# Modeling and control of an object recognition system with delta robots in CoppeliaSim

Ormanbekova A., Fazylov N., Zhumakhan N., Doszhanov O., Julayeva Zh.

Almaty technology university furkat str. 348/4, 050000 Almaty, Kazakhstan

Annotation

This study is a modular simulation-based system designed to develop and analyze the operation of a sorting system with object recognition (blob detection) in the CoppeliaSim environment. The system includes a conveyor belt, machine vision for object recognition, and two delta robots that perform automatic sorting. The paper describes the architecture of the system, provides basic control scripts in the Lua language, and performs a performance analysis based on a series of controlled experiments. The results show that there is a trade-off between conveyor speed and sorting accuracy. A comparison with physical delta robots was also performed to assess the realism of the simulation and its suitability for industrial applications.

Keywords: object recognition, CoppeliaSim simulation platform, take-and-put manipulation, delta robots, modeling, automation of industrial processes.

Introduction

Today, many factories and production lines are actively switching to full automation. This means that instead of doing all the work manually, people are now assisted by robots and "smart" machines — they assemble parts, pack products, move boxes and other operations. One of the most common tasks for such robots is the so-called "pick-and-place" — to find an object, grab it and move it to another location. For example, imagine that colorful cubes are moving along a conveyor belt. A robot with a camera looks at these cubes, determines their color, decides where to send which cube, and then captures them and puts them in the appropriate boxes. This is exactly what the pick-and-place system does. Such systems allow factories to work faster, reduce the number of errors related to the human factor, and operate around the clock without interruptions and fatigue. In recent decades, industrial robotics has undergone radical changes, from machines that needed to be manually programmed to intelligent autonomous systems capable of making decisions in real time.

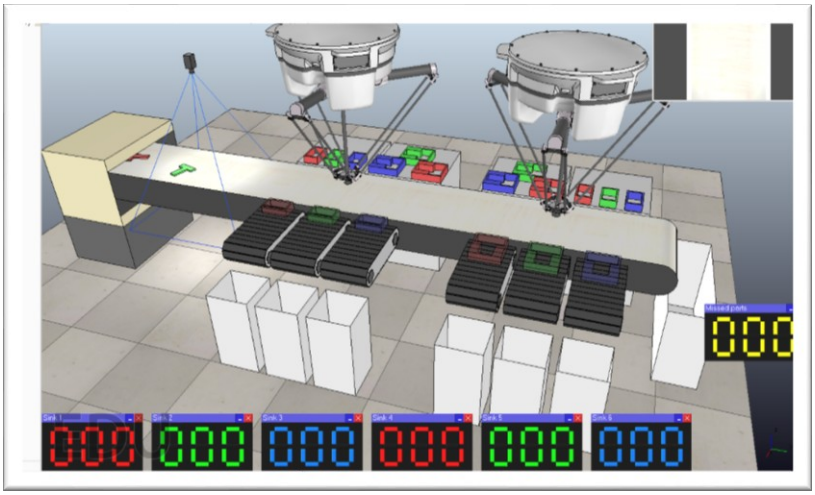

Figure 1. General view of the blobDetectionWithPickAndPlace simulation scene in the CoppeliaSim environment.

Experiments

We offer a multi-level architecture that includes combining data from various sensors (sensor fusion), real-time control algorithms, and machine learning modules. All this makes it

possible to increase the level of autonomy, reliability and efficiency of industrial robots. Our experiments and simulations show that the proposed management strategies can significantly increase the productivity of robotic operations, even in conditions of variable industrial tasks.

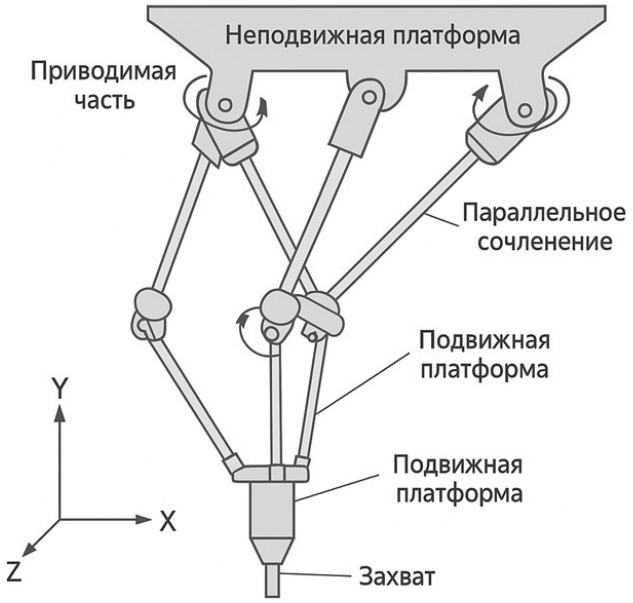


Figure 3 Kinematic diagram of delta operation

The kinematics of a delta robot is a way to understand how it moves and how its structure works. It has a fixed part on top — a platform that is attached to the frame and does not move anywhere. Three motors are mounted on it, and each motor moves its "arm" down. These motors have long levers that connect to other, lighter levers. These levers are connected to a movable platform at the bottom. It turns out that this lower platform has three attachment points, and each of them is connected to the upper levers. Thanks to this device, the lower part can quickly move up and down, left and right, forward and backward - but it does not rotate around its axis.

Discussion

The simulation results showed a significant difference in the behavior of the system before and after the application of optimization measures. Before the changes were made, the number of missing parts increased exponentially, which indicated the inconsistency of the current control configuration with increasing load. The rapid increase in the number of errors indicates that the system was losing its ability to respond to incoming objects in a timely manner, and the robots did not have time to capture them. This is due to both movement dynamics limitations (insufficient speed and acceleration parameters) and lack of coordination between the two manipulators, which led to conflicts or inaction.

Conclusion

The simulation we developed shows that even a relatively simple system consisting of a camera, a color recognition module, and two robotic arms can effectively perform useful tasks under appropriate conditions. In our case, the system was able to recognize the red, green, and blue cubes moving along the conveyor and sort them into their respective boxes. At first glance, such a task may seem insignificant, but in practice it is very common in real factories and warehouses. One of the most important observations was that the system works very well when the environment is clean and predictable. With good lighting, a uniform distance between objects and a stable conveyor speed, robots can handle tasks easily.

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**Ormanbekova Ainur Alibekovna**, PhD, Associate Professor, Almaty Technological University, Almaty, Kazakhstan. Email: ain_25@mail.ru

**Fazylov Nurtalap Nurlanuly**, Master's student, Almaty Technological University, Almaty, Kazakhstan. Email: fnurtalap@bk.ru

**Doszhanov Ospan Matkarimovich**, Assistant Professor, Almaty Technological University, Almaty, Kazakhstan. Email: ospan.doszhanov@mail.ru

**Zhulayeva Zhazira Tulegenovna**, Senior Lecturer, Almaty Technological University, Almaty, Kazakhstan. Email: Zhazj@mail.ru


## МОДЕЛЮВАННЯ ТА КЕРУВАННЯ СИСТЕМОЮ РОЗПІЗНАВАННЯ ОБ'ЄКТІВ ІЗ ЗАСТОСУВАННЯМ ДЕЛЬТА-РОБОТІВ У СЕРЕДОВИЩІ COPPELIASIM


**Анотація**

*У цьому дослідженні представлено модульну симуляційну систему, призначену для розробки та аналізу роботи системи сортування з розпізнаванням об'єктів (визначення плям) у середовищі CoppeliaSim. Система включає конвеєрну стрічку, машинне бачення для розпізнавання об'єктів та два дельта-роботи, які здійснюють автоматичне сортування. У роботі описано архітектуру системи, наведено базові керувальні скрипти мовою Lua та проведено аналіз продуктивності на основі серії контрольованих експериментів. Результати демонструють компроміс між швидкістю руху конвеєра та точністю сортування. Також виконано порівняння з фізичними дельта-роботами з метою оцінки реалістичності моделювання та його придатності для промислових застосувань.*



**Ключові слова:** розпізнавання об'єктів, платформа моделювання CoppeliaSim, маніпулювання «взяти-покласти», дельта-роботи, моделювання, автоматизація промислових процесів



**Орманбекова Айнур Алібеківна**, PhD, доцент, Алматинський технологічний університет, м. Алмати, Казахстан, ain_25@mail.ru

**Фазилов Нурталап Нурланұлы**, магістрант, Алматинський технологічний університет, м. Алмати, Казахстан, fnurtalap@bk.ru

**Досжанов Оспан Маткаримович**, асистент-професор, Алматинський технологічний університет, м. Алмати, Казахстан. Email: ospan.doszhanov@mail.ru

**Джулаєва Жазира Тулегенівна**, старший викладач, Алматинський технологічний університет, м. Алмати, Казахстан, Zhazj@mail.ru