一种基于几何方式实现的拖拉机避障规划方法

1.障碍物模型构建

障碍物半径计算公式：$R_c = max\{R, r - w/2\}$

The obstacle avoidance area is assumed as a circle area. The centre position of the obstacle circle area is the same as centre position of minimum circumscribed circle of small obstacles. Because agricultural machinery holds the minimum turning radius and the equipment carried by the machine holds a certain working width, determination of the radius of the small obstacle circle area should consider these factors. When the minimum turning radius of agricultural machinery is denoted by r, working width of the equipment carried by the machine is denoted by w, and the radius of minimum circumscribed circle of small obstacle is denoted by R, the radius of the small obstacle circle area R_c is defined

障碍物参数含义解释

原始路径用直线表示：$y = kx + b \equiv ax + by + c = 0$

障碍物的圆心使用(x_o, y_o)表示,障碍物距离该路径的距离为： $d = \frac{ax_o + by_o + c}{\sqrt{a^2 + b^2}}$

判断是否需要处理的条件：

(1)When $R_c + w/2 <= d$, agricultural machinery can work along the original operation path without taking any obstacle avoidance strategy.

(2)When $R_c + w/2 > d$, if the farm machinery still works along the original operation path, the machinery and equipment will collide with the small obstacles, which will affect the normal operation of agricultural machinery. Therefore, it is necessary to take the corresponding strategy to avoid the obstacles.

判断条件

此方法是利用三段大于车辆最小转弯半径的圆弧构成

其中三段圆弧分别是ＡＢ、ＢＣ、ＣＤ，构造是哪个辅助圆，其中辅助圆1表示远离原始路径，辅助圆2表示表示返回到原始路径，辅助圆3和构造的辅助线段以及辅助圆1和辅助圆2的圆心相关。

构造的辅助线的公式是：$y = kx + b + r/cos(\arctan(|k|))$

辅助圆3的圆心是小障碍物的圆心，辅助圆3的半径是$R_c + w/2 + r$,其坐标符合下面的公式：$(x - x_o)^2 + (y - y_o)^2 = (R_c + w/2 + r)^2$

计算出辅助圆3和辅助线的两个交点O1和O2,分别作为两个辅助圆的圆心，半径为r,则辅助圆1的公式为：$(x - x_0)^2 + (y - y_o1)^2 = r^2$,辅助圆2的公式为：$(x - x_o2)^2 + (y - y_o2)^2 = r^2$

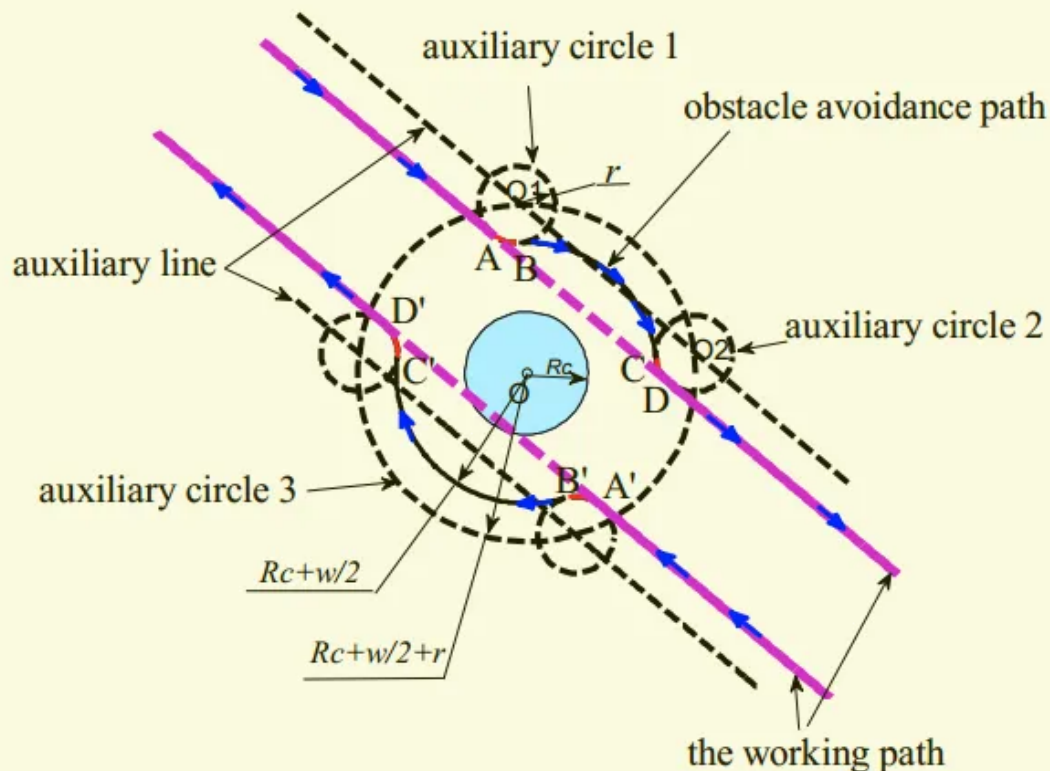通过原始路径和辅助圆1、2可以求得点A和点D，通过线段OO1和辅助圆1可以求得点B，同理可求得点C，至此Ａ，Ｂ，Ｃ，Ｄ构成的圆弧路径就是拖拉机避障的路径。

Fig. 1. Obstacle avoidance path of a single small obstacle.

拖拉机避障路径图