SwarmTouch

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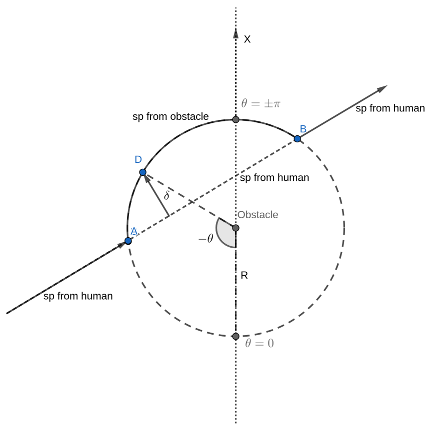

Fig. 1. Obstacle avoidance algorithm

***Abstract*—**

I. INTRODUCTION

II. DRONES CONTROL

A. Obstacle avoidance algorithm

The location of drones and obstacles is given by Vicon Vantage 5 motion capture system. Every object pose is broadcasted at 60 Hz frequency and is known at each period of time. So each quadrotor is aware of the obstacles positions relative to it. Drones goal positions are commanded relatively to the human location. However if a quadrotor from the swarm is approaching the obstacle its position is corrected relatively to the obstacle pose as depicted on the fig. 1. If the drone is commanded by the human to fly inside the circular vicinity of the obstacle, the aerial vehicle will avoid the object, following the circumference, defining the obstacle boundary. However this obstacle avoidance method requires drones to move through the arc faster in comparison with following straight line trajectory. In addition the quadrotors should perform sharp maneuvers being in points A and B of the circumference.

B. Delta-impedance control

Impedance control is used in order to make trajectories near obstacles feasible for the drones as follows. In the circle-like obstacle vicinity the impedance correction term is added to the drone goal position, based on the distance between the set-point on the circumference and the goal position commanded by human if there were not obstacles. This distance is denoted by the letter δ on the fig. 1. In order to calculate impedance pose correction term the following equation should be solved for the drone, situated near the obstacle:

$$m\ddot{x} + b\dot{x} + kx = F_\delta(t),$$

where $F_\delta = -K\delta$, m is the desired mass of virtual body, b is desired damping, and k is the desired stiffness. In such a way the external force $F_\delta(t)$ acting on the drone near the obstacle affects drone's desired position proportionally to δ-value. Drones trajectories in the vicinity of the obstacles become more smooth.

C. Theta-impedance control

In order to control drones angular velocities near obstacles circumferences another impedance model is implemented.

$$J\ddot{\theta} + D\dot{\theta} = M(t),$$

where $M(t) = K(\theta_{imp} - \theta_{sp})$ is a torque acting on the robot near the obstacle, J is an inertia moment of the drone, and D is damping coefficient. The impedance model choice is explained by damped convergence of the set-point of the drone to desired position (R, θ_{imp}), expressed in polar coordinates relatively to the obstacle.

REFERENCES