [13].

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