DEXTRA – A Drone Localization System

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Abstract:

In this new era of technology there are a great demand of embedded systems through which we can control various equipments useful in our day to day life. It has a great scope and requirement in almost every field like industry, transportation, communication, infrastructure, security so on. With the usage of a large number of heterogeneous sensor devices that contain processing capability, sensor(s) and actuator(s), a power source, multiple types of memory and a radio frequency (RF) based transceiver we can build amazing smart devices useful for rescue operations. Natural disasters, such as earthquake, Landslides and avalanche, have caused great loss of lives and property each year, which makes emergency monitoring and rescue an imperative problem to be addressed. Thus we designed a novel monitoring and rescue system based on wireless sensor network (WSN) for disaster scenarios, which combines environment monitoring, information transmission, and emergency localization. In our system, fast localization through WSN is a crucial technique for searching and rescuing along with an addition of UAV(Unmanned aerial vehicle) technology. Unmanned Aerial Vehicle can stay in the air for up to 30 hours, doing the repetitive tasks, performing the precise, repetitive raster scan of the region, day-after-day, night-after-night in the complete darkness or in the fog and under computer control. We further used LoRa(Low Range Low Power) technology for further rescue operation.

Introduction:

This project is build specifically for rescue operations. Every year, numerous people lose their lives in the earthquake, typhoon, debris flow, and other natural disasters all over the world. Many tragedies occurred because of inefficient disaster report and rescue. On one hand, infrastructures including cell sites, signal towers, telecom bases would be damaged heavily after a disaster. On the other hand, the injured people might lose their mobility or even the ability to speak to send signal for help. Thus, localization and disaster rescue becomes a challenging problem under disaster scenarios. In this case, we can resort to wireless sensor network (WSN) to detect the injured, to recover basic communication and to other emergency scenarios. Wireless sensor network is the most efficient way for our project.

Initiative:

So this all came in to picture when an incubation lab called cisco thingQbator gets opened in our campus. This is the first lab which gain my attention a lot as it's allow me to work on something which is of my interest. Thus with full excitement and thrill, I applied for its application process. Since during that time I was fascinated by the UAV(Unmanned aerial vehicle)technology so I thought of using this technology in my project of cohort1. I made a proposal accordingly along with my friend and submit it for further selection process. After few days the results got declared and our proposal got selected for actual implementation and execution. Later on due to other commitments my friend back out from the project but as I am very excited about this idea I want to take it on ahead. So I searched for other team members and yes I got some wonderful people from my own college who are willing to join me and ready to work together in this project.

My Role and Contribution:

Though the technology I applied for was quite new to me and very challenging as well because being a software engineer I never work on hardware much but thankfully my team members are fully aware about it as they are from mechanical and electrical branch. So we started working on the project and being an IT professional I want to add on some of my skills on the project as well, thus with the help of mentors we work on the LoRa technology for the localization process. We divided the work 2members each on hardware and software. Then the development of project take place further and we build localization system with three major devices beacon, locator and rescue station through which we can locate buried victim under snow and send rescue system as soon as possible. Thus this will enhance the rescue and search operation. My major role in the respective project is handling the software part and to present the idea to the audience. The devices we have built are shown in the diagram:

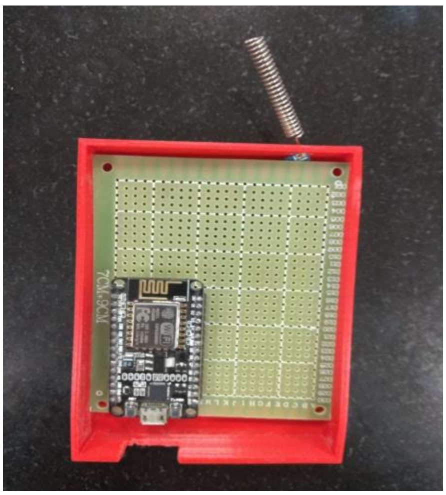

Fig1: Locator

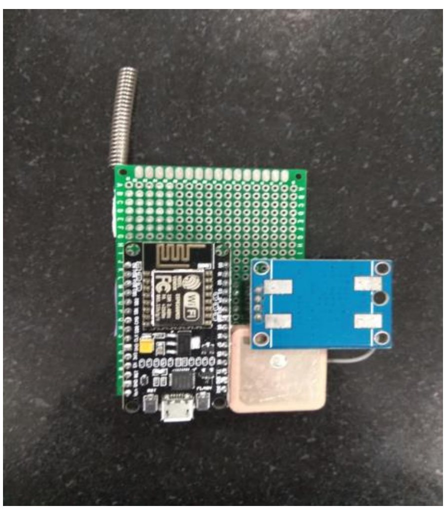

Fig2: Beacon

Another important aspect of this project is to work with UAVs for the first time. This is something we have never done but always want to try thus we build one drone that will be an add on to our system and enhance its functioning. This we build all together and name the whole rescue system as **DEXTRA.**

Our plan is to use a drone to detect a victim as in the unfavourable areas it would be efficient way to use this technology to increase the rescue operation. Unmanned Aerial Vehicle can stay in the air for up to 30 hours, doing the repetitive tasks, performing the precise, repetitive raster scan of the region, day-after-day, night-after-night in the complete darkness or in the fog and under computer control. They greatly reduce putting the military personnel in harm's way or in combat, They have low cost, and are cheaper to purchase, fuel, and maintain than the regular airplanes.

The drones can have more pinpoint accuracy from greater distances thus reducing the collateral damage to the civilians and the infrastructure. The drones are as lethal to the enemy combats as regular airplanes. Drones offers low risk, Since the drones are smaller and they can fly lower than the traditional airplanes, there is less risk to the military hardware, Without the human pilot and they can stay in operation for longer hours of operation without fatigue. The average flight time is a couple hours and can go up to an impressive 16 hours or more if the drone is gas engine powered Fixed wings can fly at a high altitude They are more forgiving in the air than other models And have the ability to carry more weight thus used efficiently in the accomplishment of our project.

Fig3: Drone

Technical Challenges:

The biggest technical challenge that we face during the working of this project is to make this drone autonomous. As dealing with such hardware is already a new thing for us and now making it autonomous is the biggest challenge.

Though this is tough but with the help of good mentors and a strong determination of team we build our first autonomous drone. As right now in our country a proper protocols needs to be follow to drive such vehicles thus we thought of approaching government so that this project can actually be used to save various lives in our country during such natural calamities.

Further this can also be used for Defense rescue operation for our military safety.

Learning Experience:

Working on this project has been a great learning experience for all of us as we did something which is relevant to the society and serve good purpose to the community as well.

I too got a chance to work on something challenging which I have never done before. Also we met with some very good mentors who helped us all through in this journey and make this experience even more fruitful and memorable for the whole team.

References:

1. M. Aernouts, R. Berkvens, K. Van Vlaenderen, and M. Weyn. Sigfox and lorawan datasets for fingerprint localization in large urban and rural areas. Data, 3(2):13, 2018.
2. W. Bakkali, M. Kieffer, M. Lalam, and T. Lestable. Kalman filterbased localization for internet of things lorawanTM end points. In Personal, Indoor, and Mobile Radio Communications (PIMRC), 2017 IEEE 28th Annual International Symposium on, pages 1–6. IEEE, 2017.
3. A. Dongare, C. Hesling, K. Bhatia, A. Balanuta, R. L. Pereira, B. Iannucci, and A. Rowe. Openchirp: A low-power wide-area networking architecture. In Pervasive Computing and Communications Workshops (PerCom Workshops), 2017 IEEE International Conference on, pages 569–574. IEEE, 2017
4. B. C. Fargas and M. N. Petersen. Gps-free geolocation using lora in low-power wans. In Global Internet of Things Summit (GIoTS), 2017, pages 1–6. IEEE, 2017.
5. Z. He, Y. Li, L. Pei, and K. O'Keefe. Enhanced gaussian process based localization using a low power wide area network. IEEE Communications Letters, 2018.
6. K.-H. Lam, C.-C. Cheung, and W.-C. Lee. Lora-based localization systems for noisy outdoor environment. In Wireless and Mobile Computing, Networking and Communications (WiMob),, pages 278–284. IEEE, 2017.
7. K.-H. Lam, C.-C. Cheung, and W.-C. Lee. New rssi-based lora localization algorithms for very noisy outdoor environment. In 2018 IEEE 42nd Annual Computer Software and Applications Conference (COMPSAC), pages 794–799. IEEE, 2018.
8. R. Nandakumar, V. Iyer, and S. Gollakota. 3d localization for subcentimeter sized devices. In Proceedings of the 16th ACM Conference on Embedded Networked Sensor Systems, pages 108–119. ACM, 2018.
9. N. Podevijn, D. Plets, J. Trogh, L. Martens, P. Suanet, K. Hendrikse, and W. Joseph. Tdoa-based outdoor positioning with tracking algorithm in a public lora network. Wireless Communications and Mobile Computing, 2018, 2018.
10. F. Wolf, C. Villien, S. de Rivaz, F. Dehmas, and J.-P. Cances. Improved multi-channel ranging precision bound for narrowband lpwan in multipath scenarios. In Wireless Communications and Networking Conference (WCNC), 2018 IEEE, pages 1–6. IEEE, 2018.
11. Basic communication protocol between lora gateway and server. https://github.com/Lora-net/packet_forwarder/blob/master/PROTOCOL.TXT.
12. Wireless sx1276 lora module. http://modtronix.com/inair9b.html.
13. J. Yang, Y. Chen, "Indoor localization using improved rss-based lateration methods", *GLOBECOM 2009-2009 IEEE Global Telecommunications Conference*, pp. 1-6, Nov 2009.
14. N. Salman, A. H. Kemp, M. Ghogho, "Low complexity joint estimation of location and path-loss exponent", *IEEE Wireless Communications Letters*, vol. 1, no. 4, pp. 364-367, August 2012.
15. N. Patwari, A. O. Hero, M. Perkins, N. S. Correal, R. J. O'Dea, "Relative location estimation in wireless sensor networks", *IEEE Transactions on Signal Processing*, vol. 51, no. 8, pp. 2137-2148, Aug 2003.
16. R. W. Ouyang, A. K.-S. Wong, C.-T. Lea, "Received signal strength-based wireless localization via semidefinite programming: Noncooperative and cooperative schemes", *IEEE Transactions on Vehicular Technology*, vol. 59, no. 3, pp. 1307-1318, 2010.
17. A. Bel, J. L. Vicario, G. Seco-Granados, "Localization algorithm with on-line path loss estimation and node selection", *Sensors*, vol. 11, no. 7, pp. 6905-6925, 2011.
18. B. Hofmann-Wellenhof, H. Lichtenegger, E. Wasle, GNSS-global navigation satellite systems: GPS GLONASS Galileo and more, Springer Science & Business Media, 2007.
19. H. S. Kim, J. B. Park, Y. H. Joo, "A position accuracy enhancement algorithm for a low-cost gps receiver under distance boundary consideration", *Robotics and Automation Engineering (ICRAE) International Conference on*, pp. 83-86, 2016.
20. D. Sathyamorthy, S. Shafii, Z. F. M. Amin, A. Jusoh, S. Z. Ali, "Evaluating the trade-off between global positioning system (gps) accuracy and power saving from reduction of number of gps receiver channels", *2015 International Conference on Space Science and Communication (IconSpace)*, pp. 221-224, Aug 2015.
21. A. El Abbous, N. Raissouni, A. Azyat, N. Samama, "A software post-processing method for gps receiver's accuracy characterization", *Electrical and Information Technologies (ICEIT) 2015 International Conference on*, pp. 154-159, 2015.
22. N. Drawil, H. Amar, O. Basir, "A solution to the ill-conditioned gps accuracy classification problem: Context based classifier", *GLOBECOM Workshops (GC Wkshps) 2011 IEEE*, pp. 1077-1082, 2011.
23. C.-S. Ho, "An effective approach in improving a-gps accuracy to enhance hybrid positioning computation", *Embedded and Real-Time Computing Systems and Applications (RTCSA) 2011 IEEE 17th International Conference on*, vol. 1, pp. 126-130, 2011.
24. K. Venkatraman, B. Amutha, S. R. Sankar et al., "A hybrid method for improving gps accuracy for land vehicle navigation system", *Emerging Trends in Robotics and Communication Technologies (INTERACT) 2010 International Conference on*, pp. 74-79, 2010.
25. J.-i. Meguro, T. Murata, J.-i. Takiguchi, Y. Amano, T. Hashizume, "Gps accuracy improvement by satellite selection using omnidirectional infrared camera", *Intelligent Robots and Systems 2008. IROS 2008. IEEE/RSJ International Conference on*, pp. 1804-1810, 2008.
26. K. Nakajima, T. Tanaka, "Study on accuracy improvement under bad condition in gps", *SICE 2004 Annual Conference*, vol. 1, pp. 234-238, 2004.
27. O. Siebert, "The impact of expected satellite availability on global positioning system (gps) accuracy", *Satellite Systems for Mobile Communications and Navigation 1988. Fourth International Conference on*, pp. 178-180, 1988
28. M. Hashemi, H. A. Karimi, "A machine learning approach to improve the accuracy of gps-based map-matching algorithms", *Information Reuse and Integration (IRI) 2016 IEEE 17th International Conference on*, pp. 77-86, 2016.
29. Mobile Experts White Paper for LoRa Alliance: Where does LoRa Fit in the Big Picture, LoRa Alliance, Nov 2015.