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Research paper

An Efficient Assistive Solution for Elderly Dementia Care

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Abstract

Aging population is becoming a major concern of human society in the recent years. Elderly people suffering from Alzheimer and dementia have cognitive declines making them difficult in remembering landmarks in their outdoor navigational tasks. Therefore, disorientation and wandering become common for elderly people even in their familiar environments. Providing assistive guidance to such elders is a challenging task for caretakers as most of the elders prefer to live independently. Thus, there arises a need for detecting the disorientation of the elders in their outdoor navigation and alerting the caretakers in the account of either disorientation or wandering being detected. Further, elderly people can be provided with navigational assistance by mining through their previous historical trajectories and suggesting a location to which the elder has frequently visited at the time when the disorientation had been detected. In addition, a tool can be developed to analyse the level of cognitive decline by identifying the frequencies of different types of wandering patterns that might help to provide effective medication in the treatment of cognitive decline and guidance.

Keywords: *Alzheimer, Cognitive Decline, Dementia, Disorientation, Wandering Patterns, Navigational Assistance*.

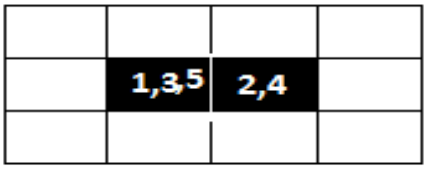
1. Introduction

Dementia is a syndrome accompanied with a decline in memory and thinking abilities severe enough to reduce a person's ability to perform everyday activities. Most of the people diagnosed with dementia are affected by Alzheimer's, a chronic disease that causes brain cell death and shrinkage of total brain size which ultimately affects nerve cells and connections which lead to problems in memory, language and judgment. Dementia mainly affects older people making them difficult to remember their daily routine activities thereby increasing the risk of disorientation and wandering.

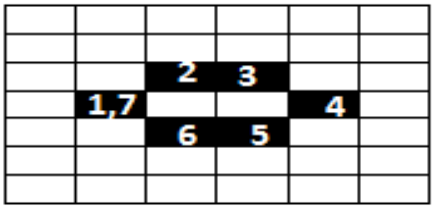
Disorientation is often termed as "getting lost". Since the family members cannot keep constant monitoring of elderly people activities, it is quite possible for elders to perform outdoor navigation such as visiting hospital, do shopping by their own without even notifying their family.

Elderly people with mild dementia face the risk of getting lost in unfamiliar locations and even in familiar locations for those with moderate cognitive decline.

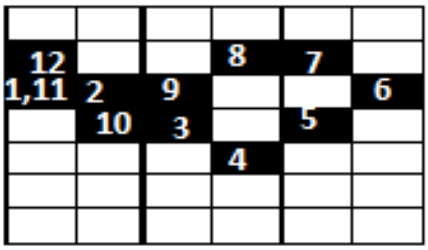
Wandering may be termed as a syndrome of dementia related locomotion behavior having spatially disoriented nature observed to be deviating from one's past navigation history due to confusion and memory decline. Older people with dementia may exhibit different types of wandering such as pacing, lapping and random wandering. According to Martino-Saltzman, Pacing may be explained as a repetitive back and forth movement between two locations (Figure 1.1). Lapping may be characterized as a repetitive travel circling a large area(Figure 1.2). Random wandering may be explained as visiting of places randomly with no pattern involved(Figure 1.3).



1) Pacing Pattern



2) Lapping pattern



3) Random

Fig1: Wandering Patterns; each cell represent physical location; coloured cell represent visited locations; numbers represent the sequence of visited places.

Disorientation and wandering present a concern for family members and care takers as these behaviors are associated with adverse outcomes such as fall, injuries and elopement.
Therefore, there arises a need for monitoring and automatically identifying the outliers in the current outdoor mobility of the elderly people and alerting the caretakers as well as family members in case of emergency situation being recognised. Further, an analysis on the type of wandering pattern [1][2] observed may help in better treatment of cognitive decline as researchers suggest that pacing is an indicator of agitation and anxiety while random pattern may indicate worsening of cognitive decline stating the necessity for immediate attention by the care takers.
Also, every time the disorientation being observed, there is likely a chance that on providing navigational assistance by mining elder's historical trajectories could help the elder to reach back to their original track and continue his/her mobility.
The rest of the paper is organized as follows: Section II describes the literature survey on several wandering detection, identifying the type of wandering pattern and understanding various navigational assistance-ship methods. Section III gives the proposed conceptual idea. Section IV presents conclusion and future work.

2. Literature Review

Eleanor Bantry Whiteand Paul Montgomeryet al.[4] suggested the idea of using GPS (Global Positioning System) to monitor the people with dementia in their outdoor mobility as GPS is considered to be a convenient electronic device which could be easily embedded in people's cell phone and can be used to locate a person at any given moment by positioning the device via satellite technology.
Qiang Lin and Daqing Zhanget al.[10]proposed an approach that uses historical GPS trajectories and the on-going trajectory of the elderly people suffering from cognitive decline in order to automatically detect whether the on-going trajectory contains disorientation or wandering pattern by directly comparing the current movement with the history and alerts the caretaker in the event of emergency. The authors suggested that the minimum threshold for categorizing a trajectory as deviating should be 3 since there is a possibility for the elder to visit back a place for the reason that he/she had forgotten things or interested in visiting again due to personal reasons.
Qiang Lin, Daqing Zhang, Kay Connelly,Hongbo Ni, Zhiwen Yu and Xingshe Zhouet al.[8] proposed the idea of detecting the wandering patterns based on the sharp changes in the on-going trajectory. Sharp changes were identified based on the vector angle computation of the current and previous points in the on-going trajectory. If the angle computed between the points is 180°, then there is a sharp change corresponding to pacing. If the vector angle is between 90° - 180°, then the sharp change corresponds to lapping.
NhuKhueVuong BEng, Syin Chan and Chiew Tong Lauet al.[6] suggested using machine learning approaches to classify travel patterns. They presented a survey on the usage of several machine learning techniques in effective identification of wandering rates, duration and patterns which could help caregivers in providing better care distributions by analysing the impact of treatment ,medication and guidance.
JariTervonenand Muhammad ZeeshanAsgharet al.[5] suggested the use of body worn laser device as a navigation aid for disoriented people suffering from dementia. This method could allow a remote caretaker to guide the demented person to get their way back to home by directly pointed the real objects with a laser pointer to show direction.
Jesse Hoey, Xiao Yang, MarekGrzes, Rene Navarro, and Jesus Favelaet al.[3] proposed a decision theoretic model that could reason about stochastic events and make decision choices about the help to offer such as either providing navigational help to the disoriented elder or alerting the care taker. The model uses partially observable markov process which can monitor the state of the system using Bayesian network. The model takes the background and contextual information of the demented elders, detects the wandering episodes which might be risky and act accordingly.

3. Proposed Conceptual Idea

3.1 Disorientation and Wandering Detection Method

The proposed detection method shalltake an elder's historical movement trajectories which were obtained through cell phone equipped with GPS (Global Positioning System) from their outdoor mobility and then shall pre-process the historical traces to remove noises. Noise may arise due to surrounding conditions such as bad weather and tall buildings. Further, the system shall record the frequency of places visited in the history to identify the frequented and non-frequented places which is personalized to the individual being monitored.
The elder's on-going trajectory path shall then be given to the algorithm to determine whether there is any disorientation or wandering in the current trace obtained from GPS.
In the context of this algorithm, the term "disorientation" refers to visiting a new physical location which was not observed in his/her historical trajectories and "wandering" refers to forming a loop like pattern by visiting the locations which were visited in the history but not in a confined sequence of visit with respect to history.
The algorithm shall analyse the on-going trajectory to determine whether there is disorientation or wandering by comparing the frequency of each location in the history with the current trajectory point. If the frequency exceeds, then there is a wandering. If the on-going point is found to be a new point on comparing it with the history, then there is disorientation. If neither is correct, then the path followed so far is regarded as normal.

3.2 Wandering Pattern Identification Method

The proposed pattern identification method includes the use of vector angle computation of the GPS points to identify the cos angle between the current and previous GPS points according [7].
If the angle formed between the current and previous GPS points if greater than 90 and lesser than 180, then the wandering is identified to be lapping. If the angle is equal to 180, then it is pacing. If there is no proper pattern identified, then it is considered to be random wandering.
Similarly, the frequency of wandering patterns shall be identified by repeating the same procedure for all detected on-going trajectory with wandering. This can help in providing proper medication in the treatment of dementia and Alzheimer.

3.3 Providing Context and Location Aware Assistance

Human navigation is highly random and different people have different frequency of places they visit and the routes they take. Thus, providing context and location aware navigational assistance is important.
Also, it was mentioned before that providing navigational assistance could help the elder to reach back to their original track and continue his/her usual mobility. Therefore, modelling the system in such a way that it automatically decides on the appropriate action to take i.e., whether to alert the care takers or prompt navigational assistance shall be beneficial.
The system shall use Markov decision process which includes a set of preferences encoded as utilities. Further, the system

computes the policy of assistance provided the state and dynamics of the elder. The system shall use Bayesian network to implement Markov decision process. Finally, the utility function in Markov process indicates which states are desirable depending upon factors such as cost of calling a caregiver etc.,

After the system decides to provide navigation assistance, the historical trajectories can be mined to recommend a place which the elder might have wished to go but unfortunately he/she had disoriented due to cognitive decline.

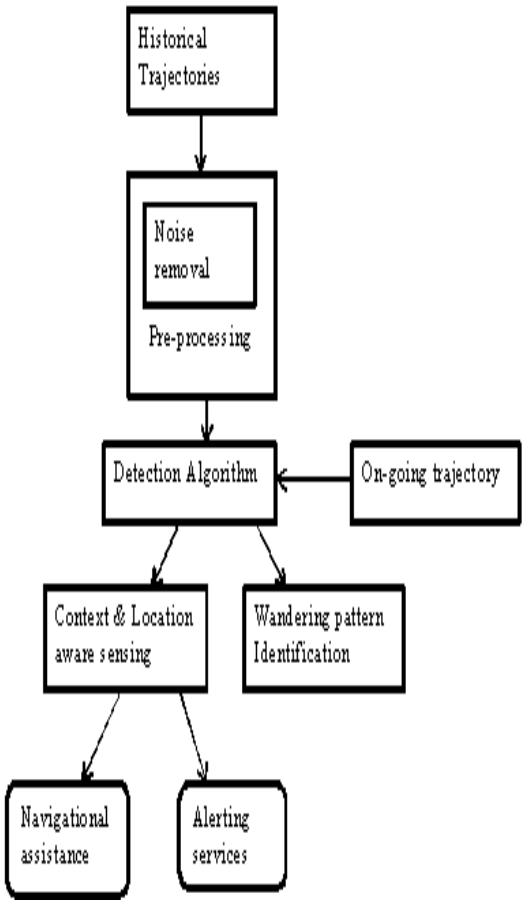


Fig. 2: Flow diagram of the proposed method

4. Conclusion and Future Work

The proposed method of detection of wandering as well as disorientation in the elder's outdoor mobility could relieve the care takers and family members concern on elderly people outdoor navigation. Moreover, it can provide opportunities for the elders to live safely and independently. Also, identification of the pattern in wandering could help in providing effective medication of dementia. Meanwhile, providing navigational assistance could further increase the level of independence of the elderly people. Further, a prototype can be developed as a future work that provides complete assistance in real-time on setting up of a cloud server which processes the location information of the elderly people obtained from GPS based on the proposed model and provides assistance appropriately.

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