5.1 Conclusion

Many research have beenstudied about RF controlling in drone and find outthat it’s very weak in large distance and behind line of side and needsbetterantenna to reach long distance.
And so move to study more ways to control over large distance and unlimited range.
And so LTE is suitable choiceto control the drone because of many benefits one of them is makingit easier to fly in non -line of sight conditionsfrom the pilot to the multicopter and it makes unlimited range of control.
Many researches have been drone about how to communicate with the drone over LTE, and how to build adrone itself and suitable way to build it and how to assemble and calibrate parts together and test over time to reach the best fly experience.
Thereare many problems encounteredduring this project one of them was hard to get the partsfromthe local market, soenforced to search and buy it over internet from another country ,and that was time consuming , the second one was the signalquality of LTE coverage over distance.

5.2 Recommendation

As future research still some work needs to be done, as this thesis was mainly for building the LTE connection for a drone. It would be good to make redundancy for the LTE control, as one operator networks can be lacking in coverage, and it would grow reliability. Furthermore, more intelligence should be added to handle situations such as complete signal loss and obstacle on the flight path. Good add laser obstacle avoidance and adding gimbals system interfacing camera.

5.3 References

[1]I. Nourbaskhsh and R. Siegwart, "Introduction to autonomous mobile robots," The MIT Press, Cambridge, Massachusetts, England, ISBN 0, vol. 262, pp. 142-150, 2004.

[2]A. Güçlü, "Attitude and altitude control of an outdoor quadrotor," ATILIM UNIVERSITY, 2012.

[3]S. S. Ge, Autonomous mobile robots: sensing, control, decision making and applications vol. 22: CRC press, 2006.

[4] Friedrich, G., 2014. Applications of military and non-military Unmanned Aircraft Systems (UAV). Stralsund: Stralsund University of Applied Sciences.

[5] EASA, 2015. Introduction of a regulatory framework for the operation of drones. Cologne, European Aviation Safety Agency.

[6] Ardupilot Team, 2015. Advanced MultiCopter Design. [Online] Available at: http://copter.ardupilot.com/wiki/advanced-multicopter-design/ [Accessed 4 September 2017].

[7] Gentile, P., 2012. Rise of the Multicopter. Model Aviation, 12, Issue December 2012, p. 46.

[8] Estes Rockets, 2015. 004606W - Proto-X Drone (white). [Online] Available at: http://www.estesrockets.com/helis-quads/quadcopters/004606-proto-x [Accessed 2 September 2017].

[9] e-volo, 2015. VC200 – the first Volocopter to carry two people. [Online] Available at: http://www.e-volo.com/ongoing-developement/vc-200 [Accessed 4 September 2017].

[10] 3D Robotics, 2015. 3DR Pixhawk. [Online] Available at: https://store.3drobotics.com/products/3dr-pixhawk [Accessed 14 September 2017].

[11] Lozano, J., 2015. Are Quadcopters Better Than RC Helicopters?. [Online] Available at: http://uavcoach.com/are-quadcopters-better-than-rc-helicopters/ [Accessed 10 October 2017].

[12] FPV Racing, 2015. FPVRacing.TV. [Online] Available at: https://fpvracing.tv/ [Accessed 18 october 2017].

[13] Amato, A., 2014. 5 Movies Filmed With Drones. [Online] Available at: http://dronelife.com/2014/09/25/movies-scenes-shot-with-drones/ [Accessed 21 October 2017].

[14] CineDrones, 2015. X8 Heavy Lift Cinema Package. [Online] Available at: https://cinedrones.com/store/x8-heavy-lift-aerial-package-for-red-epic/ [Accessed 5 October 2017].

[15] Red Digital Cinema, 2015. *Red Digital Cinema Store.* [Online] Available at: http://www.red.com/store/cameras?f=BAh7B0kiDWNhdGVnb3J5BjoGRUZbBkkiDENBTUVSQVMGOwBGSSILY2FtZXJhBjsARIsGSSIVRVBJQyBNWVNURVJJVU0tWAY7AFQ%253D [Accessed 12 October 2017].

[16] Pölkki, M., 2014. *Robottikopteritalkavattarkastaasähkölinjoja.* [Online] Available at: http://www.hs.fi/kotimaa/a1411589468956# [Accessed 19 August 2017].

[17] Hern, A., 2014. *DHL launches first commercial drone 'parcelcopter' delivery service.* [Online] Available at: http://www.theguardian.com/technology/2014/sep/25/german-dhl-launches-first-commercial-drone-delivery-service [Accessed 18 August 2017].

[18] Posti Oy, 2015. *Postikokeileerobottikopterinkäyttöäverkkokauppatoimituksiin.* [Online] Available at: http://www.posti.fi/tiedotteet/2015/20150901_robottikopteri.html [Accessed 22 October 2017].

[19] Ackerman, E., 2014. *Flying Inventory Assistants Are a Good Use for Drones.* [Online] Available at: http://spectrum.ieee.org/automaton/robotics/aerial-robots/flying-inventory-assistants-are-a-good-use-for-drones [Accessed 22 October 2017].

[20] Griffith, C., 2013. Drones ready to fight fires - if allowed. [Online] Available at: http://www.theaustralian.com.au/business/technology/drones-ready-to-fight-fires-if-allowed/story-e6frgakx-1226748464574 [Accessed 13 October 2017].

[21] Garver, R., 2015. North Dakota Police Can Now Legally Use Taser Drones. [Online] Available at: http://www.cnbc.com/2015/08/28/north-dakota-police-can-now-legally-use-taser-drones.html [Accessed 2 October 2017].

[22] Victor Wolfe, W. F. V. S. T., 2015. Detecting And Locating Cell Phone Signals From Avalanche Victims Using Unmanned Aerial Vehicles. Denver, International Conference on Unmanned Aircraft Systems, p. 10

[23] Simonite, T., 2014. Air Traffic Control for Drones. [Online] Available at: http://www.technologyreview.com/news/531811/air-traffic-control-for-drones/ [Accessed 2017 October 16].

[24] Nicas, J., 2014. What Happens When Your Drone Escapes. [Online] Available at: http://www.wsj.com/articles/what-happens-when-your-drone-escapes-1418086281 [Accessed 20 October 2017].

[25] Lichfield, J., 2014. French government on high alert after unexplained drone flights over nuclear power stations. [Online] Available at: http://www.independent.co.uk/news/world/europe/french-government-on-high-alert-after-unexplained-drone-flights-over-nuclear-power-stations-9850138.html [Accessed 22 September 2017].

[26] Montgomery, K., 2014. Americans Keep Losing Their Drones. [Online] Available at: http://valleywag.gawker.com/americans-keep-losing-their-drones-1632486873 [Accessed 4 September 2017].

[27] Cade, D., 2014. Watch This Camera Drone's 'Return to Home' Feature Slam it Right Into a Cliff. [Online] Available at: http://petapixel.com/2014/10/16/watch-camera-drones-return-home-feature-slam-right-cliff/ [Accessed 9 October 2017].

[28] Drone Trest, 2015. What happens when you have a motor failure on your multirotor?. [Online] Available at: http://www.dronetrest.com/t/what-happens-when-you-have-a-motor-failure-on-your-multirotor/968 [Accessed 15 September 2017].

[29] Villeda, R., 2015. 4 Commercial Planes Report Drone Encounters at Newark Airport: FAA. [Online] Available at: http://www.nbcnewyork.com/news/local/Drone-Crosses-Path-of-Aircraft-at-Newark-Airport-Authorities-321181931.html [Accessed 18 October 2017].

[30] Michel, A. H., 2015. The Age of Drone Vandalism Begins With an Epic NYC Tag. [Online] Available at: http://www.wired.com/2015/04/age-drone-vandalism-begins-epic-nyc-tag/ [Accessed 27 October 2015].

[31] Davis, K., 2015. Two plead guilty in border drug smuggling by drone. [Online] Available at: http://www.latimes.com/local/california/la-me-drone-drugs-20150813-story.html [Accessed 12 October 2017].

[32] Shear, M. D. & Schmidt, M. S., 2015. White House Drone Crash Described as a U.S. Worker's Drunken Lark. [Online] Available at: http://www.nytimes.com/2015/01/28/us/white-house-drone.html?_r=0 [Accessed 15 October 2017].

[33] Brooks-Pollock, T., 2014. Drones 'could be used as flying bombs for terror attack on passenger jet'. [Online] Available at: http://www.telegraph.co.uk/news/uknews/terrorism-in-the-uk/11290086/Drones-could-be-used-as-flying-bombs-for-terror-attack-on-passenger-jet.html [Accessed 10 June 2017].

[34] FAA, 2014. Interpretation of the Special Rule for Model Aircraft, Washington D.C.: Federal Arbitration Act.

[35] Dahan, A., 2014. China's UAS Regulation: An interesting precedent.. [Online] Available at: http://www.suasnews.com/2014/11/32433/chinas-uas-regulation-an-interesting-precedent/ [Accessed 11 April 2017].

[36] Maddalon, J. M. et al., 2013. Perspectives on Unmanned Aircraft: Classification for Civil Airworthiness Standards, Virginia: NASA.

[37] Jansen, B., 2015. FAA approves Amazon drone research again. [Online] Available at: http://www.usatoday.com/story/money/2015/04/09/faa-amazon-drone-approval-prime-air/25534485/ [Accessed 4 September 2017].

[38] Ilmailuhallinto, 2007. Miehittämätönlennokki, ilmailusääntöjä. [Online] Available at: http://mekri.uef.fi/uav/ilmailuhallinto.htm [Accessed 10 September 2017].

[39] Kopterit.net, 2014. Trafiilmailulaki - muutoksia 2014/2015. [Online] Available at: https://www.kopterit.net/index.php?topic=21712.0 [Accessed 10 September 2017].

[40] Trafi, 2015a. Määräysluonnos - Miehittämättömänilma-aluksen ja lennokinlennättäminen, Helsinki: Trafi.