APTAS (Advanced Personal Tracking & Analyze System) Design Document

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Introduction

In order to satisfy the needs of a), the APTAS is designed to track and analyze individual activities in big shopping centers, provides individuals with helpful advice to ensure them a safer journey and gives observers processed real-time information, helping them to monitor and act when emergency happens. Personal background information, locations, routes, behaviors and crowd scale are chosen to be focused on, as they are crucial data which will be used to fulfil APTAS's key functions.

Three iterations of investigation and design have been conducted. During the first stage of investigation, several popular contact-tracing applications such as Safe2go and Google Health are analyzed, the result is obvious that route tracking is the key feature when identifying risks. Thus, the aim was set to implement route tracking inside a specific area with much greater details, with a set of routes, every individual can be tracked precisely, and every contact can be calculated, also potential hazard can be predicted. The second stage focused on efficiency. As general tracking applications have great scale of background support, APTAS is implemented by service buyers independently with limited resources, in order to work in real-time, priority marking is introduced. Throughout a series of monitoring methods like motion sensor, target identification, personal background information analysis, high risk individual will be given higher observation priority, more resources are distributed to them. The last stage confirmed APTAS with route tracking as main function, facial recognition, behavior analysis, surrounding analysis, route optimization and emergency strategies as support, provide useful solutions to both users and observers.

Stakeholders are the Government, service buyers, developers, business partners. For the government and service buyers, APTAS will provide them a better approach to promote social stability and safety. For developers, they get support from the government and financial benefit as service buyers purchase the system. For business partners, they will get gain sharing since they provide service for APTAS.

Summary

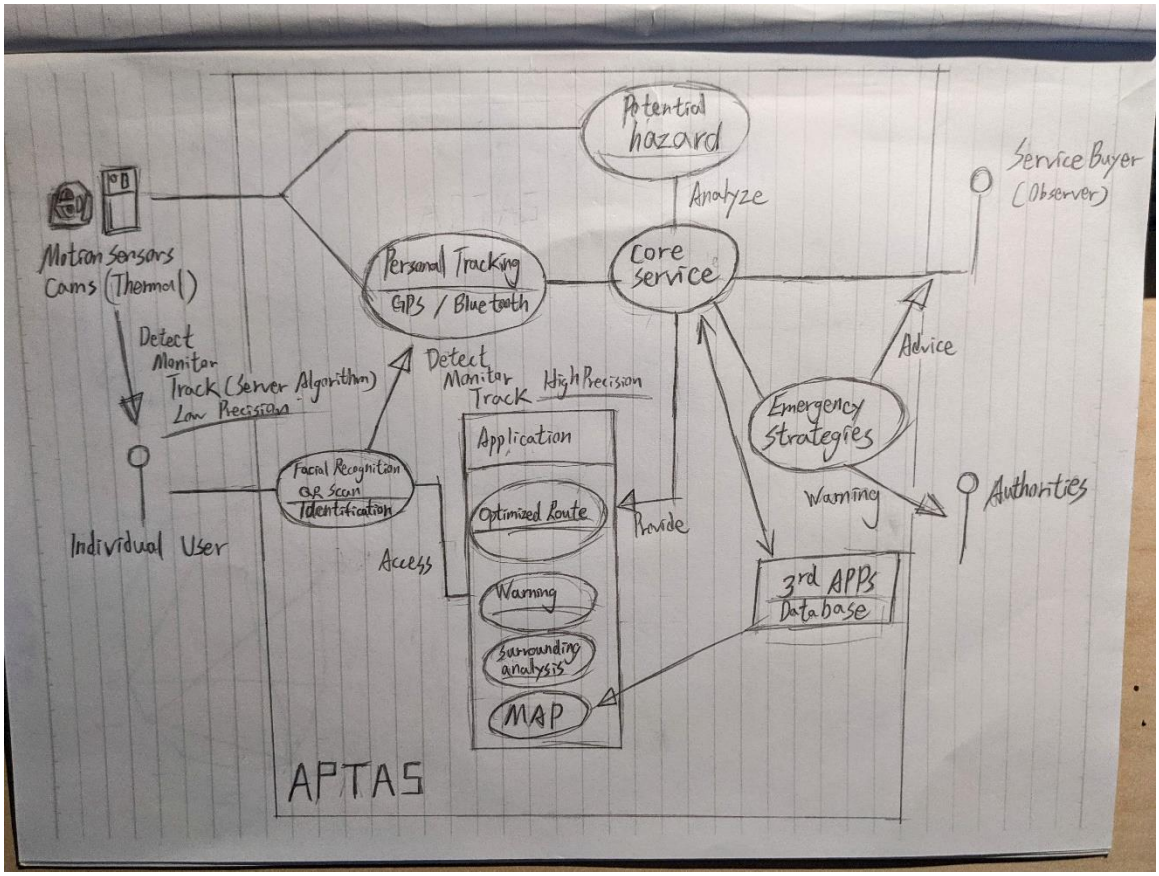
As overview, APTAS is designed to: offer optimized paths and warnings to users to avoid over-crowding areas, therefore reducing potential contagion risk; real-time route tracking for every individual, provide observers with a clear view; identify potential hazard personals and zones and mark them with high observation priority; generate real-time emergency strategies for hazard and crowd control accordingly.

Service buyers such as shopping centers will implement this solution to obtain safety and control of their commercial areas during pandemic period, individual users as shoppers are required to use this solution as soon as they enter the area, APTAS will provide them convenience and safety. Service buyers need a server system to run APTAS, also a series of motion sensors and monitoring cams with background real-time target identification support should be installed. Individual users can choose to install APTAS application on their mobile devices for full experience, or simply scan the QR code to sign in for real-time personal tracking, GPS or Blue Tooth permission is required.

Although APTAS is dedicated to shopping centers, it can be modified to be operational for other large-scale areas like theme parks and museums. APTAS server-side service is required to be operated on Windows and Linux, at user's end it is compatible with Android and IOS since they are the most popular mobile systems, a special version of Google Map is embedded, and NHS

connection is active constantly. Data link with Safe2Go, Google Health and other tracking applications will also be enabled if permitted by users.

Requirements



As shown by the UML graph, it can be classified as 3 types of users, which are individual users, service buyers and authorities (NHS, government, etc.).

For individual users, they are identified at first to be marked and tracked by APTAS. If mobile application is installed, advanced features like route optimization, hazard warning and surrounding analysis would be available for users. Either way, GPS or Blue Tooth permission is required to track down single individual, this is a high precision solution comparing to motion sensors and monitor cameras, which provide lower precision and work as an alternative approach.

For service buyers, through the core service of APTAS they are informed of every movement and route of users in real-time. Link to business partners' database will provide detailed information on every single individual, with existing data and integrated analysis algorithm, potential hazard personals and zones are automatically calculated and highlighted, emergency strategies will be generated accordingly.

For Authorities such as NHS and government, they will be warned whenever an emergency happens.

A powerful server bank, efficient core algorithm, fast and stable network connection, reliable backups, fail-safe measures, trained and professional workers, 24h technical support and third-party supervisions are also key non-functional requirements that need to be addressed.

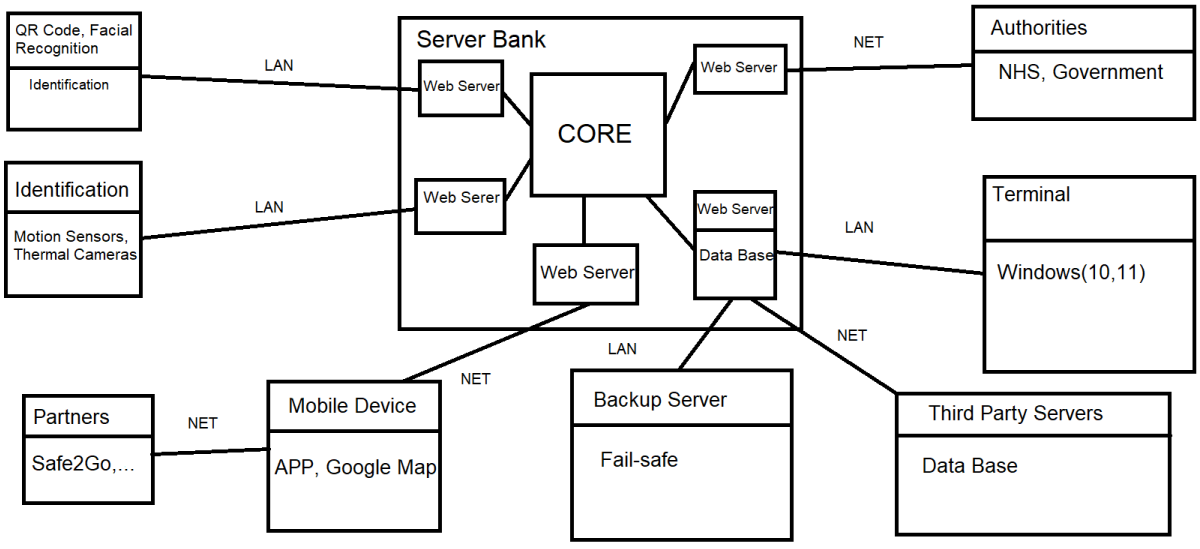
Using the Proposed Solution

Different cases are simulated during development. In common case, individual user is required to scan QR code or be facial scanned before entering the area. After identifying, APTAS server will fetch data from NHS and service partners' database, core service will begin analyzing and decide observation priority. The users can choose to install APTAS application as they scanned the QR code, therefore they can check their current location through embedded Google Map. Besides, users can check their surroundings to see if there are potential hazard dangers, thus, to avoid them. As the main function, users will be advised with optimized routes towards their destinations, these routes are analyzed and generated by the application. If the permission is granted, user can also establish link between different applications to get better experience.

Observer can track down every individual's movement, potential dangers are highlighted and warned. The whole area is divided into several sections for better control, overcrowded area: average distance between personals is shorter than 1 meter, over 50 personals, is marked to be in high priority for monitoring. Any action of frequent coughing or high body temperature captured by thermal cameras with target identification algorithm will also be marked as potential hazard threat.

When a user appears to have Covid related symptoms, APTAS will mark the section to be locked down immediately. This user's complete route and close contacts will be investigated and given NA test. Authorities will be informed; medical and police personals will arrive to assist hazard control.

Implementing the Proposed Solution



As the implementation diagram indicates, APTAS's hardware consists of a server bank, a backup server, web servers dedicated to different uses, operating terminals for observers, thermal cameras, motion sensors, QR codes, facial recognition devices and user's mobile devices are required for APTAS to be fully functional. The server bank and backup server can be located at site or being cloud services. Third party database, user application, GPS and Blue Tooth signals, thermal camera and motion sensor signals, facial recognition, and communication with authorities, they all have dedicated web servers to receive, send, process, and linked to core server through local area network and hardware connections.

On software level, in order to achieve best performance and easy maintenance, the server bank is operated on Linux system, and the interactive terminals are operated under Windows environment. User application is developed to be operational on Android and IOS. As it was mentioned, location display function is provided by Google Map which is embedded. The application is also optimized to interact with other popular tracking applications such as Safe2Go. Accessibility is considered and implemented to help people with visual difficulties, key elements size can be adjusted, optimized color plans for deuteranomalous and achromatopia can be selected. There is no advertisement inside the application in order to provide user a clean and satisfying experience.

Python, C++, Java, as well as web, database, and other technologies will be used to develop APTAS. The core algorithms include facial recognition, personal tracking, route calculation and prediction, involves deep learning, neural network, and target identification (YOLO, Paddle Detection). Sufficient network bandwidth should be calculated and given, also a backup server with similar scale with multiple fail-safe measures should be operated alongside the main server bank. All APTAS operators need to be fully trained and be able to deal with possible system malfunctions. Moreover, a professional technical support team is at standby 24 hours in order to deal with emergencies. Third party supervisors need to monitor the uses and data safety of APTAS in routine to prevent illegal usage.

Conclusion

It is certain that APTAS is a relatively complex system which involves in not only technical issues but also legal, ethical, and sociological concerns. As APTAS depends heavily on personal data, it is crucial these data are protected and used in strict legal form. APTAS is designed to defend data from hacker attacks, the solution needs to be updated from time to time. As mentioned before, third party supervisors are involved to make sure APTAS's stuff won't do anything illegal. Meanwhile, there are still ethical concerns about what kind of data APTAS is collecting. From design perspective, user's location and behavior are the only key data that matters, however after processing, these data might generate predictions which would endanger privacy. For these data, they won't be used in any form and will be destroyed after a day's operating cycle. In terms of sociological, APTAS is aimed to promote stability and safety for the public. Still, there are concerns that the observation priority and potential hazard analysis might raise unnecessary panic, this is reasonable to some extent, therefore the public should be told not to worry too much and be respectful to each other.

Regarding to software engineering principles, APTAS has a well-designed life-cycle plan, the development stages will take approximately 2 months with a budget of £20m, each stage follows iterative water fall model, supported with continuous testing and validation. The alpha version is planned to be released after the first month, then followed with bug fixing and optimization, beta version should be released 2 weeks after. Final product will be deployed at the end of the second month with complete post-launch support. After launch, server and service maintenance, security and quality update, evaluation on product and feature improvement will be delivered by developers in a routine. Additional support will be delivered when emergency happens.

Although APTAS is well-planned, yet there are limitations and problems need to be investigated further. Personal tracking solution still lack efficiency even though the character of priority is introduced. Neural network algorithm was carried out to calculate and predict personal movements accordingly, however, personal tracking needs to be in great precision, the algorithm will never achieve the same accuracy compared to real signal tracking. Through constant machine learning which would take a great number of samples and time, this problem would be solved. There is also an outstanding issue whether APTAS can be fully functional under complicate environment is still unknown. APTAS has already gone through many tests, it still needs to be tested with real scenarios, which would be much crueler, not only APTAS system will be battletested, the hardware and stuffs will also face with consecutive challenges.