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Hand Gesture Recognition using MACD

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ABSTRACT: Shape disintegration is a principal issue for part-based shape representation. We propose the minimum approximate decomposition (MACD) to deteriorate arbitrary shapes into least number of "approximate convex" parts. The minimum approximate decomposition is detailed as a discrete optimization problem by minimizing the amount of nonintersecting cuts. Two discernment guidelines are forced as constraints into the objective function to enhance the visual naturalness of the decomposition. With the level of close convexity a userspecified parameter, the proposed decomposition is robust to local distortions and shape deformation. The optimization could be effectively explained by means of binary integer linear programming. Both theoretical analysis and experiment results indicate that our approach outperforms the state-of-the-art results without presenting redundant parts and in this way leads to strong shape representation.

I. INTRODUCTION

Gesture recognition is a topic in computer science and language technology with the goal of interpreting human gestures via mathematical algorithms. PART-based representation has shown promising results in object recognition and detection. Instead of characterizing an object as a whole, visual parts serve as intermediate components to represent an object and are robust to articulated movement and partial occlusions

One common strategy for dealing with large, complex models is to partition them into pieces that are easier to handle. Many problems can be solved more efficiently when the input is convex. Although strict convex decomposition has been well-studied in computational geometry, its application in real problems is limited. So an approximate convex decomposition was devised.

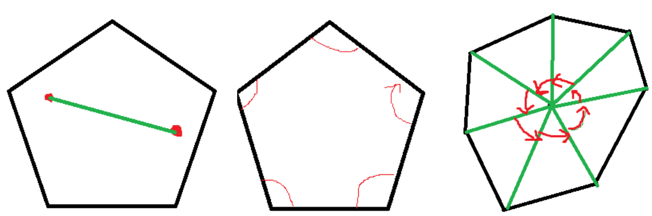

Fig 1: Properties of Convex Figures

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II. RELATED WORK

Exact Convex Decomposition

Polygon decomposition is an important step towards shape analysis and understanding. Generally, people prefer to pre-process polygons by decomposing them into convex components.

This is not only because convexity has topological and geometric properties that can make some operations available and many algorithms efficient, but also because convexity plays an important role in human perception and pattern analysis.

Minimum Convex Decomposition

The minimum convex decomposition problem asks for a decomposition of the interior of polygon into the minimum number of convex regions. But MCD algorithm cannot handle polygons with holes.

Approximate convex decomposition

ACD method is a strategy to decompose a polygon, containing zero or more holes, into "approximately convex" pieces.

This method produces an exact convex decomposition in O(nr) time which is faster than existing O(nr^2) methods that produce a minimum number of components, where n and r are the number of vertices and notches, respectively, in the polygon.

ACD Rules

- Convexity constraint
- Non-overlapping constraint

Benefits of ACD

- For many applications, the approximately convex components of this decomposition provide similar benefits as convex components.
- The resulting decomposition is both significantly smaller and can be computed more efficiently.
- An approximate convex decomposition can more accurately represent the important structural features of the model by providing a mechanism for ignoring insignificant features, such as wrinkles and other surface texture.
- It produces an elegant hierarchical representation

III. PROBLEM FORMULATION

In near-convex decomposition, each decomposed part may not be strictly curved; accordingly, the user needs to define a parameter that demonstrates the close curved tolerance of the decayed parts. Formally, a -close curved decay of a shape S, D (S),is characterized as a decomposition that only contains near-convex non-overlapping parts

To measure concave(Pi), we utilize the shape characteristic mutex pair. For any two vertices on a shape contour,v1 and v2, if the associating line between v1 andv2 crosses with the form or finds outside the shape, v1v2 is a mutex pair. As indicated

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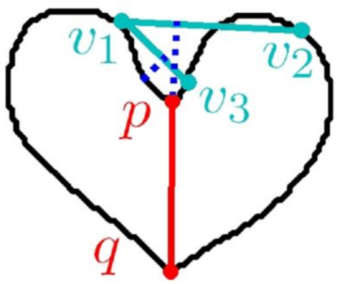
in Fig. 2, v1v2 and v1v3 are two mutex sets. The concavity of a part Pi is characterized as the maximal concavity of the mutex combines in the part.

concave(Pi) = max(concave (vi,vj))

where(vivj) signifies the mutexpair in Pi; concave(v1,v2) is theconcavity of mutex pair(v1,v2).



Motion capture and depth sensing are two emerging areas of research in recent years.

Because of its sensitivity to small variations of the shape, strict convex decomposition cannot bring stable decomposition.

Existing Convex Shape Decompostions cannot avoid introducing redundant parts.Thus limits its application in real problems.

Minimum Approximate Convex Shape Decomposition, decomposes an arbitrary 2D shape into minimum number of near convex parts.

This method is stable, can well handle local shape distortions and shape deformations.

It is visually more natural.

The optimization is efficiently solved with simple calculations.

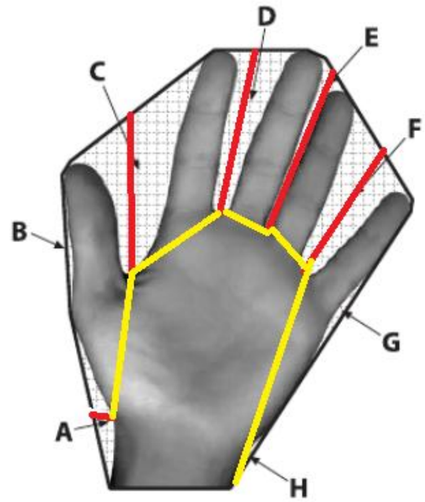


Fig 3: Proposed MACD of Human Hand

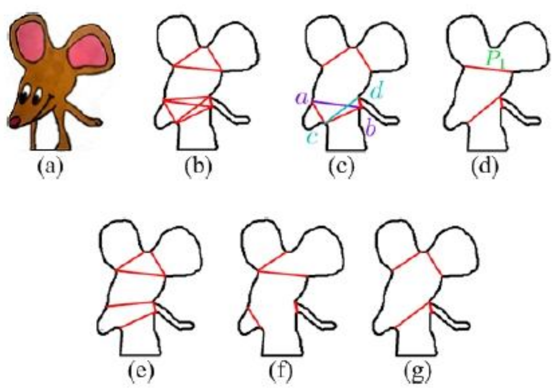


Fig 4: Illustration of minimum near convex decomposition

IV. HAND SHAPE DECOMPOSITION AND ITS APPLICATION

In Fig. 4, the decomposition results of hand shapes are shown. In the first two rows and the last two rows on the left half of the dark line, shows two sets of deterioration effects. As we see, the calculation can speak to the hands as finger parts and palm part reliably. The shapes in the last two rows have introduction, enunciation, or scale progressions, and the outcomes show the heartiness of MACD to these progressions. The rightmost section on the right half of the dark line shows defective outcomes. Particularly, the second hand shape does not decay the ring finger out, and the remaining three shapes produce one "excess" part, as indicated in the oval. These are because of the convexity demand. The calculation

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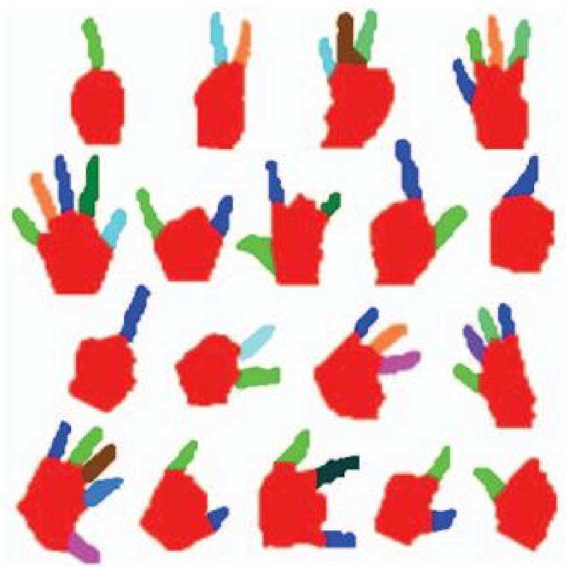
requirements to generate the part in the oval to fulfill the convexity demand. Also for the second shape, the ring finger and the palm make up a part that can fulfill the convexity demand; accordingly, it is not divided.



Modules

- Capture Image
- Threshold control
- Background subtraction
- Finding contours
- Detect convex hull
- MNCD
- Gesture detection
- Arithmetic computation

Challenges

- Distinguish Angular changes in gestures
- Distinguish same gestures with different fingers
- Distinguish left and right hands (distinguish thumb and pinky finger)

Application where the MACD can be useful

- Man-Machine interface
- Computer games
- Virtual reality
- 3D Animation
- Control of mechanical systems

V. CONCLUSION

In this paper, we show a novel near approximate shape deterioration strategy for robust shape representation, Minimum Approximate Convex Decomposition, which disintegrates 2d shapes into least number of parts with high level of visual instinctive nature. We form the shape deterioration issue as a as a binary integer linear programming problem which has been theoretically demonstrated and experimentally validated that can proficiently disintegrate shapes into least number of close curved parts. Experiments on complex 2d shape datasets indicate that the proposed technique is robust to shape mutilation and distortion. Also, the robustness of our deterioration is shown in the representation of hand shapes and in the provision of hand motion distinguishment.

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