

Concordia University
Department of Computer Science and Software
Engineering

**SOEN 331-S: Formal Methods
for Software Engineering**

**Tutorial exercise on UML State Machines:
Drone control**

Dr. Constantinos Constantinides, P.Eng.
`constantinos.constantinides@concordia.ca`

February 18, 2022

1 System description

Motivation Consider a software system that controls a drone that is deployed for search missions. For the sake of simplicity, we may consider that a search involves the identification of a target (such as an injured individual, or the site of an accident etc.) and the acquisition of the target's coordinates.

High-level behavior Upon activating the system, the drone automatically calculates its own base coordinates and stays idle. While idle, the drone maintains a red light on. While idle, we can instruct the drone to take off. While off the ground we consider the drone as flying and once we instruct the drone to land then it becomes idle again. The drone may be shut off only when instructed while being idle. While flying, the system maintains a blinking red light and it transmits its own coordinates to its base.

Flying The drone takes off only under manual control, and it can either stay under manual control or go to auto control. (Note that the actual tracking of the target can only be done under auto control. In other words, the drone can only perform its mission while in auto control. See later.) The system will move to auto control automatically once a target is found, or it can move to auto control if instructed to do so. While in auto control, the drone can go back to manual control either once instructed to do so, or it will go back to manual automatically once the auto mode concludes (When the mission terminates successfully, or under an emergency situation. See later). When the system moves from auto control to manual control under any condition, it will produce a sound indicating a transition to manual control.

Manual control There are three parallel modes while the drone is in manual control: There is a vertical control under which the drone can navigate up, or down, or just stay stable in the air. There is also a horizontal control under which the drone can move left or right or just stay neutral in its current path. Finally there is a mode under which the drone maintains active monitoring or has disabled monitoring. While the drone maintains active monitoring, the camera of the drone must stay on. In other words, we can manually navigate the drone with configurations such as “going up, neutral, with the camera on”, or “going up, towards the right, with the camera off”, etc.

Auto control There are two modes in auto control. Initially the system is in normal mode, but if it detects low power or if somehow is damaged, then it goes to emergency mode. While in normal mode the system maintains its camera on. Once the normal mode successfully concludes (see later), or if the system is instructed to abort the auto mode, then the auto mode concludes. When it goes to emergency mode, the system initially puts the camera off and while it remains in emergency mode the system produces some sound to indicate emergency. The system will stay in emergency mode for 5 seconds which is considered enough time to transmit its current coordinates to base and then the auto mode will conclude.

Normal auto control Initially the system is in a tracking mode. We assume here that the system implements some AI algorithm in order to identify a target, based on some criteria that are not relevant for this assignment. If a target is found and the target's position is identified, then the system gets into a mode whereby it will be moving to position itself over the target. If while doing that the system loses the target, then it moves into a mode whereby it searches to relocate the target and, once found, it will go to tracking the target. While in moving mode, the system performs a check every 3 seconds to verify whether or not it has reached a position over the target. Once the drone moves right over the target, then it will move into a mode whereby it will start transmitting data to its base (such as coordinates, pictures, videos etc.) Once transmission is completed, then the system concludes the normal auto control mode.