

Research on security control technology of smart community based on personnel positioning management

Chao Long^a, Wenjing Wu^b, Donglin Wang^c, Wenxia Liu^d

Tianjin architectural design and Research Institute Co., Ltd, TianJin, China

^almflongchao@126.com, ^bwuwenjing-2002@163.com, ^cwangdonglin3898@126.com,
^dliuwenxia2018@163.com

Abstract. as the place where residents live, safety has always been the top priority of community construction. Safety has also become one of the important factors for residents to choose the community. At present, there are common problems in the community, such as large personnel flow, chaotic data management and weak comprehensive management ability. At the same time, there is a large flow of people in the community, and public security incidents occur from time to time. It is difficult to solve the problem of personnel management only through traditional security control means. Based on face recognition and Bluetooth positioning, community identity verification, personnel positioning and trajectory analysis management are realized. Through the positioning analysis of community personnel, combined with face recognition and other intelligent systems, comprehensively improve the quality of community security.

Key words: Bluetooth technology beacon technology face recognition personnel location.

1. Introduction

The rapid development of Bluetooth technology has spawned the landing of various Internet of things applications. More and more people use high-precision indoor positioning technology to locate and manage personnel. Among them, the positioning technology based on Bluetooth has attracted more and more attention because of its small size, easy implementation and high universality. Focusing on the construction of safe city and smart city, this paper actively promotes the deep integration of modern information technologies such as animal networking and artificial intelligence with the planning, construction and management services of residential communities, so as to create a safe smart residential community. Through face recognition technology, face control, trajectory analysis and crowd density management of community personnel can be realized. Combined with beacon technology, carry out accurate positioning management of personnel, effectively solve the difficulties of community personnel management and control, improve the level of community security management and control, and effectively enhance the sense of security and happiness of residents.

2. Smart community face recognition control platform

For the key control areas of the community, combined with the epidemic prevention and control and temperature measurement needs of the community, face recognition cameras are set at the main entrances and exits of the community in combination with the pedestrian gate. In key areas with high personnel mobility and easy to gather, face recognition cameras are set in combination with light poles or building exterior walls, and combined with data analysis platform to realize real-time identity verification and alarm for all people entering and leaving, so as to improve the safety factor of public places.

The management platform consists of four parts: front-end device layer, transmission layer, platform layer and intelligent application layer. The front-end equipment realizes face information collection. Combined with the equipment situation, the data is summarized to the big data platform through the transmission layers such as equipment IP network, WiFi and nb-iot. The front-end data is subject to face feature extraction and data comparison. Combined with intelligent algorithms, the

comprehensive intelligent applications such as face control, trajectory analysis and people flow density of community personnel are realized.

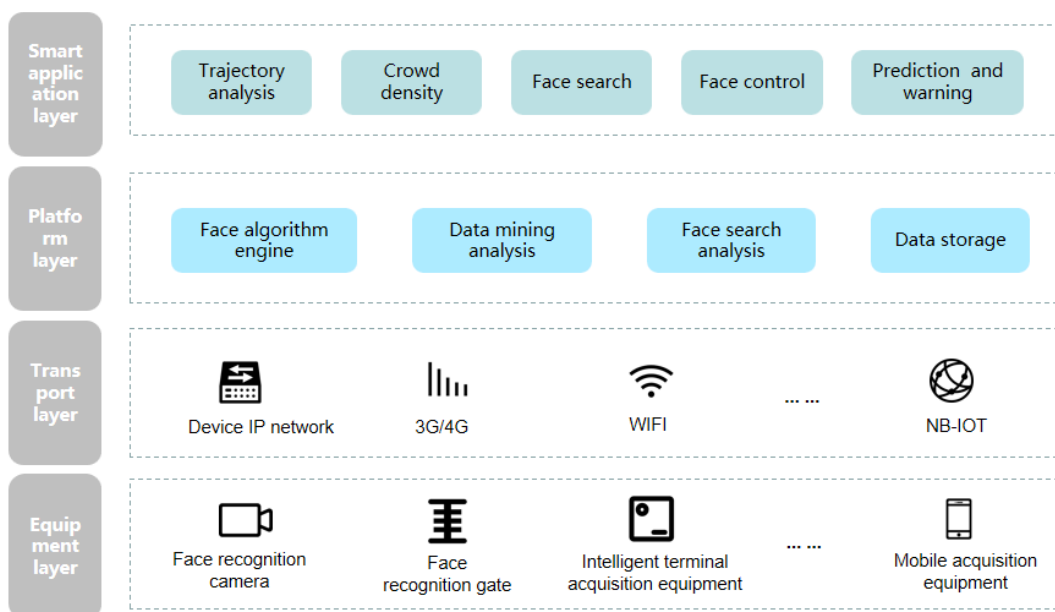


Figure 1. architecture of smart community face recognition control platform

The face recognition management and control platform can realize:

1) Real time control: comprehensively improve the safety factor of public places through face recognition technology, 360 ° monitoring without dead corner, automatic non perceptual face comparison, improve service experience and reduce human investment

2) Intelligent analysis of crowd density: through big data analysis, the platform makes statistical analysis on the crowd information of the community, makes real-time comparative analysis on the crowd, predicts the crowd blocking point in advance, reduces the risk of large-scale personnel gathering, and improves the comprehensive safety management level of the community.

3) Track tracking and post judgment: after the accident, the management personnel can trace the activity time and scope of the suspect through the platform to provide clues and evidence for the police to solve the case.

4) Static identity recognition and confirmation: the platform can connect the information of permanent population database and migrant population information database, and establish a community black-and-white list. According to the face data information captured in the platform, search and check in the population information database to confirm the identity of the suspect.

3. Personnel positioning based on beacon Technology

For the positioning of community personnel, this paper adopts the combination of PDR technology and beacon technology. Pedestrian dead reckoning (PDR) is a commonly used mobile positioning technology, which estimates the actual position in real time through intelligent sensors. Beacon protocol integrates micro positioning and push, and provides scene awareness while using RSSI ranging and positioning. The combination of the two technologies realizes the positioning of community personnel through smart phone sensors.

3.1 PDR Technology

PDR technology accurately infers the real-time position of personnel by estimating the step length and heading angle of personnel through smart phone sensors. The initial heading angle can be

obtained by using the acceleration sensor and geomagnetic sensor of smart phone, and the real-time heading angle can be calculated by gyroscope.

The position reached in step k is shown in formula (1). The position coordinates of the personnel are represented by (x_n, y_n) , where (x_0, y_0) represents the starting position of the personnel, and the initial position can be obtained through the Bluetooth base station. L_i represents the estimated step size of step i , and θ_i represents the heading angle of step i .

$$\begin{cases} x_k = x_0 + \sum_{i=1}^k L_i \cos \theta_i \\ y_k = y_0 + \sum_{i=1}^k L_i \sin \theta_i \end{cases} \quad (1)$$

PDR algorithm shall be calculated in combination with step length and heading angle. The specific calculation method is as follows:

1) Calculation of step frequency and step length

During walking, the vertical acceleration will change periodically. Through acceleration analysis, calculate the time interval of alternating acceleration peaks, and infer the pedestrian's step frequency.

For the step estimation, the existing research shows that there is a relationship between the step and the acceleration value when pedestrians walk, and the estimation model of the step is calculated by formula (2):

$$L_i = c_0 * \sqrt[4]{V_{max} - V_{min}} - c_1 \quad (2)$$

Where V_{max} and V_{min} represent the maximum and minimum values of acceleration values respectively, and c_0 and c_1 are constants.

2) Heading angle calculation

The heading angle calculation can collect the data of accelerometer and geomagnetic meter through smart phone; Processing to obtain the rotation matrix; Calculate the initial heading angle. After obtaining the initial heading angle, collect the gyro angular velocity value and convert it into quaternion; Obtain the rotation matrix; Calculates the rotation about the Z axis.

3.2 beacon single point location algorithm

Beacon base stations are installed and deployed at a fixed distance for personnel positioning in community light poles, building eaves or indoor ceilings. When the personnel's smartphone enters the coverage of beacon base station, it can obtain RSSI signal and calculate the current distance d . As shown in Figure 2, if the height of the base station from the ground is h and the maximum allowable error of ranging is r , the radius of the inner area is the threshold, and the current position $P(x,y)$ meets the requirements as shown in formula (3):

$$P(x, y) = P_{ibeacon}(x, y), d < \sqrt{h^2 + r^2} \quad (3)$$

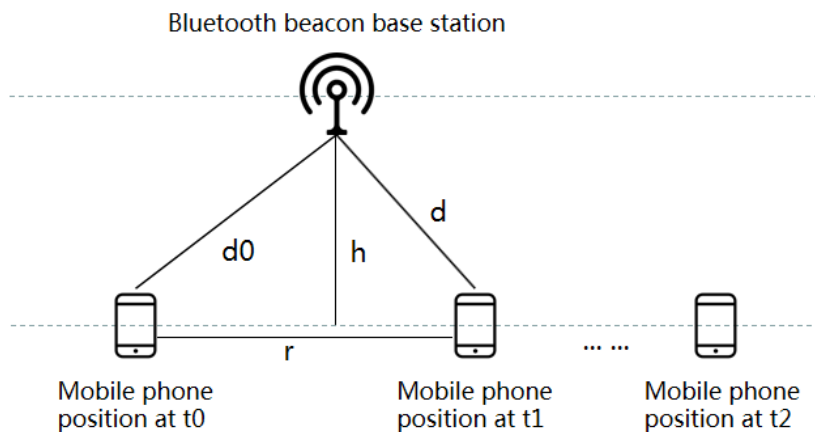


Figure 2. Schematic diagram of Bluetooth positioning

The beacon base station deployed in the community will periodically uniquely identify the UUID and RSSI (signal strength) values of the broadcasting equipment. When a person carries a smartphone to the coverage of beacon base station, the distance between them can be calculated through RSSI value. The common transmission model is shown in formula (4):

$$r = r_0 + 10n \log\left(\frac{d}{d_0}\right) \tag{4}$$

Where r represents the RSSI value currently received, r_0 represents the RSSI value 1m away from the beacon base station, and n represents the environmental attenuation factor. d_0 is the distance from the reference point, usually taken as 1m. According to the RSSI transmission loss model, the ranging formula (5) can be obtained:

$$d = 10^{\frac{r-r_0}{10n}} \tag{5}$$

The above formula is the ranging formula obtained according to the classical model of signal strength, which is used to calculate the actual distance from the mobile terminal to the beacon base station. Finally, combined with the location of the base station, it can be converted to the location of the indoor coordinate system, so as to locate the personnel.

Based on the above personnel positioning algorithm, four Bluetooth beacon base stations are set in the indoor area, including base station 1 coordinate (0,0), base station 2 coordinate (0,5), base station 3 coordinate (5,0) and base station 2 coordinate (5,5). Through the positioning algorithm and fixed time interval, calculate the distance between the test mobile phone and each base station, and get the location as shown in the table below.

Table 1. Indoor positioning results

Time interval (10s)	Distance from base station 1 (unit: m)	Distance from base station 2 (unit: m)	Distance from base station 3 (unit: m)	Distance from base station 4 (unit: m)
Time 1	1.4	4.0	5.7	4.2
Time 2	2.9	4.2	4.3	2.9
Time 3	4.2	3.3	2.9	3.9

4. Application analysis

In this paper, the personnel positioning based on beacon technology can be used in a variety of indoor scenes, such as communities, shopping malls, exhibitions, museums, hotels, campuses and so on. This paper takes the community as an example to introduce the application.

1) Care for special groups in the community

Community face recognition and personnel positioning can take care of special groups such as the elderly and the disabled living alone in the community. Combined with the face recognition system, it can detect the access information of specific personnel. When the platform detects that there is no access information of special personnel for many consecutive days, the system will automatically alarm and remind the property and management personnel to visit and check the situation in time.

2) Wisdom perimeter

For personnel supervision, the location of the elderly or children can be managed in real time to prevent loss. The virtual perimeter can be set in combination with the personnel activity range, and the functions of cross-border alarm, detention alarm and long-time static alarm can be analyzed and realized in combination with the personnel position data. Prevent the elderly and children from leaving the safe area and entering the dangerous area to avoid accidents.

3) Intelligent patrol

The personnel positioning platform can realize the intelligent patrol inspection of community property managers, view the real-time patrol inspection supervision of managers through the real-

time accurate positioning of property managers, and analyze and manage the historical patrol inspection track.

4) Intelligent early warning analysis

Personnel positioning technology can conduct efficient data analysis. Through the platform, you can view the personnel location and thermal map distribution in the community in real time. Assist the property management personnel to grasp the location of personnel in real time to prevent personnel from gathering.

5. Conclusion

To sum up, aiming at the pain points of community security, this paper analyzes and gives the architecture of smart community face recognition management and control platform, and analyzes the application of face recognition in the community. Based on Bluetooth beacon technology, the personnel location algorithm is deduced, and the personnel location scheme is given. Through the analysis of personnel positioning application, the intelligent application scenario is analyzed and given, the community data analysis application is enhanced, and the community security quality is comprehensively improved.

References

- [1] Luochangwei, Yu Jun, Yu Lingyun, Li Yali, Wang Shengjin Overview of research progress in 3D face recognition [j] Journal of Tsinghua University: Natural Science Edition, 2021, 61 (1): 12Wang S, Liu K, Yu L, et al. Analysis for Low Cost Inertial Sensors Based Pedestrian Dead Reckoning[J]. Springer International Publishing, 2014.
- [2] Wangshaochu, Liu Yu, haowenfei, et al Recognition method of human movement based on inertial sensing [j] Journal of electronic measurement and instrumentation, 2014, 28 (6): 7.
- [3] Khan S D, Basalamah S. Multi-Scale Person Localization With Multi-Stage Deep Sequential Framework[J]. International Journal of Computational Intelligence Systems, 2021, 14(1).
- [4] Wang Y, Xu Y, Zhao Y, et al. Bluetooth positioning using RSSI and triangulation methods[C]// Consumer Communications and Networking Conference (CCNC), 2013 IEEE. IEEE, 2013.
- [5] Zhou C, Yuan J, Liu H , et al. Bluetooth Indoor Positioning Based on RSSI and Kalman Filter[J]. Wireless Personal Communications, 2017.
- [6] Zhou Guolin, Hu Wei, Xiong Jian Research on personnel positioning technology of underground comprehensive pipe gallery based on ibeacon [j] Journal of underground space and engineering, 2019 (S01): 6.
- [7] Deng Ping, zhufeixiang, zhaorongxin, et al An inertial navigation indoor positioning method based on accurate correction of heading angle [j] Chinese Journal of inertial technology, 2020, 28 (6): 7.
- [8] Shizhijing, xutiefeng, liutaijun, et al Research on indoor positioning technology based on ibeacon base station [j] Mobile communication, 2015 (7): 4.
- [9] Dinglin, Guan Xiaowei, Zhu Xia Design of cluster real-time positioning system based on RSSI [j] Foreign electronic measurement technology, 2014 (12): 5.
- [10] Shi Xin, Yin Aimin, Chen Xi Multi-dimensional scale indoor location algorithm based on RSSI [j] Journal of instrumentation, 2014, 35 (2): 8.
- [11] Wu Jian, Wang Xiu Design of PDR enhanced indoor positioning method based on ibeacon technology [j] Journal of Fuzhou University: Natural Science Edition, 2017, 45 (5): 6.