Flight Chair: An Interactive Chair for Controlling Emergency Service Drones

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ABSTRACT

In future, emergency services will increasingly use technology to assist emergency service dispatchers and call taker with information during an emergency situation. One example could be the use of drones for surveying an emergency situation and providing contextual knowledge to emergency service call takers and first responders. The challenge is that drones can be difficult for users to maneuver in order to see specific items. In this paper, we explore the idea of a drone being controlled by an emergency call taker using embodied interaction on a tangible chair. The

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KEYWORDS

Emergency Service; 9-1-1; Drones; Chair; Tangible; Embodied Interaction.

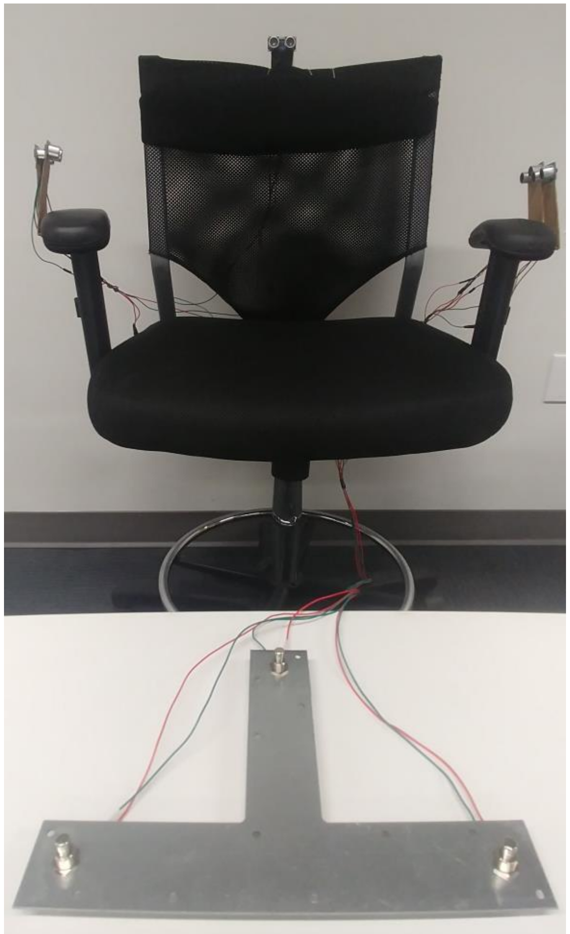

Figure 1: Flight Chair with the T-shaped foot pedal

interactive chair, called Flight Chair, allows call takers to perform hands-free control of a drone through body movements on the chair. These include tilting and turning of one's body.

INTRODUCTION

People in Canada and the United States dial the number 9-1-1 to report an emergency. 9-1-1 emergency services are undergoing a series of transformations to make use of new and emerging technologies to assist emergency call takers and first responders. Currently, 9-1-1 call takers often face challenges in gaining information about an emergency from callers and would value additional contextual information about the situation [5,12]. This includes information about where exactly the emergency is happening and what the extent of the problem is [8].

One possible technology for addressing this problem is a drone that could quickly fly to the scene of an emergency and send video back to a 9-1-1 call taker. This information could then be shared with first responders such that they could better prepare to support an emergency. However, the current literature has not yet explored drones for 9-1-1 emergency situations that focuses on assisting call takers with additional information. Therefore, we do not yet know how to design drone technologies to support emergencies and information sharing between callers, 9-1-1 call takers, and first responders. This includes knowing how to easily fly the drone to a scene and capture relevant information such that it can be shared with others. Although fully autonomous drones have been explored in indoor search and rescue (SAR) scenarios [11], there is not enough information in terms of the necessity of call takers to program fully autonomous drones for everyday emergencies including the outdoor ones.

We have explored this design space through the creation of Flight Chair (Figure 1): an interactive chair that enables 9-1-1 call takers to easily fly a drone to an emergency and survey the scene. While sitting on the chair, a call taker can control a drone's movements while tilting left or right, leaning forwards or backwards, or using a special foot pedal for takeoff/landing (Figure 1). We imagine that such drones could be set up in key locations in a city such as fire stations, police stations, etc. When a caller calls 9-1-1 and seeks emergency service, the call taker could immediately send a drone to the scene and assess the scenario in order to dispatch the proper emergency service.

RELATED WORK

Previous research looked into the usage of drones to help victims, i.e., equipping drones with automated external defibrillators (AEDs) and delivering it rapidly to treat a victim of cardiac arrest [4]. Also, autonomous drones have been explored for Search and Rescue (SAR) in indoor environments [11]. However, none of those explored drones to assist 9-1-1 emergency call takers. Previous research related to human-drone interaction (HDI) explores social adaptability and acceptability of drones [1]. This work also explored personal gesture-controlled drones. The authors proposed multimodal drone interaction as they concluded that no single modality would provide natural human-drone interaction. Another work explored different natural user interfaces (speech, gestures, markers) and graphical user interfaces to control drone movements inside an

Figure 2: Video feed from drone camera

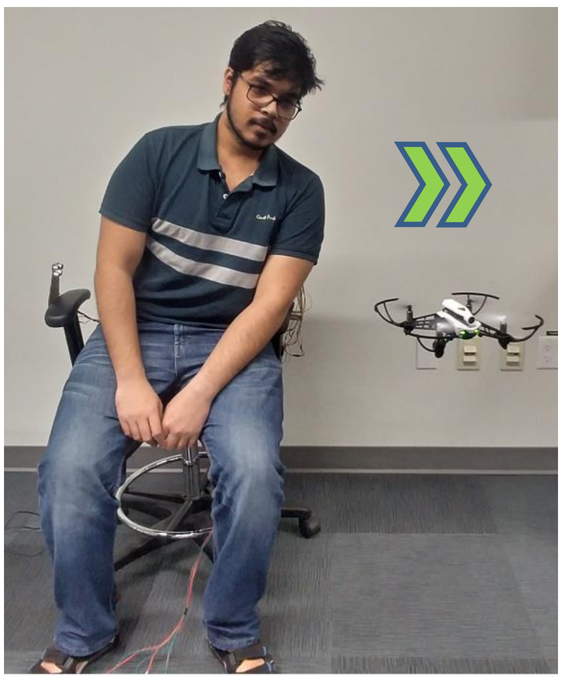

Figure 3: Tilting left to move the drone to left

indoor environment [3]. These studies did not explore interactive chairs to control the movements of a drone.

Previous work on interactive chairs explored embodied interaction to navigate in virtual reality (VR) environment [6,7]. Most users were able to learn to use the chair without too much struggle [6]. Another work compares joystick interactions with locomotion interfaces such as a rotating swivel chair, NaviChair, for VR [6]. However, the results did not show any significant improvement over joysticks in VR environments. Chairs have been explored to promote activity in an office environment where office workers use rotation/tilting, bouncing etc. to control a computer [9].

Previous research suggests there has been no attempt to use embodied interaction with a chair to control drones although this is potentially easier to learn to use than most current drone controls [6].

PROTOTYPE DESIGN

Flight Chair is built with a swivel chair wired with five ultrasonic sensors, one gyro sensor, and three foot buttons placed in a T-shaped panel (Figure 1). The ultrasonic sensors are placed on the back and both sides of the chair (Figure 1). The ultrasonic sensors collect information when user leans forward or backward and tilts left or right. The gyro sensor collects data when the chair is rotated and the foot buttons are simple momentary foot switches. All these sensors are connected to an Arduino Mega 2560 microcontroller. The chair is then connected to the server (computer) via a USB cable. Based on the data received from the sensors, the server sends direct commands to a drone which is connected to the server. In order to show the video feed of the drone, the drone camera is connected to the server.

Users step on a T-shaped panel (the isolated button from the other two) to take off and land the drone. The left button on the panel causes the altitude of the drone to decrease while the right button increases the altitude of the drone. When the user tilts her body left or right, the drone moves left or right respectively (Figure 3). Leaning forward or backward on the chair would move the drone forward and backward respectively (Figure 4). The video feed from the drone camera is displayed on a 9-1-1 call taker's computer screen.

USAGE SCENARIO

Next, we offer a usage scenario to further illustrate how Flight Chair works: Paul is driving to work on a Monday morning. He is drinking coffee and a little distracted from driving due to a work problem. All on a sudden, he hears a loud noise and before realizing anything, he crashes into another car. Seeing this, a passerby immediately calls 9-1-1 and cannot quite describe what's going on inside. The 9-1-1 call taker calmly asks for the location. A drone is sent to the location within a minute. The 9-1-1 call taker leans right on the chair and leans forward to get closer to the crashed car and take a look at the victim. Realizing the person inside the car (Paul) is still alive and stuck in the car, he immediately dispatches a medical emergency team along with a rescue team to free Paul from the car.

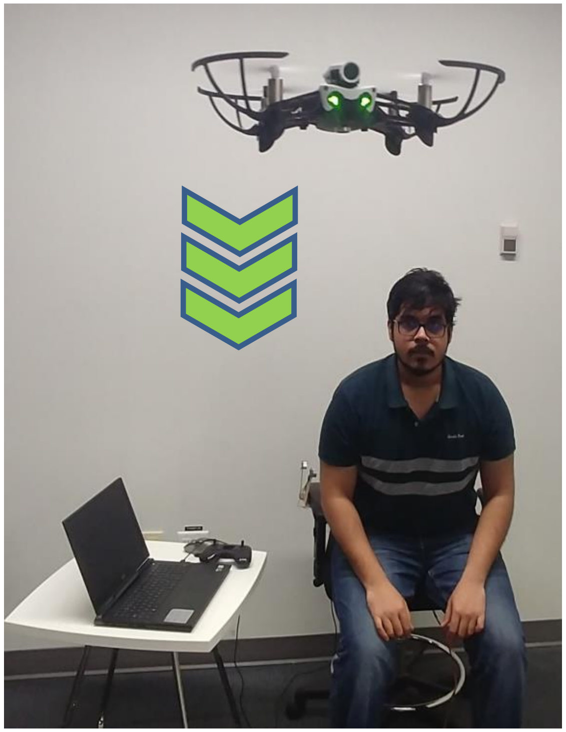

Figure 4: Leaning forward to move the drone forward

DESIGN RATIONALE

We chose the components and interactions for certain characteristics to design and develop our prototype. A chair is one of the fundamental objects with which 9-1-1 call takers interact at work. We thought about using speech control, however, this would be impractical as the call taker is already using speech to interact with the caller. Call takers are also already using their hands to type notes about the situation into their computer-aided dispatch system [8]. Thus, their hands are occupied and they are unable to use a joystick or mouse to move the drone. Yet their body as a whole is free and able to direct the drone's flight path. Using a virtual reality headset in conjunction with the chair could make sense if it wouldn't obstruct the views of the call takers.

We selected how the user's body movements would affect the drone's movement based on a one-to-one mapping, e.g., moving one's body left moves the drone left. The ultrasonic sensors were placed on the upper back and the sides of the chair arm rests (Figure 1). Placing these sensors in the specified areas provided optimal data to detect leaning and tilting of the user. The gyro sensor was used to detect chair rotation. We decided to use foot buttons (Figure 1) instead of other forms of user interaction to allow hands-free control. We imagined that using one's feet may not cause a lot of distraction during an emergency call.

DISCUSSION

Flight Chair is currently a prototype to demonstrate a proof of concept idea for how a drone could be controlled during a 9-1-1 emergency situation to provide additional contextual information. Our upcoming steps involve testing and studying user interactions with the chair as a part of 9-1-1 test calls. Overall, we believe this research will be able to help 9-1-1 call takers to overcome the challenges they face during their work and ensure minimal training is required to use drones as a part of emergency calls.

Of course, there is the potential to have drones automatically fly to an area on their own. However, given the varied nature of emergency situations and their highly dynamic nature, we felt that 9-1-1 call takers themselves may be in the best situation to decide what video footage is needed and fly the drone themselves. One could also consider combining automated control with manual controls for specific situations, e.g., the call taker wants to adjust want the automated control is showing. In this case, a user could toggle between using Flight Chair and automated path flights.

Flight Chair points to the needs for more research since it would require changes of practice at work for emergency call takers and first responders. Ergonomic factors should be considered while designing such chairs due to the possible health outcomes. A chair to control drones could, for example, cause nausea. It could also limit one's physical movements. Other possibilities could include exhaustion of call takers or cause information overload.

Feasibility against controlling drones remotely needs to be investigated if this type of system is to be implemented. Moreover, there are issues with privacy and safety of citizens since a drone will

Figure 5: Rotating the chair to rotate the drone

continuously capture visual data. More investigation is necessary to address these challenges through design and figure out what may not be feasible to be addressed by the design space.

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