ALMA MATER STUDIORUM – UNIVERSITÀ DI BOLOGNA

Corso di Laurea in Ingegneria e Scienze Informatiche

Sistema di visione artificiale per la rilevazione e posa di marker ArUco sviluppato in Java

Tesi di laurea in:
Programmazione ad oggetti

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Sommario

Max 2000 characters, strict.

Optional. Max a few lines.

Indice

Elenco delle figure

List of Listings

Capitolo 1

Introduction

Write your intro here.

Bacchini Lorenzo: Add sidenotes in this way. They are named after the author of the thesis

You can use acronyms that your defined previously, such as **IoT!** (**IoT!**). If you use acronyms twice, they will be written in full only once (indeed, you can mention the **IoT!** now without it being fully explained). In some cases, you may need a plural form of the acronym. For instance, that you are discussing **vm!**s (**vm!**s), you may need both **vm!** and **vm!**s.

Structure of the Thesis

Bacchini Lorenzo: At the end, describe the structure of the paper

Capitolo 2

Background

2.1 Visione artificiale

2.1.1 Cos'è la visione artificiale?

Quando parliamo di visione artificiale o computer vision stiamo considerando un insieme di processi e tecniche che hanno come scopo finale quello di trasformare degli input (solitamente foto o video [1]) in una serie di informazioni utili al calcolatore che possono poi essere utilizzate per prendere decisioni in maniera autonoma, analizzare una situazione o addirittura creare una rappresentazione del mondo reale 3D che ci circonda. [BK08] [Mic]

Quanto sopra descritto non è troppo diverso da ciò che i nostri occhi fanno tutti i giorni, ed infatti la visione artificiale nasce proprio per permettere al calcolatore di "vedere" esattamente come un essere umano, in modo da poter interagire con l'ambiente circostante.

2.1.2 Come funziona la visione artificiale?

Il processo di visione artificiale può essere suddiviso tre fasi principali:

1. Rilevazione di un immagine

2. Interpretazione e analisi dell'immagine

[1] gli input potrebbero essere anche generati da scanner, sensori LiDaR, radar ecc.

3. Richiesta di informazioni sull'immagine analizzata

Nella fase di rilevazione come sopra citato è possibile utilizzare diversi tipi di strumenti come fotocamere o videocamere, ma è nella fase centrale che il processo può differire maggiormente, infatti, l'interpretazione dell'immagine viene effettuata secondo algoritmi che possono essere anche molto diversi in base al loro scopo, negli ultimi anni inoltre si stanno facendo largo nuove tecnologie [2] come l'intelligenza artificiale, il machine learning e il deep learning per poter intraprendere decisioni e svolgere compiti in modo autonomo senza il bisogno dell'intervento umano.

2.1.3 Applicazioni e finalità

Alcune applicazioni della visione artificiale sono le seguenti:

- Classificazione di immagini
- Identificazione di oggetti
- Suddivisione di immagini in sezioni da analizzare
- Riconoscimento facciale
- Rilevazione e riconoscimento dei sentimenti in una immagine
- Ricostruzione di ambienti 3D
- Guida autonoma

La lista dei possibili utilizzi è ovviamente molto vasta ma quelli riportati sopra sono tra i più gettonati sia in ambito professionale che di ricerca.

2.1.4 Principali criticità

Tutte le operazioni che caratterizzano un sistema di visione artificiale possono essere largamente influenzate da una serie di condizioni interne o esterne con il risultato che il nostro sistema potrebbe non operare come previsto.

[2] con il termine nuove non si intende che tecnologie come l'intelligenza artificiale o il machine learning siano state sviluppate negli ultimi anni ma che iniziano ad essere prese sempre più in considerazione nell'ambito della visione artificiale

Un esempio di condizioni esterne che possono influenzare il comportamento del nostro sistema sono sicuramente l'illuminazione, la prospettiva ed eventuali occlusioni dell'immagine in input, che possono portare ad una maggiore difficoltà di rilevazione e riconoscimento, per quanto riguarda invece i parametri interni possiamo considerare la risoluzione della camera che stiamo utilizzando, l'algoritmo di elaborazione e la complessità (in termini numero di pixel da elaborare) dell'immagine ottenuta, come parametri che possono variare anche di molto la velocità e la precisione del nostro sistema.

2.1.5 Cenni storici

I primi articoli prodotti riguardanti la visione artificiale risalgono agli anni '60 dove però l'idea di poter acquisire immagini ed elaborarle, facendone comprendere il contenuto all'elaboratore era ancora troppo precoce per l'hardware a disposizione, solo intorno agli anni '80 si sono iniziati a vedere i primi sviluppi significativi grazie all'introduzione della trasformata di Hough e dei primi algoritmi di riconoscimento ottico dei caratteri (OCR - optical character recognition). Dagli anni '90 sino ai primi anni '00 l'attenzione si è spostata sullo sviluppo di algoritmi di machine learning, questo ha permesso nel 2001 di sviluppare il primo algoritmo di riconoscimento facciale.[Tea]

Ad oggi la visione artificiale adotta tecniche e processi completamente differenti rispetto a quelli visti nei suoi primi anni di sviluppo, facendo largo uso di reti convoluzionali e dell'intelligenza artificiale (ormai largamente utilizzabile grazie alla sempre crescente potenza di calcolo a disposizione) che le permettono non solo di essere più veloce ma anche di garantire una precisione dei risultati molto maggiore grazie anche al vasto numero di dati a disposizione.

2.2 Marker fiduciari

I marker fiduciari sono degli oggetti che posti all'interno del campo visivo di una fotocamera possono essere utilizzati come punto di riferimento.

Gli scopi principali di questi marker sono sicuramente la calibrazione della camera, la localizzazione, il tracking e la rilevazione di oggetti.

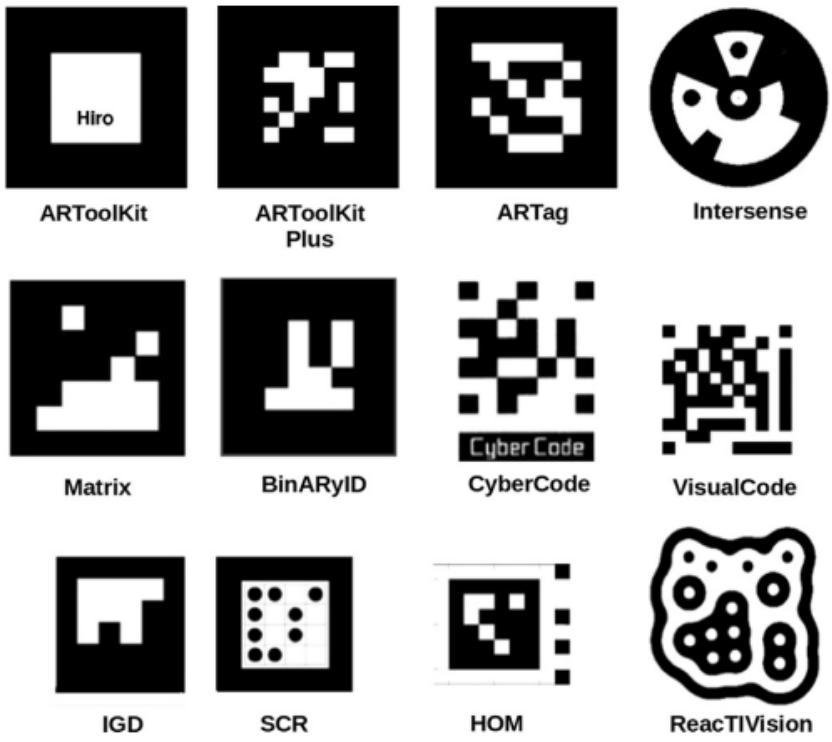

Figura 2.1: Marker fiduciari[GJMSMCMJ14]

Alcuni possibili tipi di marker fiduciari sono riportati nella figura 2.1:

2.2.1 Applicazioni

- **Fisica**: per ottenere posizione e riferimenti di oggetti
- **Realtà aumentata**: utilizzano i marker come "ancore" così da sapere dove posizionare gli elementi virtuali nel mondo reale
- **Circuiti stampati**: identificano dei pattern così che i macchinari possano operare sui circuiti autonomamente

2.2.2 ArUco markers

I marker ArUco sono una tipologia di marker fiduciari binari molto utilizzata in ambiente di visione artificiale, proprio il nome ArUco sta ad indicare: "Augmented

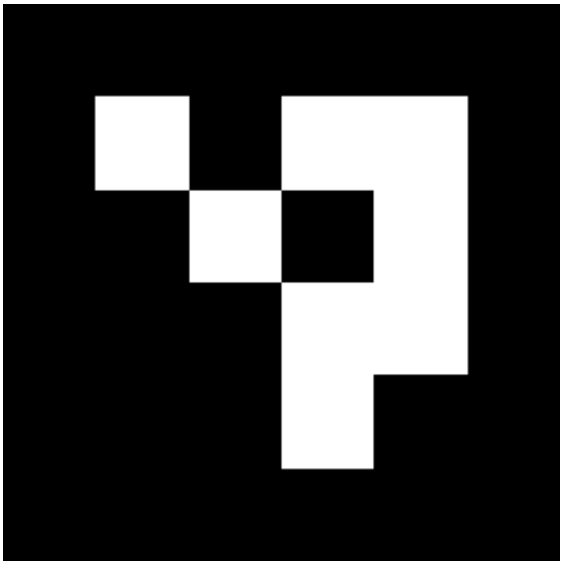

Figura 2.2: ArUco Marker 4x4 id: 0

Reality University of Cordoba".

La caratteristica principale di questo tipo di marker risiede nel fatto di essere estremamente versatile, come è possibile infatti vedere dalla figura 2.2 all'interno del marker abbiamo dei quadrati bianchi e neri che identificano univocamente il marker stesso, il numero di quadrati sulle righe e quindi sulle colonne (i marker ArUco sono sempre di forma quadrata) sono definiti in base al dizionario

Dizionario

Ogni ArUco marker appartiene ad un dizionario il quale specifica la dimensione del marker e la disposizione interna dei quadrati bianchi e neri, modificando il dizionario possiamo ottenere marker più grandi e complessi che consentono rilevazioni più precise, riducendo la possibilità di confondere tra loro due marker simili, d'altro canto utilizzando marker più piccoli e semplici, nonostante si vada in contro ad una riduzione della precisione, si guadagna in velocità di elaborazione.

parla della rotazione

[Min]

2.3 OpenCV

Capitolo 3

Analisi

Capitolo 4

Design

Capitolo 5

Implementazione

Capitolo 6

Valutazione

Capitolo 7

Conclusioni

Capitolo 8

Sviluppi futuri

Capitolo 9

Ringraziamenti

I suggest referencing stuff as follows: fig. 9.1 or Figura 9.1

9.1 Some cool topic

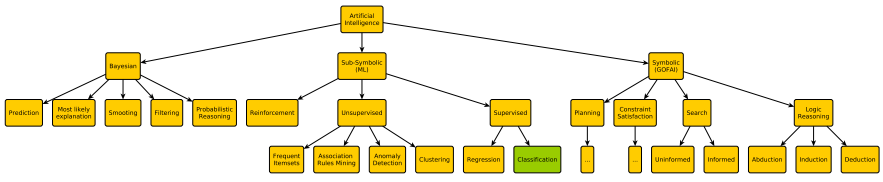

Figura 9.1: Some random image

Capitolo 10

Contribution

You may also put some code snippet (which is NOT float by default), eg: capitolo 10.

10.1 Fancy formulas here

```
public class HelloWorld {
  public static void main(String[] args) {
    // Prints "Hello, World" to the terminal window.
    System.out.println("Hello, World");
  }
}
```

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