

Popular Summary

Society has always been dependent on good navigation. From using the stars to navigate the seas, or simply just remembering landmarks to help you go back to an area where there is a plentiful source of food. These systems of navigation still exist today but with more urbanised areas and a vastly greater number of people, the demand and precision has also increased. In modern society, the vast majority of mobile phones, cars and planes all have a high requirement of good navigation and positioning. For mobile phone users, it can help you find your way to a specific shop, find local services you may require and also give your location to others in an emergency. For cars, it can help you find your way from one place to another and update the route depending on traffic, or to avoid tolls for instance.

One of the main systems that is used today, is Global Positioning System (GPS). This system has been effective on meeting the high demands of the users, but it comes with its drawbacks. In urban areas, where the majority of people today live, the buildings can block the signals from the GPS Satellites. This in turn means the positioning of users can become inaccurate.

So how can we overcome this issue? This is the key question of this thesis. Here, we explore using other radio based systems to help navigate and position indoors. One key infrastructure which already exists in urban areas is Wi-Fi. Most homes and offices, even telephone boxes, have a Wi-Fi router in them. As part of our work, we have developed methods to find these routers in order to use them as landmarks to help navigate indoors. One of the main issues we have incurred due to the complex indoor environment, is that Wi-Fi measurements we use can also become inaccurate. In our methods we try and find a model in the data in order to identify the bad measurements. By doing so we can ignore the bad measurements and accurately find the locations of such Wi-Fi routers.

We also looked at new radio technologies to further increase our precision. These advancements have the potential to help society greatly, and meet the increased needs of navigation in the future. As we come into the new era of wireless devices, commonly known as 5G, more and more devices will require positioning and navigation. This generation of wireless devices has been developed to meet the demands of the Internet of things (IoT). IoT is

the idea of objects with internet capabilities, such as a toaster. These IoT devices usually have some form of radio based communication system, such as Wi-Fi, Bluetooth or Ultra-Wideband (UWB). Although a toaster may not have a need for positioning, IoT devices could be installed on robots, hospital equipment and even packages. Having the ability to find or help these objects to navigate is important and advantageous to society. In this thesis, we also explore using our previous methods to find these radio based devices, in an environment where there are many devices and multiple users to help give insight to future requirements.