

Cloud Enabled Smart Firefighting Drone Using Internet of Things

N. Jayapandian
Assistant Professor / CSE
CHRIST (Deemed to be University)
Kengeri Campus, Bangalore
jayapandian.n@christuniversity.in

ABSTRACT

Internet of Things is fasted booming sector. This technology is evolved in various fields. The frequent updates in concerning the progress of Skyscraper fire or high-rise fire it is essential for us to ensure effective and safe firefighting. Since high-rise fire is typically inaccessible by ground vehicles due to some constraints or parameters. Due to less advancement in technology most skyscrapers are not furnished with proper fire monitoring and prevention system. To solve this issue this article is propose Unmanned Air Vehicles (UAVs) are making an appearance and making promises to prevent such kind of incidents. In this system, UAV can be launched from the Fire Control Unit (FCU). The proposed methodology is implemented with the help of Internet of Things (IoT). Sensors which are installed at the skyscraper detects the presence of fire and immediately send stress signals to the command and control unit from where further possible action can be taken. The pilot at the fire control unit continuously monitors the flight path and receives the video and fire scan information from the UAV. Upon detection of a stress signal or fire signal the Skyscraper position is determined with the help of Global Positioning System (GPS) and permission is requested from the applicable security agency to launch the extinguisher vehicle. The permission is granted, the coordinates of the location are filled in the system and the nearest station sends the UAV to the location. The fire suppressant are deployed it comes back to the nearest landing location and re-loaded with another fire suppressant to be carried to the fire location. The proposed methodology should improve the Quality of Service.

Index Terms – Internet of Things, Service Oriented Architecture, Security, Protocol, IoT Layers.

I. INTRODUCTION

The last few decades, Robotics community has developed a huge interest in the field of Unmanned Aerial Vehicles because of their small size and efficient working of those devices. Quadcopters are one of the members of these Aerial Vehicles and they are capable of vertical take-off. The Quadcopter is made up of four rotors, Control unit and battery [1]. It is operated by varying the RPM of rotors to control lift and maintain torque. Quadcopter takes off with the help of thrust produced by the rotors and this thrust plays a major role in maintaining the quadcopter during its airborne [2]. A path planning algorithm is required for the autonomous movement

of the drone that is without the human intervention [3]. These high-payload platforms are normally capable of carry on-board sensors such as Inertial Measurement Unit (IMU). This on-board visual camera is used for visual surveillance and RTK navigation system. Quadcopters are provided with the GPS coordinates and with the help of navigation system they are able to reach at their destination [4]. The figure 1 is to elaborate functional directions of drone technology.

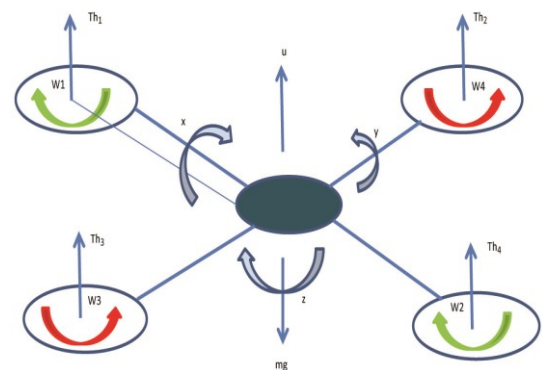


Figure 1: Drone Direction Architecture

The role of high-rise buildings is to provide shelter to human beings or create workspaces for the wellbeing system. However, every year many properties get damaged due to fire incidents and due to lack of fire safety systems many people lost their lives. To avoid such kind of huge loss a fire extinguisher ball was designed which can be carried by Unmanned Aerial Vehicle to reduce risks associated with skyscraper fire, human lives and firefighter crew [5]. A fire extinguishing ball is a sphere shaped product which contains Non-toxic Mono Ammonium Phosphate and weight is less than 1.5 kg. It can be activated within 10 seconds after getting in contact with fire [6]. The special advantage of this method is no training is required to handle this ball. To getting in contact with fire it explodes and spreads all the Non-toxic chemical powder to all over the place. This ball weight is between 1.5 to 1.7kg also it has been 147mm diameter. In the

modern technology this ball is available different variety and size. The minimum ball size is 0.5kg. The maximum ball size is 1.3 to 1.4kg. Medium size is also available; the weight of that ball is 0.7kg. These balls are having standard certifications, for example these fire balls some companies is having ISO certifications. Three different classes are classified in this ball material. The class A is material of solid burning, then class B is the liquids and final Class C is categorized as electrical items. This ball is really helpful in fire industry, it reduce the man power [7]. Naturally it is developed by plastic material with additional advantage is water proof technology. Inside of this fire ball is filled with powder this should be harmless. Two popular brands are very famous in sector, first one is Elide this should be developed and marketed in the year of 1997. Second one is AFO; it can be introduced in the middle of 1990 – 2000. These brands are designed and manufactured initially Thailand and china [8]. The advancement of recent trends this technology has gained with the various industries. Many big companies have started to launch IOT based products and services. The tech companies acknowledge that IOT has a huge opportunity in the future [9]. Internet of Things is basically derived by embedded system, it should be working both internal and external environment. The word IOT comprises mainly of two words one is “INTERNET” another one is “THINGS. The major aim of IOT is to provide device connectivity to the entire network. This is three pillar technologies; first one is electronic circuit development. Second one is wireless communication it will help to establish the device connection. Third one is network protocol structures. It will create a space for each and every device with a unique identity so that these things will be able to communicate and exchange data while executing meaningful applications towards a common user or machine. Each Internet of Things device is having unique ID that ID is assigned by the help of IP address. The imminent of connectivity and reachability is defined by IOT. This Internet of Things is a latest and powerful modern technology working with the help of internet connection [11]. This is multi-functional technology involvement that means combination of several techniques. That technologies are cloud computing and portable sensor based devices. One of the trending technologies in IT industry is cloud computing which is going to revolutionize the whole world [12]. It is a transformative computing paradigm that involves delivering applications and services over the Internet. It takes computing to whole new level that is modern technology help to reduce the computational cost. At the same time modern computational power is systematically controlled. The help of cloud computing is a large data centre can be integrated in our smart phones [13]. This cloud technology is basic origin of computing technology. Scalability is one of the major helpful factors in this computing platform. Also this can be working in virtual server in different geographical areas. Cloud is major dealing of storage and bandwidth [14].

In general wireless device and networks are used to monitor the environmental and physical conditions in computational distributed system. In this cloud wireless devices are handling

with power consumption and data bandwidth problems [15]. A WSN consist of a number of end-nodes and routers and a coordinator, each node have several sensors attached to them. Nodes can also act as a router which is responsible for routing the data packets from one node to the coordinator. These kinds of sensors are used in smart city device [16]. The coordinator collects the data from all the nodes. The Coordinator acts as gateway that connects the WSN with the internet. The deployment of such smaller wireless sensors helps us in delivering information to internet which opens many novel application domains. Fault tolerance is one of the major components in wireless device. Then gateway protocol system is help to connect one wireless device to other device. This technology is combined with the RFID tag; this can help to finding the position of that IoT device.

II. RELATED WORK

The modern world information technology and IT service is plays a major role in technology development. This IT service is an important and unavoidable one in the common life, there are many applications developed by this IT service. One of the major applications is Internet of Things. This Internet of Things is applied in various fields, this article should focus on to solve high-rise building fire by using quadcopter fire extinguish system. This IoT technology is involved in larger industry to develop higher end embedded system. This embedded system is old technology but not modern internet technology is incorporated with this system [17]. This IoT technology is used to monitor the object and increase the machine performance. This technology is normally working with future products with the help of wireless communication system. For effectiveness firefighting, the images received from satellite are of very low temporal and spatial resolution and not much effective in populated areas. Restrictions are imposed on ground measurement equipment due to surveillance ranges. Firefighters require frequently high resolution images regards to fire behavior which is mainly used for automatic aerial drone system. It is designed by multiple components like sensors and embedded circuits. This vehicle is detecting the fire automatically based on radiation also it takes photo of that fire. This image is really useful for taking further decision for that fire. The modern trends, this drone technology is economically very affordable for day to day usage. The main advantage of this modern technology is not required for special training. But at the same time lesser flexibility compare to other modern device [18].

The Internet of Things is a global network connection also it takes intelligent decision. IoT is by and large described by genuine world and little things with constrained capacity. It is also preparing limit and considerable issues with respect to dependability, execution, security and protection. Cloud computing has for all intents and purposes boundless capacities in terms of capacity and preparing power. This technology is also used in solar power management [19]. It is a considerably more experienced innovation and has the greater part of the IoT issues at any rate in part tackled. Cloud

computing along with IOT is the next biggest thing which is going to revolutionize the Internet. This cloud computing is major evaluation in technology field. This cloud and IoT combined process is provide better solution in technology. Distributed environment system is additional benefit of cloud computing. Same way IoT is also working in distributed environment. RFID technology is play vital role in this IoT device; based on this technology each IoT device is getting unique identification. This technology is middleware connection and establishes the reliable communication [20]. Wireless Sensor Networks is the middleware which acts as gateway to connect things with the Internet. The smart computing algorithms are used to provide better computational power in IoT device [21]. This computational power is serving device to device connection [22].

The data from the sensors will make significant information in the Internet. Best example of lowest power embedded system is this sensor based wireless network connection. These devices are controlled with different sensors and operated by port connection. These sensors monitored the different system parameters. That parameter is temperature of that device and current state of that device. The purpose of this technology is less power consumption at the same time computational cost is also very low. All these technology are controlled and operated by internet connection.

III. PROBLEM STATEMENT

In all over world fire accidents have been increasing in a unexpected way because of electric short-circuit, kitchen fires, careless smoking, children playing with matchstick and candles. The firefighting is detect based on fire smoke, combusting factual are providing better solution for this problem. In general they maintain oxygen level; normal oxygen level is 21%. Sometime oxygen short will happen that time it is up normal condition of less than 19%. Third one is elevated temperatures and final one is toxic atmospheres. These hazards cause various types of serious injuries and loss to personal property which lasts forever because curation of these injuries is next to impossible. Since we do not emphasize on being proactive fire safety always take a back burner in any country. The normal uneducated people's still not having aware of this fire hazards. Also once it is happen the normal people are not having proper knowledge for escaping. Whenever a fire incident takes place people starts creating panic and instead of resolving the incident starts to run here and there which creates many injuries to local people. Due to lack of proper fire safety systems for preventing fire many people suffer from casualties. In modern building construction like apartment structures, more number of peoples staying in one particular building. That kind of situation fire is happen means people don't know how to come out of that building, that scenario this firefighting drone is helpful. Firefighter's faces a lot of difficulties while evacuation because they have to travel a great vertical distance. Due to traffic, sometimes firefighters do not reach at time which clues to massive loss of property and people lives. In High-rise buildings or in densely populated region it is very

difficult for fire fighters to reach at the location where fire has occurred and to extinguish it. When fire takes places it not only risks the lives of people who are stuck in it but also the firefighters risk their lives to extinguish the fire. All over world there are very less Fire brigade trucks and very less people who engage themselves in this work. For prevention of fire in high rise buildings huge investment is needed for implementing fire safety systems and people always try to run away from investing in those plans which increases a risk of lives. In hospital is best example of this kind of fire incident.

IV. PROPOSED MODEL

The proposed solution is to extinguish fire at a very early stage so as to prevent huge loss. Regardless of whether in the home or work environment, the significance of powerful fire security can't be focused on enough. One of the real dangers related with firefighting tasks is the dangerous condition made by burnable materials. Noteworthy dangers are burn, oxygen insufficiency, raised heats, and harmful airs. Extra perils incorporate sprays and auxiliary breakdown, compound the issues experienced that poisonous situation. To battle a portion of these dangers, firemen need to hold independent breathing hardware which is not very secure to prevent risk of their lives. The firefighter is need reasonable health fitness; also they need some guidelines for operating those machines. Firefighting requires abilities in flame concealment, salvage, and dangerous materials relief. Firemen should likewise have, or have the option to procure, information of office associations; it should consult so as to play out their obligations. In order to avoid all these things and ensure a safe method for firefighting a special technology has been adopted which is combining Internet of Things with Fire Extinguisher Drone. In this technology drones can carry fire extinguisher material with them and drop it off at the desired location for this to work smoothly and properly. Drone should have internet connectivity and it should be continuously updating its location with the help of GPS. The Drone should be embedded with collision avoidance sensor and a camera and it should have good stability while flying. The figure 2 proposed methods for implementing this technology embarks with a high rise building catching a vast fire. It is difficult for firefighters to reach to that fire and extinguish the fire. The solution for this problem is to embed all buildings with Fire/Smoke detecting sensors. These sensors are able to detect the presence of fire and can send stress signals over the cloud using Internet of Things. The stress signal is received to the Fire Control Unit (FCU) they can verify whether the fire is big or small and whether it is possible for the drone to complete its task. The authority is grants access to perform drone technology.

This operation will send the details of fire location to the Drone Flight Planning Unit, where the team of experienced users will develop a flight plan for the drone for its successful execution of the operation. The drone is pre-embedded/loaded with high quality cameras, thermal sensors, collision detection sensors with a fire extinguisher ball. After the successful examination of the drone, the drone will be launched from the

station for its mission's execution. The Drone specialist will be continuously monitoring the flight plan of the drone and as well as the condition of the drone. In case of any emergency, the specialist will control the drone with the help of flight controller or it the drone can be called off from the operation in the mid-way. After reaching at the desired location the specialist will find a way to let the drone enter into the fire and drop the fire ball.

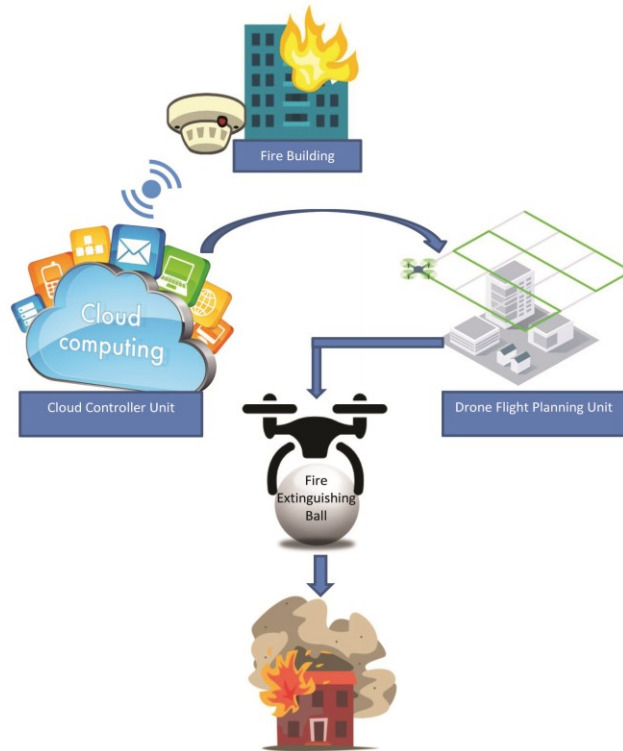


Figure 2: IoT Based Drone Firefighting Architecture

And as soon as the ball is dropped from the drone the drone will move back towards the station. Now the fire extinguisher ball after getting in contact with fire within 15 seconds it will explode and will release all the Non-toxic material into the area which will eventually cause the fire to get extinguish. The fire still persists another drone will be used for extinguishing the fire by the same method. This will repeat until fire gets completely extinguished. The proposed solution will not only extinguish the fire but also save lives of people because there is no direct involvement of any human being for extinguishing. The fire all the work is performed by a non-living creature (drone) and incase if any emergency occurs to drone it will automatically return back to its home position. The foremost motivation is behind multi-reason airborne automations, or unmanned ethereal vehicles (UAVs). It is to lessen the danger of damage or death toll because of putting out fires and scaffold examining. By actualizing a practical way to deal with creating a UAV to quenching flames and examining spans, labor can be limited, which will thusly expand wellbeing and diminish the dangers of wounds and fatalities engaged with either assignments.

V. CONCLUSION

In recent days, increase in fire incidents over the past few decades many lives have been lost and a vast number of properties got devastated. To solve the issue and reduce the loss of lives a smart solution is been implemented which not only reduces time to extinguish a fire but also saves lots of life. Unmanned Air Vehicles (UAVs) are making an appearance and making promises to prevent such kind of incidents. The solution uses IoT technology and Cloud computing along with quadcopter which carries fire extinguishing ball to extinguish the fire. The use of this technology reduces the efforts made by firefighters and ensures safety of water because in case of any fire incident enormous amount of water gets wasted. The use of this technology will revolutionize the world and it can reduce the number of fire incidents happening in the world.

REFERENCES

- [1] Mahmood, A., & Kim, Y. Decentralized formation flight control of quadcopters using robust feedback linearization. *Journal of the Franklin Institute*, 354(2), 852-871. (2017)
- [2] 2. Pan, Y. J., Werner, H., Huang, Z., & Bartels, M. Distributed cooperative control of leader-follower multi-agent systems under packet dropouts for quadcopters. *Systems & Control Letters*, 106, 47-57. (2017)
- [3] 3. Niu, H., Lu, Y., Savvaris, A., & Tsoordos, A. An energy-efficient path planning algorithm for unmanned surface vehicles. *Ocean Engineering*, 161, 308-321. (2018)
- [4] 4. Trujillo, J. C., Munguia, R., Guerra, E., & Grau, A. Cooperative monocular-based SLAM for multi-UAV systems in GPS-denied environments. *Sensors*, 18(5), 1351. (2018)
- [5] 5. Roosjen, P. P., Brede, B., Suomalainen, J. M., Bartholomeus, H. M., Kooistra, L., & Clevers, J. G. Improved estimation of leaf area index and leaf chlorophyll content of a potato crop using multi-angle spectral data-potential of unmanned aerial vehicle imagery. *International journal of applied earth observation and geoinformation*, 66, 14-26. (2018)
- [6] 6. Alshbatat, A. I. N. Fire Extinguishing System for High-Rise Buildings and Rugged Mountainous Terrains Utilizing Quadrotor Unmanned Aerial Vehicle. *International Journal of Image, Graphics & Signal Processing*, 10(1). (2018)
- [7] 7. Ambekar, A., & Yoh, J. J. A reduced order model for prediction of the burning rates of multicomponent pyrotechnic propellants. *Applied Thermal Engineering*, 130, 492-500 (2018)
- [8] 8. Aydin, B., Selvi, E., Tao, J., & Starek, M. J. Use of Fire-Extinguishing Balls for a Conceptual System of Drone-Assisted Wildfire Fighting. *Drones*, 3(1), 17. (2019)
- [9] 9. Swamy, S. A., & Jayapandian, N. Secure Bitcoin Transaction and IoT Device usage in Decentralized Application. In *2018 3rd International Conference on Communication and Electronics Systems (ICCES)* (pp. 271-274). IEEE (2018)
- [10] 10. Li, S., Da Xu, L., & Zhao, S. The internet of things: a survey. *Information Systems Frontiers*, 17(2), 243-259 (2015)
- [11] 11. Amadeo, M., Campolo, C., & Molinaro, A. Information-centric networking for connected vehicles: a survey and future

- perspectives. *IEEE Communications Magazine*, 54(2), 98-104. (2016)
- [12] 12. Dikaiakos, M. D., Katsaros, D., Mehra, P., Pallis, G., & Vakali, A. Cloud computing: Distributed internet computing for IT and scientific research. *IEEE Internet computing*, 13(5), 10-13 (2009)
 - [13] 13. Jayapandian, N., & Md Zubair Rahman, A. M. J. Secure Deduplication for Cloud Storage Using Interactive Message-Locked Encryption with Convergent Encryption, To Reduce Storage Space. *Brazilian Archives of Biology and Technology*, 61 (2018)
 - [14] 14. Jayapandian, N., Rahman, A. M. Z., & Gayathri, J. The Online Control Framework on Computational Optimization of Resource Provisioning in Cloud Environment. *Indian Journal of Science and Technology*, 8(23), 1. (2015)
 - [15] 15. Centenaro, M., Vangelista, L., Zanella, A., & Zorzi, M. Long-range communications in unlicensed bands: The rising stars in the IoT and smart city scenarios. *IEEE Wireless Communications*, 23(5), 60-67 (2016).
 - [16] 16. Jayapandian, N. Threats and Security Issues in Smart City Devices. In *Secure Cyber-Physical Systems for Smart Cities* (pp. 220-250). IGI Global (2019).
 - [17] 17. He, J., Lo, D. C. T., Xie, Y., & Lartigue, J. Integrating Internet of Things (IoT) into STEM undergraduate education: Case study of a modern technology infused courseware for embedded system course. In *2016 IEEE Frontiers in Education Conference (FIE)* (pp. 1-9). IEEE (2016).
 - [18] 18. Vergouw, B., Nagel, H., Bondt, G., & Custers, B. Drone technology: Types, payloads, applications, frequency spectrum issues and future developments. In *The Future of Drone Use* (pp. 21-45). TMC Asser Press, The Hague (2016).
 - [19] 19. Jayapandian, N., Rahman, A. M. Z., Poornima, U., & Padmavathy, P. Efficient online solar energy monitoring and electricity sharing in home using cloud system. In *2015 Online International Conference on Green Engineering and Technologies (IC-GET)* (pp. 1-4). IEEE (2015).
 - [20] 20. Adame, T., Bel, A., Carreras, A., Melià-Seguí, J., Oliver, M., & Pous, R. CUIDATS: An RFID–WSN hybrid monitoring system for smart health care environments. *Future Generation Computer Systems*, 78, 602-615 (2018).
 - [21] 21. Raj, J. S. Qos Optimization Of Energy Efficient Routing In Iot Wireless Sensor Networks. *Journal of ISMAC*, 1(01), (2019).
 - [22] 22. Kumar, R. Praveen, and S. Smys, A novel report on architecture, protocols and applications in Internet of Things (IoT). In *2018 2nd International Conference on Inventive Systems and Control (ICISC)*, pp. 1156-1161. IEEE, 2018.