CSC720 Artificial Intelligence 2
Project Proposal
Find Bahler

Leveraging COTS components to realize realtime facial detection and recognition in *Lego: Mindstorm NXT Robots*

Benjamin Wheeler and Chung-Wei Hang
Department of Computer Science
North Carolina State University
bmwheeler@ncsu.edu, chang@ncsu.edu

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1 Purpose

The purpose of this project is to combine facial detection and facial recognition techniques, creating robots that can identify people in realtime.

2 Motivation

To physically implement pattern recognition algorithms in Commercial Off The Shelf (COTS) components, in effect providing rational to buy a cool toy.

3 Background

3.1 Algorithms

Facial recognition has been an important application of pattern classification for decades. Many classification algorithms described in textbook have been used, for example, Principle Components Analysis (PCA) and Fisher's Linear Discriminant.

To recognize faces under variations, such as lighting and poses and facial expressions, is the most challenging issue in this area. In order to deal with such variations of faces, it is helpful to extract useful features from original samples, which means to reduce high-dimensional image space to a lower dimension feature face. One famous method is linear projection, to project away variations but maintain useful features. Eigenfaces[2], Fisherfaces[2] , and Laplacianfaces[3] are three well-known methods dealing with such variations.

However, it is not easy to apply facial recognition to real-world application, since, in real cases, machines do not have the ability to detect faces or humans from what they see. These facial recognition methods cannot be implemented if given samples are normal pictures rather than faces. What we need is a way to pick "faces out of a crowd." Such a method is described by Viola and Jones[5], who proposed an efficient method of facial detection for realtime applications.

3.2 Hardware

Lego Mindstorms[4] were first released as the Robotics Invention System (RIS) by the Lego Corporation in partnership with the MIT Media Laboratory in 1998 as part of the Lego Educational Products Department. It was sold in both a commercial and educational model, included a GUI-based programming interface, and provided for one of the first times affordable, programmable, and highly adaptable robots to the general public. For years these "toys" have been used both for fun and education by children and adults, to learn, teach, and just have fun with robotics. At it's heart is an "intelligence brick", essentially a mini-computer with three sensor input ports and three motor output ports. The strength of the system relied on the ability to combine specialized parts with standard Lego components to make countless possibilities achievable using the RIS.

In August 2006 Lego released the next (NXT) generation of *Lego Mindstorms*[4], providing more functionality, a bigger, faster, more capable "intelligence brick", an open source standard, and USB 2.0, bluetooth compatibility. At it's heart is a 32 bit ARM7 main microproccessor (48 MHZ) and 8 bit Atmel AVR microcontroller (4MHZ), each with onboard flash memory and RAM. It currently supports 4 sensor input ports, and three output ports, with capability for extension[6]. Currently, the full capabilities of this new platform have yet to be fully realized, with future component releases planned to add even greater possibilities.

4 Approach

We will use Fisherfaces[2] and CMU PIE database[1] to train our facial classifier, and use Viola and Jones[5] method to detect and recognize face in realtime.

5 Deliverable

Goal Robot can *search* a room and *locate* a single individual from several, given previously only picture representations. Here are sub-points:

- Robot must distinguish *goal items* (people) from non-goal items (tables, chairs, etc).
- Robot must distinguish identifying traits of *goal items* to differentiate and select correct item.
- Selection will be made by *pointing* to the object to be identified.

We will achieve this by controlling the *Lego Mindstorm* robot via a blutooth interface with a mainstation PC, to take advantaged of the increased processor power for computation of digital imagery. Possible extensions to this project include "tracking" moving goal objects, moving image processing "on robot", and shooting soft projectiles at identified goal objects.

References

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