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COMPARATIVE ANALYSIS OF TRACKING OBJECTS USING DIFFERENT METHODOLOGIES

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Abstract: *Object tracking is very vital task in many application of computer vision such as surveillance, vehicle navigation, autonomous robot navigation, etc. It contains detection of amusing moving objects and tracking of such objects from frame to frame. Its main task is to find and follow a moving object or multiple objects in image sequences. This paper present a brief survey of various video object tracking techniques like radar, sensor networks and wireless tracking algorithms. Also it presents Comparative study of all the techniques.*

Keywords: *frame, sensor networks, wireless, radar*

ӘРТҮРЛІ ӘДІСТЕМЕЛЕРДІ ПАЙДАЛАНАТЫН БАҚЫЛАУ ОБЪЕКТІЛЕРІН САЛЫСТЫРМАЛЫ ТАЛДАУ

Аңдатпа: *Объектілерді бақылау маңызды міндеттердің бірі болып табылады, мысалы, қадағалау, көлік құралдарын тасымалдау, автобусқа бағыттаушы роботтарды және т. б. Одан бөлек объектілерді қозғалысқа келтіретін және кәдімгі кадр объектілерін қадағалауды қамтиды. ЕО негізгі міндеті – объектілерді немесе объектілерді кейінірек табу үшін іздеп көріңіз. Бұл мақалада радиобайланыс, сенсорлық желілер мен желісіз бақылау алгоритмдері сияқты бейнеобъектілерді бақылаудың әртүрлі әдістерін критикалық түрде ұсынады. Сондай-ақ, барлық әдістермен салыстырмалы түрде алынған.*

Түйінді сөздер: *кадр, сенсорлық желілер, сымсыз, радар*

СРАВНИТЕЛЬНЫЙ АНАЛИЗ ОБЪЕКТОВ СЛЕЖЕНИЯ С ИСПОЛЬЗОВАНИЕМ РАЗЛИЧНЫХ МЕТОДОЛОГИЙ

Аннотация: *Отслеживание объектов является очень важной задачей во многих приложениях компьютерного зрения, таких как наблюдение, навигация транспортных средств, автономная навигация роботов и т.д. Оно содержит обнаружение забавных движущихся объектов и отслеживание таких объектов от кадра к кадру. Его основная задача - найти и проследить за движущимся объектом или несколькими объектами в последовательности изображений. В этой статье представлен краткий обзор различных методов отслеживания видеообъектов, таких как радар, сенсорные сети и алгоритмы беспроводного отслеживания. Также представлено сравнительное изучение всех методик.*

Ключевые слова: *рамка, сенсорные сети, беспроводная связь, радар*

I. INTRODUCTION

Smartphone application nowadays provides numerous useful ways for users to encompass their proficiencies of their phone [1]. The report articulates that there are more than 1+ million applications and 50+ billion downloads [2] both in PLAY store for Android and APP store for Apple products. The stated numbers are considered as valuable downloads by users. Unfortunately, there are considerable security and secrecy risks which were reported by a research [3]. After that mobile OS developers made an option to the users to turn on/off the location service accessibility for specific applications. The effectiveness of fine-grained controls has not been resolved so for. In the recent development mobile app developers for iOS or Android designed in such a way to prompt a pop-up get permission from users to get the location service access.

The idea on cellular based location tracking makes the usage range and measurement of network system. It was analyzed and the probability of rectifying only two range system [4]. Location tracking of the user was via mobile network and in later stages via GPS [13] service was addressed as privacy issues. And also illustrates the user privacy while tracking their location without their knowledge [5]. Likewise, we have other method to get information of the object/person. Here we considered sensor, radar, RFID [16] and cellular network [18] and created a comparison of all this.

This paper provides a complete review of existing technology of tracking. The remaining part of the paper is organized as follows: in Section 2, algorithms for measuring & positioning using wireless are provided. Section 3, impact of the radar on the tracking. Section 4, RFID based evaluation for tracking and comparison.

II. ALGORITHMS FOR MEASURING &POSITIONING USING WIRELESS

A. Triangulation

It uses geometric properties of triangles to find the location of the target object. Under geometric properties we have two (literation and angulation) [11]. Literation - estimates the position of an object by measuring its distances from multiple reference points. So, it is also called range measurement techniques. Instead of measuring the distance directly using received signal strengths (RSS)[18], time of arrival (TOA) or time difference of arrival (TDOA) is usually measured, and the distance is derived by computing the attenuation of the emitted signal strength or by multiplying the radio signal velocity and the travel time.

a. TOA

TOA measurements must be made with respect to signals from at least three reference points. It uses below formulae to get the accuracy of the location.

$$F(x) = \sum_{k=0}^{n} a^k f^2 \quad (1)$$

Where, k is the measuring unita is reflect the reliability of the signal received

b. TDOA

The idea of TDOA is to determine the relative position of the mobile transmitter by examining the difference in time at which the signal arrives at multiple measuring units [10], rather than the absolute arrival time of TOA. We have the below formulae to determine the TDOA

$$P(i,j) = \sqrt{(xi-x)^2+(yi-y)^2+(zi-z)^2} - \left(\sqrt{(xj-x)^2+(yj-y)^2+(zj-z)^2}\right) \quad (2)$$

This (xi, yi, zi) and (xj , yj , zj) represent the fixed receivers i and j; and (x, y, z) represent the coordinate of the target

1. Scene Analysis

RF-based scene analysis refers to the type of algorithms that first collect features (wireless) of a scene and then estimate the location of an object by matching online measurements with the closest a priori location fingerprints [9]. RSS-based location fingerprinting is commonly used in scene analysis. In this scene analysis we have few methods to prove

a. Probabilistic Method

One method considers positioning as a classification problem. Assuming that there are n location candidates L1, L2, L3 ,..., Ln , and is the observed signal strength vector during the online stage, the following decision rule can be obtained

b. The other techniques are kNN and neural network. By using kNN averaging uses the online RSS to search for k closest matches of known locations in signal space from the previously-built database according to root mean square errors principle [6]. By averaging these k location candidates with or without adopting the distances in signal space as weights, an estimated location is obtained via weighted kNN or unweighted kNN. In this approach, k is the parameter adapted for better performance.

B. *Proximity*

Proximity algorithms provide symbolic relative location information. Usually, it relies upon a dense grid of antennas, each having a well-known position. When a mobile target is detected by a single antenna, it is considered to be collocated with it [4-5]. When more than one antenna detects the mobile target, it is considered to be collocated with the one that receives the strongest signal [17]. This method is relatively simple to implement. It can be implemented over different types of physical media. In particular, the systems using infrared radiation (IR) and radio frequency identification (RFID) are often based on this method. Another example is the cell identification (Cell-ID) [7] or cell of origin (COO) method. This method relies on the fact that mobile cellular networks can identify the approximate position of a mobile handset by knowing which cell site the device is using at a given time. The main benefit of Cell-ID [11] is that it is already in use today and can be supported by all mobile handsets.

III. IMPACT OF THE RADAR ON THE TRACKING

The local-area wireless networks have fostered a growing interest in location-aware systems and services. A key distinguishing feature of such systems is that the application information and interface presented to the user is, in general, a function of his or her physical location [13]. The granularity of location information needed could vary from one application to another [3],[9]. For example, locating a nearby printer requires fairly coarse-grained location information whereas locating a book in a library would require fine-grained information.

While much research has focused on developing services architectures for location-aware systems, less attention has been paid to the fundamental and challenging problem of locating and tracking mobile users, especially in in-building environments [17]. The few efforts that have addressed this problem have typically done so in the context of infrared (IR) wireless networks. The limited range of an IR network, which facilitates user location, is a handicap in providing ubiquitous coverage. Also, the IR network is often deployed for the sole purpose of locating people and does not provide traditional data networking services. To avoid these limitations, we focus on RF wireless networks [19] & [22] in our research. Our goal is to complement the data networking capabilities of RF wireless LANs [21] with accurate user location and tracking capabilities, thereby enhancing the value of such networks.

In this paper, we present RADAR, an RF-based system for locating and tracking users inside buildings. RADAR uses signal strength information gathered at multiple receiver locations to triangulate the user's coordinates. Triangulation is done using both empirically-determined and theoretically computed signal strength information.

The primary motivation for the radio propagation model is to reduce RADAR's dependence on empirical data [22]. Using a mathematical model of indoor signal propagation, we generate a set of theoretically-computed signal strength data akin to the empirical data set. The data points correspond to locations spaced uniformly on the floor [23]. The NNSS algorithm can then estimate the location of the mobile user by matching the signal strength measured in real-time to the theoretically-computed signal strengths at these locations. It is clear that the performance of this approach is directly impacted by the "goodness" of the propagation model. In the following subsections, we develop the model and discuss the performance of location determination based on the model given by equation (3).

$$P(d)[dBm] = p(d0)[dBm] - 10nlog(d/d0) - \\ - \{nW * WAF \; nW < C, C * WAF \; nW > = C \quad (3)$$

Table 1 shows the used parameters.

Where n indicates the rate at which the path loss increases with distance, P(do) is the signal power at some reference distance do and d is the transmitter-receiver (T-R) separation distance. C is the maximum number of obstructions up to which the attenuation factor makes a difference, nW is the number of obstructions between the transmitter and the receiver, and WAF is the wall attenuation factor. In general, the values of n and WAF depend on the building layout and construction material, and are derived empirically. The value of P(do) can either be derived empirically or obtained from the wireless network hardware specifications.

IV. RFID BASED EVALUATION FOR TRACKING

At present, there are several types of location-sensing systems, each having their own strengths as well as limitations. Infrared, 802.11, ultrasonic, and RFID [12], [15] are some examples of these systems. We are interested in using commodity off-the-shelf products. The results of our comparative studies reveal that there are several advantages of the RFID technology [21]. All RF tags can be read despite extreme environmental factors, such as snow, fog, ice, paint, and other visually and environmentally challenging conditions. They can also work at remarkable speeds. In some cases, tags can be read in less than a 100 milliseconds [5]. The other advantages are their promising transmission range and cost-effectiveness. Since RFID is not designed for location sensing, the purpose of prototype indoor location-sensing system is to investigate whether the RFID technology is suitable for locating objects with accuracy and cost-effectiveness.

The RFID reader can read data emitted from RFID tags. RFID readers and tags use a defined radio frequency and protocol to transmit and receive data. RFID tags are categorized as either passive or active. Passive RFID [16], [19] tags operate without a battery. They reflect the RF signal transmitted to them from a reader and add information by modulating the reflected signal. Passive tags are mainly used to replace the traditional barcode technology and are much lighter and less expensive than active tags, offering a virtually unlimited operational lifetime. However, their read ranges are very limited. Active tags contain both a radio transceiver and a button cell battery to power the transceiver. Since there is an onboard radio on the tag, active tags have more range than passive tags [13], [15]. Active tags are ideally suited for the identification of high-unit-value products moving through a tough assembly process. They also offer the durability essential for permanent identification of captive product carriers.

In order to increase accuracy without placing more readers, the LANDARC (Location Identification based on Dynamic Active RFID Calibration) system employs the idea of having extra fixed location reference tags to help location calibration. These reference tags serve as reference points in the system (like landmarks in our daily life). The proposed approach has three major advantages. First, there is no need for a large number of expensive RFID [22-23] readers. Instead we use extra, cheaper RFID tags. Second, the environmental dynamics can easily be accommodated. Our approach helps offset many environmental factors that contribute to the variations in detected range because the reference tags are subject to the same effect in the environment as the tags to be located [7], [11]. Thus, we can dynamically update the reference information for lookup based on the detected range from the reference tags in real-time. Third, the location information is more accurate and reliable. The LANDMARC [17], [19] approach is more flexible and dynamic and can achieve much more accurate and close to real-time location sensing. Obviously, the placement of readers and reference tags are important to the overall accuracy of the system.

$$(x,y) = \sum_{i=1}^{k} wi(xi,yi) \quad (4)$$

$$wj = 1/E2i \Big/ \sum_{i=1}^{k} \frac{1}{E2i} \quad (5)$$

$$e = \sqrt{(x-x0)^2 + (y-y0)^2} \quad (6)$$

TABLE 1- Parameters and description

Parameters	Description
wi	weighting factor
e	location estimation error
X&y	computed coordinates
X0&y0	real coordinates
k	nearest neighbors
n	rate at which the path loss increases with distance
P(d0)	signal power at distance do
d	transmitter-receiver separation distance
C	maximum number of obstructions
nW	number of obstructions

Where wi is the weighting factor to the ith neighboring reference tag. The choice of these weighting factors is another design parameter. Giving all k nearest neighbors with the same weight would make a lot of errors. Thus, the third issue is to determine the weights assigned to different neighbors. Intuitively, wi should depend on the E value of each reference tag in the cell, i.e., wi is a function of the E values of k-nearest neighbors. This approach

Table 2: Characteristics of different technologies

Technologies	Accuracy	Commercial Use	Ease of Use	External Device for Support	Implementation & Maintenance	Security & privacy	Preference
RADAR	Accuracy level falls under 90 to 100%	No	Not so user friendly	Yes	Take's long time and Costly	More Secured	Preferred of Aviation field
RFID	99% but within short bandwidth	Yes	No	Yes	More maintenance required	More Secured	Medical field, Inventory tracking
Sensor networks	More Accurate in less coverage area	Yes	Yes	Yes	Average(Scalable for large scale use)	Less secured	Pollution monitoring, Water Quality
Wireless	No accuracy. Closed tracking system	Yes	No	Yes	More maintenance required	Less secured	User/object scanning and identification
GPS	Fall under 100% if we don't have any obstacle distraction	Yes	Yes (when using 3rd party tools)	Yes	No maintenance required(but frequent updates needed)	Depends on the vender and their support	Location tracking with good efficiency(Without any obstacle distraction)
Cellular Network	Just simulation result which shows above average accuracy rate	Yes	Yes	No (Trying to get user location without any device support)	Initial setup cost is high	More Secured	Preferred to use all kind of safety and location tracking

Table 3: Advantages and disadvantages

Tools	Advantages	Dis-Advantages
RADAR	• Beam spread can incorporate many targets • Can often select fastest target, or best reflection	• Cannot track if deceleration is greater than one • Large targets close to radar can saturate receiver
RFID	• Pinpoint location a specific location. • Very Smaller in size	• Lengthy time to program devices • Skills need to use the device
Sensor Network	• Wireless sensor networks improve sensing accuracy by providing distributed processing of vast quantities of sensing information	• should monitor 24hrs • needs additional wiring
GPS	• Low of cost • system is self-calibrating	• Depends on Quality of signal • not Accurate
Cellular Network	• No internet required • No third party application is required	• Accuracy issues • Initial implementation cost

provides the least error in most of the experiments, which means the reference tag with the smallest E value has the largest weight. This may be explained by the fact that the signal strength is inverse proportional to the square of the distance.

Based on the comparison study, table 2 shows interesting characteristics for different technologies.

Based on the comparative study, the advantages and disadvantages of each high level tools are given in table 3.

V. CONCLUSION AND FUTURE TRENDS

In this paper, we have presented a comprehensive review of existing tracking schemes. The main challenges associated with accuracy. Despite the large number of research activities and the excellent progress that has been made in tracking

management system in recent years.Finally, It is recommended based on the comparative analysis that accuracy should be considered with respect to the location tracking of any system discussed in this paper.

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