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Autonomous Robots that can Navigate & Explore

Machine learning has caught a lot of traction in recent years for autonomous systems to make decisions based on classifiers. Many robots can be seen using such methodologies in exploration and automation of processes. However, the algorithms and implementation for each case is not the same; for flying vehicles, they are limited in the variety of sensors onboard due to weight restrictions and are unable to support 2D algorithms adopted by ground vehicles *(Ziparo 2013)*. The complexity of ground vehicles also faces many challenges in sensor accuracy and correction in localization.

There are many mathematically intensive paradigms which serve as a basis in solving a popular problem in navigation and localization problems (also known as the simultaneous localization and mapping problem). These paradigms include graph-based optimization, the extended Kalman filter and particle filtering. SLAM exists because autonomous exploration robots do not necessarily have a premade map for navigation and error in sensor data is plausible. As the robot roams in an unknown environment it faces the problem of accuracy in building the map while simultaneously determining its position relative to the map. Projects such as the ROVINA project, an EU-funded project, are developed with LIDAR (light detection and ranging) technology for precise measurements in environment mapping and are mainly used in exploration of dangerous environments. Its capabilities expanded to also being able to make use of semantic information to identify interesting artifacts *("One Small Step for Robots, One Giant Leap for Robot-kind?" 2016)*.

Particle filtering makes use of Bayesian statistics, the idea of posterior probability of a random event or uncertain proposition is that of a conditional probability assigned after using all relevant information. A lot of systems wanting to capture human motion use such paradigms as there is a lot of uncertainty as to what an event can be identified as. Unlikely possibilities are not thrown away but rather kept and are constantly updated in the case one of them is the outcome but were simply deferred by noisy data *(Deutscher et al. 2000)*.

I find that this topic of SLAM and automation in exploration algorithms is very relevant currently. With the introduction of wearable devices there has been a demand in being able to accurately track and classify human motion. Especially with the rising topics of the Internet of Things (IoT) we can expect more compact devices to be just as capable as these bulky robots. Platforms such as the Intel Edison can develop and implement programs which can learn simple human motion and perform particle filtering for localization (with the help of detecting Wi-Fi strength). By being able to track and map human motion we can more accurately pinpoint a location or count the miles walked by a wearables user. Products such as the Fitbit run into problems in which steps are accounted for despite absence of the event. Being able to track these kinds of activities are in the interest of the growing trend of eHealth – incorporating systems which can track a patient's routines to provide doctors with accurate data (as compared to hearing it from the patients themselves).

Another critical application of these autonomous robots would be those seen in various DARPA challenges. Natural disasters and catastrophic events are difficult to deal with in the urban setting as collapsed buildings are dangerous for rescue teams to search through. Using autonomous robots or drones, recuse efforts can be more effective in identifying where people are located. The ROVINA project maps ancient ruins and catacombs which are deemed dangerous for archeologists. With advances in autonomous navigation and machine learning more efficient products and work can be done unsupervised. In the new future, it could be the case that robots can take care of urban cities using navigation techniques.

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