Identificazione delle cause di micro fermate e Recupero autonomo nelle Macchine automatiche di confezionamento

Short-latency Stop Identification and Autonomous Recovery in Automatic Machines for Packaging

Project description

This project will investigate the automatic identification and recovery of short-latency stops occurring in automatic machines for packaging.

The most common causes of short-latency stops are (in order of frequency):

- blank misalignment or lack of packaging material in the forming zone;
- failed box transfer;
- double blank extraction.

Table 1 reports, in particular, data about the average frequency of the short-latency stops in a tea packaging machine, provided by the company IMA, partner of the project and world leader in the manufacture of automatic machines for packaging of pharmaceuticals, cosmetics, food, tea and coffee. The time necessary to solve the problem is evaluated considering how long the machine alarm lasts, therefore it also includes the time the machine waits for the operator arrival. Short-latency stops are usually solved by removing the blocked bag/blank or by cleaning the sensors (for instance photocells).

<table>
<thead>
<tr>
<th>Number of failures per day</th>
<th>Blank misalignment/lack in the forming zone</th>
<th>Failed box transfer</th>
<th>Double blank extraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to solve the problem (min)</td>
<td>10</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>1,3</td>
<td>2,2</td>
<td>1,5</td>
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</tbody>
</table>

Table 1: Average frequency of short-latency stops and average time to solve them.

This project will study the design and development of a vision system that is supposed to be integrated with a mobile cobot in charge of automatically loading and unloading raw packaging material in a tea packaging machine provided by IMA.

The vision system is supposed to help automatizing some of the recovery actions ordinarily performed by human operators when short-latency stops occur.

Specifically, the project goals are:

- identifying the cause of the short-latency stop among the three aforementioned cases;
- giving directives to the cobot to perform recovery actions;
- notifying the operator in case of exception (unidentified problem or impossibility to autonomously solve it).

The vision system will mainly rely on an on-board camera mounted on the end-effector of the cobot. The collaborative robot will consist of a flexible robotic system based on an autonomous mobile vehicle equipped with a lightweight compliant robotic arm.
The project will also investigate the possibility of applying static markers and/or perform minor, non-invasive modifications of the packaging machine in order to maximize the effectiveness and efficiency of the task.

**Plan of activities**

In order to achieve the project goals, the following operations are to be addressed:

- **Identification of the cause of the short-latency stop among the three aforementioned cases:**
  1. study of the problem records and corresponding empirical phenomena
  2. collection of image samples depicting the problem
  3. training of a vision-based software tool for automatic identification and classification of the problem
  4. testing new samples, not included in the training set

- **Generation of directives to the cobot to perform recovery actions:**
  1. preliminary learning phase to understand how to control the cobot trajectories and movements
  2. design of a strategy to control the robot position for the observation phase
  3. integration of the vision-based software tool with the robot firmware
  4. design of a strategy to control the robot motion for the recovery action

- **Notification to the operator in case of exception:**
  1. error management and description
  2. development (or extension) of a notification system
Breve descrizione dell'attività di ricerca (in italiano)

Il progetto ambisce a sviluppare un sistema di visione artificiale per il riconoscimento del tipo di errore alla base di una micro-fermata di una macchina automatica per l'imballaggio del tè. Questo progetto intende sviluppare tecnologie che forniscono ai robot industriali caratteristiche che consentano di identificare condizioni di errore (computer vision, machine learning) nonché di posizionare e manipolare oggetti in ambienti angusti (manipolazione, pianificazione di traiettoria).

Brief research activity description (in English)

The project aims at developing a computer vision system for the identification and classification of the type of error causing a short-latency stop in a tea packaging machine. This project will develop technologies providing industrial robots with features that allow identifying error scenarios (computer vision, machine learning) as well as positioning and manipulating objects in narrow environments (manipulation, trajectory planning).