Abstract

Heart disease is the leading cause of death for people, and around 320,000 out-of-hospital cardiac arrests occur annually in the U.S. 90% of victims die and these deaths could have been prevented if victims were able to receive immediate medical treatment and medicine, such a defibrillator or epinephrine. This project implements the use of drones for emergency medical assistance by creating an autonomous navigation system to allow drones to carry life-saving medical devices and medicine to people in need. Traveling through crowded areas pose a challenge to current drone navigation systems that rely on GPS for pathfinding and external sensors for obstacle avoidance. These hard-coded methods are not robust or adaptable, making them unreliable to use. To implement autonomous flight and allow drones to reach people swiftly, we took a machine learning approach and created a set of novel math formulas and deep learning models that focused on imitating two key aspects of driving: speed and steering. For our steering model, we first used gaussian blurring, filtering, and kernel-based edge detection techniques to preprocess the images we obtain from the drone's built-in camera. We then use a CNN-LSTM model to predict the steering angle of the drone. This model uses a convolutional neural network as a dimensionality reduction algorithm to output a feature vector representative of the camera image, which then is fed into a long short-term memory model. The LSTM model learns time-sensitive data (i.e. video feed) to account for spatial and temporal changes, such as that of cars and walking pedestrians. Due to the nature of predicted angles (i.e. wraparound), our LSTM outputs sine and cosine values, which we use to derive our angle to steer. For the speed model, since we cannot perform depth perception with only one camera, we had to figure out a novel way of finding the probability of collision to regulate speed. We used an object detection algorithm to draw bounding boxes around all possible obstacles in an image and using our novel math formulas, we define a two-dimensional probability map to map each pixel from a bounding box to a probability of collision. We then use Fubini's theorem to integrate and sum over the boxes, finally outputting the probability of collision which we robustly predict in a completely unsupervised fashion. This probability is used to determine the speed the drone should fly for the velocity model to safely steer. Our steering angle model achieves a mean squared error of 0.1289 and a mean absolute error of 0.03155. Our model also runs, holistically, in 0.236 seconds with a standard deviation of 0.057. These figures show a high level of association between predicted and actual values, meaning that our drone navigation program will have no trouble navigating through crowded streets or cities to deliver emergency devices and medicines that can save lives. In addition to our navigation system, we implemented a user interface that allows users to request emergency medical assistance after sending their location and symptoms to a real-time database. Using the database, we can allow the drone to travel immediately to a victim's location and bring the exact medicine and medical devices needed to save their life.