Flight Ground Control Communication Voice Control for Multirotor Aircraft

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Abstract: Ubiquity Interface specializes in developing quad-copters. The user interface for the quad-copter is for it to be flown with a 2.4 Ghz controller to basically vertically take off, ascend, cruise, descend, and land. To increase market share in sales of multirotor aircrafts, Ubiquity Interface Inc., an Arlington, Texas based corporation is currently researching how to add intelligence to the multirotor aircraft. One of the two features planned is to add user interface for the drone to be able to be controlled with intelligence programmed into multirotor flight controller to enable the pilot of the quad-copter to use voice for two way communication; the quad-copter informs the pilot of the health of the quad-copter and communicates GPS information including landmarks as the quad-copter fly over a scenery, ask for information about where it should fly to. The pilot is able to use touch screen command and voice command via natural language programmed into the quad-copter and the ground station to fly the quad-copter. The second feature is to convert normal communication of Bluetooth between flight controller and drone. Bluetooth used by flight controller to control drone only enable short range for line of sight flight. With the new regulation FAA is working on and might heed to the calls from Amazon, Google and other corporations that wants to use quad- copter for delivery will make drone maker to innovate the design and communication used to control drone. The potential economic benefit associated with the development of new quadcopter with LiDAR is very promising. The global UAV industry is expanding at an unprecedented pace. On the contrary, the development of quadcopter communication platform has been sluggish. There is therefore a clear gap in the market that needs addressing by developing advanced quadcopter flight control technology that is reliable and superior to exiting multi-copter technology. Revenue for companies doing research and development work in advanced communication features for multirotor aircrafts will be generated by selling the device to tens of thousands prospective UAV owners. Also of interest to this author are research institutions which are developing applications to advance hybrid control mechanisms that incorporate Wi-Fi and voice control to multirotor aircrafts. Our estimates of the revenue potential are of millions of dollars, since every commercial and military UAV operator will want to use a multirotor aircraft with considerably enhanced performance and safety of operation. This paper will focus on Wi-Fi features to allow beyond line of sight flight and voice control of multirotor aircraft flight. This will enable the drone to be able to be control from anywhere in the world. Telecommunication will be used to revolutionize quad-copter in order to increase sales of quad-copters.

Keyword: Artificial Intelligence Multirotor aircraft, Text-to-Speech Communication, Voice Control, WiFi Technologies, 2.4 GHz controller.

INTRODUCTION

This paper will address several shortcomings in performance and flight control communication that limit their applicability in demanding environments. One strategy is to build intelligence to a quadrotor which increases the control of the quad-copter. Aircraft designers have recently come up with a less mechanically complicated, yet effective, form of enhancing quadrotor performance and flight mechanics, increasing the range of applications in special aerial surveillance scenarios. Ubiquity Interface propose the development of a quadcopter equipped with a Wi-Fi device and speech controller apps that brings innovations in the flight mechanics and flight control (Osemwengie O, 2017a,b).

In the short term, ongoing research and development activities for the development of the multirotor aircraft with Wi-Fi and speech flight controller Apps will bring the innovation closer to commercialization. The value of the new multirotor aircraft concept is that the craft will be capable of performing surveillance of special sites and locations in demanding environments effectively, and it will also have greater endurance to provide aerial imagery in critical missions such as urban or forest firefighting operations, police work, aerial filming for the film industry, and many other beyond line sight control. Commercialization of the innovative multirotor will benefit UAV owners globally that will apply UAVs in a wide range of industries; including aerial surveillance, agriculture, energy, utilities, mining, construction, real estate, news media, film production, and many other.

There is a large range of potential customers that will benefit from using our versatile quadcopter equipped with Wi-Fi and speech communication flight control. These customers include commercial companies, emergency response units, the military, and other. The craft will be particularly of interest for special users to conduct flights in tight areas, urban environments, forests, buildings or damaged structures, and windy places; customers in this category include armed forces, police, civil defense, building structural assessment brigades, and power line monitoring engineers. The development of the quadcopter will provide an innovative and low cost unmanned aircraft system to commercial clients worldwide.

A vast range of customers will benefit from the development of the novel quadcopter. Clients include manufacturers and operators of UAVs in the commercial and military sectors worldwide. A wide range of industries will benefit from the development of the advanced craft; including aerial surveillance, agriculture, energy, utilities, mining, construction, real estate, news media, film production, as well as numerous humanitarian services and security sectors such as search and rescue, disaster relief emergency response, sovereign border patrol, firefighting, and many other. The craft will be particularly of interest for special users to conduct flights in tight areas, urban environments, forests, buildings or damaged structures, and windy places; customers in this category include armed forces, police, civil defense, building structural assessment brigades, and power line monitoring engineers.

TECHNICAL DESCRIPTION

The Value Proposition

Current multirotor aircrafts in the market have several shortcomings in performance and Bluetooth flight control that limit their applicability in demanding environments. There is, therefore, a need to implement innovations in the flight mechanics and flight control of current quadcopters to ensure effective and safe monitoring of special sites of interest. Ubiquity Interface proposed quadcopter is currently researching development of a multirotor aircraft is equipped a Wi-Fi buddle and speech communication apps. Such novel flight controller system allows much

higher communication performance.

The Competition

An analysis of the competition and their technological developments is presented as follows. Several governing organizations and research institutions have conducted research on multirotor aircraft technology and the fields of quadcopter design (Mahen et al., 2014; Singh and Umanath, 2015), control (Hanafi1 et al., 2013; Pacheco et al., 2015; Ragavendhiran et al. 2015), system identification, (Sa and Corke, 2012), flight dynamics (Khan, 2014), obstacle detection and collision avoidance (Salaskar et al., 2014), hovering performance (Sanchez et al., 2011), navigation (Singh, 2015), and other. Examples of competing providers of quadcopters include DJI in the USA with crafts like the Phantom 3, Inspire 1, and Matrice 100; Aeryon labs Inc. who offer the Aeryon SkyRanger air platform; Aibotix who produce the Aibotix X6 multicopter for dynamic aerial surveying for professional photogrammetry, point clouds and 3D modelling; Lockheed Martin manufacture their Indago System for commercial and military markets; and the Novadem NX110m has been designed for military surveillance.

Key Risks in Bringing the Innovation to Market

Ubiquity Interface proposed advanced quadcopter designed for specially demanding surveillance settings addresses an important gap in the small unmanned aircraft market. Elements of risk in developing the quadcopter are posed by competing research institutions that may attempt to develop similar technology in the next few years. To mitigate the risk, barriers to entry for 'fast follower' competitors will be set in the forms of technological patents, patents on business processes, a strong brand identity, and strong customer loyalty. Another risk factor is the complexity of the UAV controller that may inflate the market price of the craft. Critical success factors include technical and managerial assumptions:

Configurations of Wi-Fi and Speech Drone Controller

Wi-Fi buddle will be integrated in the drone and voice app will be stored in both the drone and ground flight controller or smart phone, or smart pad. Flight controller source code will be stored in an AT&T M2X could infrastructure. AT&T M2X provides time-series *data storage, device management, message brokering, event triggering, alarming, geo-fencing, **and** data visualization* for your industrial Internet of Things (IOT) products and services. The features of M2X will allow drone controller to automatically fly drone to up to 128 waypoints (locations) pre-programmed and adjustment to waypoints could be made real time via Wi-Fi connection. Fig. 1 shows how the drone will take instruction from M2X and send back instructions back to M2x.

A potential challenge associated with the use of Data communication on the quadcopter flight controller is the increased visual task load. Data Communication based on text may yield an operationally relevant increase in strain in the eyes. To avoid such unintended consequences in manned air craft, the National Research Council (NRC) suggested that Data Comm should employ redundant voice synthesis operated in parallel with the visual (text and graphics) display of the message" (Wickens, Mavor, Parasuraman, & McGee, 1998, p.251).

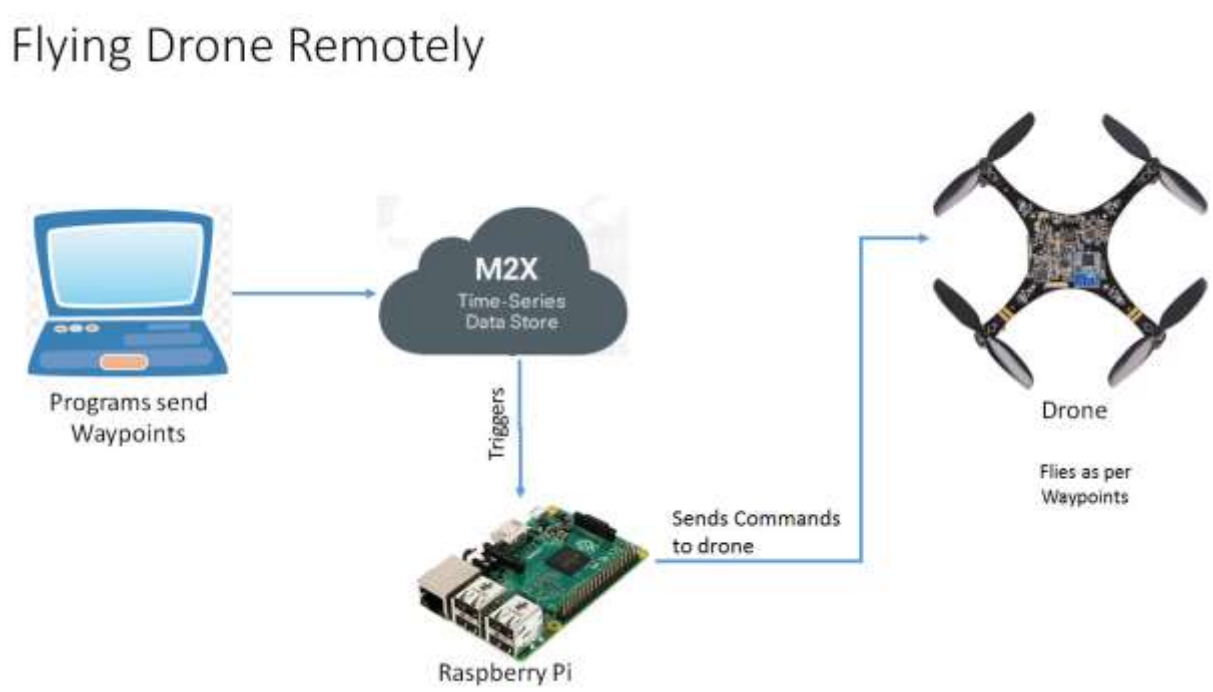

Fig. 1: Configurations of Wi-Fi and Speech Drone Controller

The current research builds on the Volpe Center's past research addressing the questions raised in the NRC recommendations (see Phase I; Lennertz, Bürki-Cohen, Sparko, Macchiarella, Kring, Coman, Haritos, & Alvarado, 2012a). That Phase I research compared the effects of a custom-made Data Comm display with text only to a Data Comm display with text and synthetic speech on single-pilot crews in the terminal environment. Another study extends this comparison to two-pilot crews communicating with Air Traffic Control (ATC) in the en-route environment. In a similar research, "thirty- two current air-transport pilots (16 flightcrews) flew a Boeing Next-Generation 737-800 fixed-base research simulator in two experimental conditions. In one condition, communication with ATC was via a text-only Data Comm display. In the other condition, communication with ATC was via the Data Comm display with synthetic speech (i.e., text+speech); synthetic speech was played aloud on the flight deck" In both conditions, an aural (e.g., chime) and visual indication announced the receipt of a new Data Comm message on the flight deck. Participants responded to messages via the Control Display Unit (CDU).

Studies indicated that a synthetic speech display aided the performance of two-pilot flightcrews in the en-route environment compared to a text-only display, replicating many of the results from Phase I (Lennertz et al., 2012a). Concurrent head-down time for both the Captain (Pilot Flying) and First Officer (Pilot Monitoring) showed that while flightcrews looked down more often in the text+speech condition than in the text-only condition, the duration of these glances was shorter with the synthetic speech display and thus less disruptive of pilots' scans.

In the sum, the research indicate that the implementation of a text+speech Data Comm display, relative to a text-only display, may yield safety and efficiency benefits on the flight deck without introducing negative consequences. Taken together, these results provide preliminary guidance for aircraft certification regarding the use and implementation of synthetic speech on

the flight deck. The result is similar to the issue of flying drone in sunny condition, you not only lose the drone to the sun, but it is also difficult to see the data in flight controller screen. Pilots and controllers of drone normally manually fly drone with controller or on smart devices using figures on device screens. This task intensive and demands a lot of concentration. In the voice environment and Wi-Fi controlled controller messages Data Comm, messages will be stored in a log—pilots and controllers can update flight plans or retrieve previous messages. This has the potential to reduce data entry errors, workload

Mixed results were also obtained with a speech-only display. In a study by McCarley, Talleur, and Steelman-Allen (2010), instrument-rated commercial pilots communicated with ATC using a text-only display, a synthetic-speech-only display, or a text+speech display. The speech-only condition elicited the longest OTW dwell time. This benefit, however, did not translate into improved flight precision. To the contrary, altitude tracking performance (a measure of flight precision) was lowest in the speech-only condition, compared to all other conditions. In an initial proof-of-concept, Lennertz et al. (2012; Phase I) examined the feasibility of supplementing a visual Data Comm display with synthetic-speech annunciations for GA pilots in the terminal environment. In general, results indicated that supplementing visual Data Comm with synthetic speech is more beneficial and improve flight precision.

Table 1 summarizes past results. It shows that previous studies have documented that the addition of synthetic speech displays to text-displays may yield several safety and efficiency benefits. In particular, that addition of synthetic speech may help to decrease head-down time (Lancaster & Casali, 2008; Lennertz et al., 2012a), yield lower ratings of workload (Lancaster & Casali, 2008), and aid memory for clearances (i.e., the conditional clearance in Lennertz et al., 2012a). The addition of synthetic speech displays to text-displays, however, may come at a cost to flight precision and traffic detection (Helleberg).

CONCLUSION

For research for this paper, I developed a prototype drone to test Wi-Fi and speech control of drone. I used an open source mini drone developed by Crazepony (http://www.crazepony.com/en/) to see if the quad's Bluetooth 4.0 communication platform used by the apps or included controller could be converted to Wi-Fi controller drone to enable the drone to be link with the M2X cloud platform. The second goal of the project I focused on was to see if voice instruction app controller could be stored in M2X cloud and write a program to turn text into speech used to fly the quad-copter.

The finding shows that it was not easy to convert the mini drone Bluetooth to Wi-Fi. It will take more than two days set aside to develop the prototype. A bigger drone able to be integrated with a Wi-Fi buddle was needed. Though, flight controller source was able to be uploaded to M2X cloud, more work needed to be done with integrating GPS coordinates with flight controller source code. For example if you have a drone connected via Wi-Fi in a building given instruction to fly to another part of the building, how would the operator use GPS to develop the waypoints for the drone to fly to. When I was outside and wanted a quad to fly from one location to another I just pointed quad to a location on a map and the drone will flew there. Therefore, the result of the prototype demo revealed areas that the Ubiquity Interface research team need to focus on. They will develop a Wi-Fi buddle for quad copter, develop flight controller integrated with GPS app for M2X cloud, develop speech recognition app for flight plan instructions and quad copter health, develop a chip for LTE cellular Wi-Fi to enable the quad copter to be able to

flow beyond line of sight. If these could be accomplished the Ubiquity Interface Quad Copter will be the smartest most advanced small category aircraft in the market.

Table 1. A summary of past studies to justify the addition of speech to control aircraft which is applicable to the operation of drone.

Study	Conditions	Main findings
Helleberg & Wickens (2003)	- Text only - Speech only - Text + Speech	- Increased flight precision and faster traffic detection with text only compared to other conditions. - Increased OTW scanning and fewer readback errors for text only and text+speech compared to speech only.
Lancaster & Casali (2008)	- Text only - Speech only - Text + Speech	- Less head-down time with Text + Speech compared to Text only. - No difference in time to initiate/comply with instructions or response to a countermanded clearance between Text only and Text + speech.
Steelman et al. (2013)	- Text only - Speech only - Text + Speech	- Lower perception of workload and better altitude tracking for text only and text+speech compared to speech only. - Less head-down time with speech only compared to text only and text + speech.

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