

## EDUCATIONAL 5 AXIS ROBOT CONTROLLER OPTIMIZATION USING ARM HARDWARE INSTRUCTIONS

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**Rezumat.** Această lucrare își propune să prezinte o metodă de programare a unui controller de tip Raspberry Pi pentru un braț articulată cu 5 axe. Scopul este optimizarea cinematicii directe, bazându-se pe o abordare universală. Înmulțirea matricelor este implementată folosind instrucțiuni de hardware prezente în standardul ARM. Avantajul principal al acestei metode este viteză mai mare de programare, ceea ce oferă viteză mai mare de reacție robotului. Cu ajutorul unui set de instrucțiuni creat în acest scop se asigură programabilitatea brațului robotic.

**Abstract.** This paper presents a programming method of a Raspberry Pi controller for a 5-axis articulated arm robot. The goal is optimization of direct kinematics calculations, based on the universal approach for direct kinematics method. Matrix multiplication is implemented using ARM hardware instructions. The main advantage of this method is lower computation time, which means faster robot response time. Programmability of the robot is done by means of a custom-made instruction set, called RASM.

**Keywords:** Robot, Programming, Hardware instruction

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### 1. Introduction

Modern advancements in technology have allowed broad access to technology. This is beginning to show even in the domain of Robotics, where more and more kits are becoming readily available. This availability allows students to study and understand the key aspects of industrial robotics, without the need to access prohibitive or specialized hardware. Using one such kit, the possibility of creating a scaled-down but otherwise analogous 5 degree of freedom robot arm was approached. The focus was the robot firmware, in other words the underlying software that allows the robot to function.

### 2. RASM – The Robot Assembler

One of the goals of this research was development of a custom programming language, in order to allow advanced control of the device. By definition, a robot must be programmable, so as to be able to perform certain actions in a definite,

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