A METHOD TO OBTAIN THE POSITION RELATION OF TWO POLYGONAL CONTOURS DEFINED BY PRIMITIVES IN THE SAME PLANE

Dora Florea*

*Department of Computer, Polytechnical University of Timisoara, Faculty of Automatic and Computer, Bul.Parvan nr.2, Timisoara,Romania

ABSTRACT

This paper presents an original method for determination position relation between two polygonal coplain contours used an original algorithm proposed by author for determination the position relation of a point with a contour. Determination of relation with a contour C of a point P: Relpoint {P,C}→{INTERIOR, EXTERIOR, BELONG TO VERTEX, BELONG TO CONTOUR} it make with add the predicative formulas. Also the algorithm which establish the position relation between two contours it presents with add the predicatives formulas.

KEYWORDS: Polygonal contour,relation of a point,relation of coplanar contours,predicatives formulas

INTRODUCTION

The problem of establishing the position relation between the plane subfigures is required in the many matters of artificial intelligence [1],[3]. This paper has investigated the possibility of defining the relation between two closed coplaning polygonal contours and Dora Florea proposes an original algorithm for this. Starting from a possible relative position classification of two contours, the method presents in this paper is based on testing of predicative formulas, which first establish whether two contours cross, then whether they are external or internal and whether they are identical. The four last classes may by evidenced by the truth value of predicative formulas relevant for each class, and for the relation of interior and exterior if necessary to establish the position of a point face to a contour.In the literature of speciality it know the algorithms for resolves the relation of a point with a polygon but this are not performed. So Sergiu Corlat[5] presents for resolves this problems two algorithm:

1)for determined the belongings of a point at a polygon by deviding in the triangles of a polygon and so can know if a point P is interior of a polygon This algorithm is not performed because it necessary many subroutine for treatment the exception situations and this algorithm is not safe. Dora Florea in this paper proposes an original algorithm for establishing the position relation between a point and a contour based on the computation of the algebraic module sum S of the angle at which the point see the contour. This sum S is relevant for the classification of the point as related to the contour (internal,external,on the contour line, on a contour vertex) no other testing being necessary. The algorithm is safe and performed ,it can use in all the situations and for all the type of contour concave or convex , defined by primitives: segment of straight line, arc of circle, arc of ellipse, function or other primitives.

THEORETICAL CONSIDERATION

Let be $C_1$ and $C_2$ two closed polygonal contours defined by primitives in the same plane. They may be found in one of the four classes of possible relative distinct position referred to as INTERIOR,EXTERIOR,INTERSECTION or IDENTICAL. Let $D_1 = C_1 \cup \text{Int } C_1$ and $D_2 = C_2 \cup \text{Int } C_2$ the polygonal field determined by two closed polygonal contours and $M_1 = \{P_i \mid i=1,m\}$ and $M_2 = \{P_j \mid j=m+1,n\}$ the set of points for the definition of the primitives which belong to the contours $C_1$ and $C_2$. The function of position relations is defined by applying this relations:
RELPOZ: \{C_1, C_2\} \rightarrow \{\text{INTERIOR, EXTERIOR, INTERSECTION, IDENTICAL}\}.

(1)

RELPOZ: \{C_1, C_2\} = \text{INTERIOR},
if \{D_1 \setminus (\text{Int}C_1 \cap \text{Int}C_2)\} = C_1 or \{D_2 \setminus (\text{Int}C_1 \cap \text{Int}C_2)\} = C_2

{C_1, C_2} = \text{EXTERIOR},
if \{D_1 \setminus (\text{Int}C_1 \cap \text{Int}C_2)\} = D_1 or \{D_2 \setminus (\text{Int}C_1 \cap \text{Int}C_2)\} = D_2

{C_1, C_2} = \text{INTERSECTION},
if \{D_1 \setminus (\text{Int}C_1 \cap \text{Int}C_2)\} \neq D_1 and \#C_1 or \{D_2 \setminus (\text{Int}C_1 \cap \text{Int}C_2)\} \neq D_2 and \#C_2

{C_1, C_2} = \text{IDENTICAL}, if \#D_1 = \#D_2

The relation (1) shows that the function RELPOZ requires knowledge of interdependence which exists between the set of points defining the primitives of two contours and the existence or nonexistence of primitives intersection which belong to the contours. In fig.1 it shows examples of possible relations of interior between two contours \(C_1\) and \(C_2\), in fig.2 it presents same position relations of exterior for two contours \(C_1\) and \(C_2\) and in fig.3 are three examples of contours what are in relation of intersection.

The algorithm proposed by Florea Dora for establishing the relation between the polygonal contours defined in the same plane considering as input data the points \(P_{h=1..m}, P_{k=1..n}\) (fig.4) which limit primitives of segment type generating closed polygons requires as follows: Relation Pred1. (3) show if the contour \(C_1\) is adjacent with the contour \(C_2\) on the distance delimited by the points \(P_{h1}\) and \(P_{h2}\) for the contour \(C_1\) and the points \(P_{k1}\) and \(P_{k2}\) for the contour \(C_2\) by testing if exist vertex of contours \(C_1\) and \(C_2\) identical or the angle coefficients is the same for primitives from contours \(C_1\) and \(C_2\).

For precisified if the contours \(C_1\) and \(C_2\) have common points, it used predicative formula Pred2. through testing if exist a point \(P_k\) for which the value of the function \(\hat{f}_{h,b+1,h1..m-1}\) which defined a primitive is 0.

(3)

For precisified if the contours \(C_1\) and \(C_2\) have common points, it used predicative formula Pred2. through testing if exist a point \(P_k\) for which the value of the function \(\hat{f}_{h,b+1,h1..m-1}\) which defined a primitive is 0.

(4)

Determination of a possible intersection relation between the two contours should be made by testing the truth value of predicative formula Pred3 (5). In the relation (5) the function which defines the straight line intersecting the points \(P_{h,b+1}\) which has been noted \(\hat{f}_{h,b+1}\), the function which defines the straight line intersecting the points \(P_{k,b+1}\) which has been noted \(\hat{f}_{k,b+1}\).

(5)
where $M_{hk}=h_{k+1} \cap f_{k+1}$ and $h=m,m=1,1 \vdash C_1$

Establishing of the position relation of INTERIOR or EXTERIOR possible between the contours $C_1, C_2$ is made by testing the truth value of the predicative formulas $\text{Pred4}, \text{Pred5}, \text{Pred6}$ expressed by (6),(7),(8). Predicative formula $\text{Pred4}$ establish the relation $C_1$ EXTERIOR $C_2$ if it detect a point $P_h$ which belong to the domain $D1$ but not belong to the domain $D2$.

$\text{Pred4. If } \forall \text{Pred3. } \exists (P_h \in D_1 \land P_h \notin D_2) \vdash C_1 \text{ EXTERIOR } C_2$

The relation (7),(8) show that the contour $C_1$ INTERIOR $C_2$ or contour $C_2$ INTERIOR $C_1$ if it detect a point $P_h$ which belong of contour $C_1$ or a point $P_k$ which belong of cotour $C_2$.

$\text{Pred5. If } \forall \text{Pred4. } \forall \text{Pred5. } \exists (P_h \in D_1 \land P_h \notin C_1) \vdash C_1 \text{ INTERIOR } C_2$

$\text{Pred6. If } \forall \text{Pred3. } \forall \text{Pred4. } \forall \text{Pred5. } \exists (P_k \in D_1 \land P_k \notin C_2) \vdash C_2 \text{ INTERIOR } C_1$

If the predicatives formulas $\text{Pred3, Pred4, Pred5, Pred6}$ are false , than the contour $C_1$ is identical with contour $C_2$.

$\text{Pred7. If } \forall \text{Pred3. } \forall \text{Pred4. } \forall \text{Pred5. } \forall \text{Pred6.} \vdash C_1 \text{ IDENTICAL } C_2$

where $P_h \in M_1$ and $P_k \in M_2$

For establish the relations of interior or exterior contours defined in the same plane (6),(7),(8) it necessary to know the position relation of a single point belong of a contour. An algorithm for establishing the position of point as related to a contour: INTERIOR, EXTERIOR,BELONGS TO LINE of contour, BELONG TO THE VERTEX of a contour, respectively is necessary. The algorithm proposed in this paper by Dora Florea relies on knowledge of algebraic module value sum of the angles under which the contour $C$ is observed from the point $P$ for desided if the point is interior or exterior of the contour (Fig.4).
directed angle $\theta_{i,i=m+1,n}$ determined by two consecutive points of contour $C_2$ and the point $P_h$ used the relation (10). Algebraic module sum $S$ of angles $\theta_i$ will define the relation of $P_h$ as to the contour $C_2$ and the field $D_2$ by testing the formulas:

\[ R_1: \text{If } S = \sum \theta_{i,i=m+1..n} = 360^\circ \implies P_h \in D_2 \setminus C_2 \text{ or } P_h \text{ INTERIOR } C_2 \]

\[ R_2: \text{If } S = \sum \theta_{i,i=m+1..n} = 0^\circ \implies P_h \notin D_2 \text{ or } P_h \text{ EXTERIOR } C_2 \]

\[ R_3: \neg R_1 \land \neg R_2 \land \neg R_3 \implies P_h \text{ BELONG TO VERTEX } C_2 \]

\[ \neg R_1 \land \neg R_2 \land \neg R_3 \implies P_h \text{ BELONG TO } C_2 \]

If the sum of the angles $\theta_{i,i=m+1,n}$ is $360^\circ$ , the point $P_h$ is interior of contour $C_2$ and if the sum of the angles $\theta_{i,i=m+1,n}$ is $0^\circ$ , the point $P_h$ is exterior to contour $C_2$. If the formula $R_1$ and $R_2$ are negatives and $P_h$ is identical with a vertex $P_k$, where $h \in \{1..m\}$ $k \in \{m+1..n\}$ $\implies P_h \in C_2$ or $P_h$ BELONG TO VERTEX $C_2$.

**REFERENCES**


**CONCLUSION**

Purpose of this paper is to offer an original method proposed by Dora Florea for determining the relation between two contours. This may lead to an algorithm involving high computation speed, reduced memory and the elimination case which need a special treatment. The algorithm was tested with a program wrote in Visual Basic language and the results was very good.

**ACKNOWLEDGEMENTS**

I take this opportunity to express my gratitude to the people who have been instrumental in the successful completion of this work.