Interface to Interact with Physical World using Human Gesture

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ABSTRACT: The aim of this project is to develop an interface that can be used to connect the digital world with physical. By using the proposed system user can interact with system by making simple hand-gestures. There by the user is not bound to use any specific hardware making him free from the limitations and bounds set by these interfaces. The software takes video stream as input and seeks for the predefined gesture. When it recognizes that a gesture is made it process and stimulates the appropriate action associated with that particular gesture i.e. it collects information about the object & stores it into database. All that user needs is a device integrated with camera that can sense hand-gestures and a processor that process it into appropriate actions.

Keywords: OpenCV, MS-VS2010, object detection & recognition, gesture recognition, Information Retrieval.

I. INTRODUCTION

Any computational system having three major parts

1. Input
2. Processing Unit
3. Output

System takes inputs, process them & generate particular information i.e. Output. This output is further used by the user. For such a Input & Output purpose many devises are used like keyboard, mouse for input purpose & monitor, printer for output purpose. After these hardware devices touch pad, virtual keyboards are used as input device. These traditional devices are must be connected to the system via wired media or wireless media. These required complex electronic devices that increases cost of devices, also these devices are not so efficient to use for the users which does not know about the system.

The project bridges this gap. It uses natural hand gestures as an input device. Any mankind can make simple gestures to perform any action. The device is basically a wearable gestural interface that connects the physical world around with digital information and let’s uses natural hand gestures to interact with this information. It implements a gestural camera that takes photos of the scene the user is looking at by detecting the ‘framing’ gesture. The user can stop by any surface or wall and flick through the photos he/she has taken. For example, if user put any product in mall then it will project all information about that product.

Computer vision:

Computer vision is used to make useful decisions about real physical objects and construction of meaningful description of object from picture or sequence of pictures.

Objectives of computer vision:

- **Segmentation**: Segmentation is breaking images and video into meaningful pieces.
- Reconstructing the 3D world from multiple views, shading and structural models
- **Recognition**: Recognizing objects in a scene
- **Control**: To control obstacle avoidance, robots, machines, etc.

The proposed system is based on Computer vision to fulfill Recognition objective of Computer vision and sees what user see but it lets out information that user want to know while viewing the object.
II. RELATED WORK

For Hand Gesture recognition & interaction systems there are mainly two phases hand detection and gesture recognition.

A) Hand Detection & Gesture Recognition:

There are many different approaches for hand detection. The straightforward way for the hand detection is to look for skin color region in the image. But skin color classification is difficult because it can also detect other body parts as a hand in the image. The use of markers attached to users hand can provide reliable detection therefore the proposed system uses red color strip on fingertip. The interface uses camera to track the movement of hand & recognizes gesture.

In computer interfaces, two types of gestures are distinguished.

- Offline gestures: Offline gestures are the gestures after performing these gestures menu gets activated. For example, if circle gesture is performing, image gets captured by camera.
- Online gestures: These gestures are used to rotate or resize the object.

In the proposed system offline gestures are used.

Steps for Gesture Recognition:

A. User moves finger having red strip and draws a conceptual sign in front of camera.
B. Finger movement of user is extracted from camera input stream. 
C. From that tracked hand movement conceptual meaning of gesture is determined.

B) Object detection:

Object detection is nothing but the localization of the object in input image. In the proposed system for the object detection, the technique SAD (Sum of Absolute Difference) is used. The sum of absolute difference is used as simple way for searching objects inside an image but it may be unreliable because of effect of factors like change in lighting, viewing direction, color, shape, size. SAD can be used in conjunction with other object recognition methods like edge detection to improve reliability of result. This algorithm measures similarity between image blocks. It first takes absolute difference between each pixel in original image and corresponding pixel in image which used for comparison and these differences are summed to create simple metric block similarity. Due to simplicity SAD is extremely fast metric. It is effectively the simplest possible metric that takes into account every pixel in a block. Therefore it is very effective for a wide motion search of many different blocks.

C) Information Retrieval:

There is some difference between information retrieval system and database system.

Information retrieval system works on unstructured data while database system works on structured data. Inverted index that is index of entries is used by information retrieval system. Main data structure used in database system is relational tables which have defined value for each row and column. Therefore database system work on data which is related to each other.

When user request for data, Information retrieval process is used to represents, search and stores collection of data for knowledge discovery. An object is an entity that is represented by information in a database. An information retrieval process begins when a user enters a query into the system. Queries are formal statements of information needs, for example search strings in web search engines. In information retrieval a query does not uniquely identify a single object in the collection. Instead, several objects may match the query, perhaps with different degrees of relevancy. User queries are matched against the database information. Depending on the application the data objects may be text documents, images, and audio.
III. WORKING

The proposed system contains mainly two modules.

1. Recognition of Gesture.

2. Detecting Object & Information Retrieval.

Module 1: Recognition of Gesture:

User performs hand gesture in front of camera. Camera takes each frame and finds red color block of strip on finger in each frame. If colored block found then, it calculates its area and if the area is greater than 1000 then it calculate x & y coordinates of center point of that block. Area is calculated because image may contain another color block but it may be relatively smaller than our red strip on finger. After that system draws line from new point to previous one and checks if these lines forms a closed polygon or not. If yes then it finds min & max points of polygon and draws rectangle. This indicates that our gesture is recognized. Then it crops the current frame i.e. object rounded by gesture. Finally this cropped image is given to the second module as input.
Module 2: Detecting Object & Information retrieval

Following diagram describes flow of module two:
In this module system crops captured image. Then system compares this cropped image with images stored in the database one by one using SAD (Sum of Absolute Difference). If difference is greater than 1000 pixels then it displays message match not found and sends this cropped image on web to retrieve information related to that object. After retrieval of information system stores that cropped image and information in the database. If difference is less than 1000 pixels, then it shows match found and displays related information from local database.

Implementation by using OpenCV:

A) OpenCV Overview:
OpenCV is an open source computer vision library. The library runs under Linux, Windows and MacOS X and it is written in C and C++. It contains active development on interfaces for Ruby, Matlab and other languages. OpenCV library has 500 functions which covers areas in vision like factory product inspection, user interface, camera calibration, robotics etc.

B) Goal of OpenCV:
1] To provide computation efficiency and strong focus on real time applications.
2] To provide simple to use computer vision infrastructure which helps people to build sophisticated vision applications.

C) Structure of OpenCV:
OpenCV contains mainly four components

- CV: CV contains basic image processing and computer vision algorithm.
- MLL: MLL is machine learning library which has many statistical classifiers and clustering tools. This library focused on statistical pattern recognition and clustering.
- High GUI: High GUI has functions for storing and loading video and images and I/O routines.
- CXCORE: It has basic data structures and contents.
IV. FUTURE WORK

As a future work we are planning to use robust algorithms for gesture recognition & object detection and going further we use voice commands to interact with system. We plan to implement OCR (Optical Character Recognizer) in the system to extract text from the image and provide related information.

Information system follows mainly three steps:
1] Data representation
2] Search and Match operation.
3] Returns appropriate result.

V. CONCLUSION

In this paper we have presented a prototype to interact with physical world using hand gestures. Our intention is to provide natural interface to retrieve information about any physical object from web. The proposed system is successfully implemented using hand gesture recognition and object detection techniques using OPENCV and information related to detected object is retrieved.

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