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A Smart Home Application for Resident Activity Prediction

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Abstract

Predicting resident activity in smart home has become an emerging research trend in the field of Pervasive computing. Resident activity prediction by using contextual data in smart home provides a resident intended service thereby makes him more flexible. In this paper, an effort has been made to achieve resident activity prediction by developing an android based smart home application which takes the following contextual parameters: resident id, location & status of the devices as input and predicts the activity of the resident as the output. The proposed smart home application involves the following steps: 1) Constructing the training dataset with the contextual parameters such as resident id, location & status of the device 2) Storing the captured data in SQL database 3) Retrieving the activity from the database by using Python programming. This can be achieved by using the Bluetooth module that communicates between the Raspberry Pi & mobile.

Keywords *resident, activity, prediction, context, python*

INTRODUCTION

The smart home improves the quality of the resident's life by providing a comfortable, flexible and safe environment. Recently, resident intention prediction using contextual data has become an emerging research trend in the area of Pervasive Computing. The necessity of predicting resident activity in smart home is to recommend resident intended services. This can be achieved by using the contextual parameters of the resident like: resident id, location, activity & by tracing the status of the devices used by the resident in his daily life. For example: Consider a scenario in single resident smart home where the contextual parameters of the resident along with the assumed values are as follows: resident-id: 123, location: living room, activity: reading & status of the device i.e. light=ON. Similar to this scenario various other contextual situations can be captured by employing sensors like RFID, GPS & activity sensors. The most important step in predicting the resident activity in smart home is to apply appropriate machine learning techniques on the contextual data in order to 1) Learn the behavioral patterns 2) To train & test the smart home datasets. The machine learning techniques used widely for predicting the resident activity in smart home are as follows: Cluster based K-means algorithm, EM-algorithm, SOM algorithm, Hidden Markov Model (HMM), C4.5 classifier, Back Propagation Neural Network (BPNN), Parallel computing, Batch Back Propagation (BBP), Levenberg Marquardt (LM) & Quick Propagation (QP), Formal Concept Analysis (FCA), Root-mean-square deviation (RMSD), DBN-ANN, DBN-R, Contrastive divergence, Non-linear Singular Value Decomposition (SVD), N-gram, Bootstrapping based online learning.

In this paper, an android based smart home application to predict resident activity has

been proposed which takes into account context history as the source of input and predicts the activity of the resident. The contextual parameters used for prediction are: resident id, location, activity & status of the devices embedded in smart home. The proposed smart home application involves the following steps: 1) Constructing the training dataset with the contextual parameters such as resident id, location & status of the device 2) Storing the captured data in SQL database 3) Retrieving the activity from the database by using Python programming.

LITERATURE SURVEY

Predicting resident activity in smart home has become an emerging research trend in recent years. Some of the algorithms proposed for achieving the resident activity prediction in smart home are as follows:

Bouchard K, Ajroud A [1], proposed a new flexible 3D smart home infrastructure open source simulator called "SIMACT" which is developed using java programming language. The simulator includes the set of pre-recorded scenarios generated using the data extracted from clinical trials for testing the activity recognition algorithms.

Muhammad Raisul Alam, M. B. I. Reaz [2], proposed a sequence prediction via enhanced episode discovery (SPEED) algorithm to predict inhabitant activity in smart homes. It works by extracting episodes (the set of user activities) based on the states of smart home appliances. Finite order Markov model is used to arrange & process the extracted episodes. The next activity of the inhabitant is predicted by applying prediction by partial matching (PPM) algorithm. The experimental results reveal that the proposed SPEED algorithm achieves a prediction accuracy of 88.3% which is better when compared with Active LeZi, IPAM, C4.5 & LeZi Update algorithms.

Andrei Papliatseyeu, Oscar Mayora [3], proposed a positioning system that recognizes & predicts the activities of the mobile user. Fusion of three wireless positioning methods were employed which results in achieving high availability & accuracy.

Ming-Je Tsai, Chao-Lin Wu [4], proposed a context-aware framework for human behavior learning and prediction. The behavioral patterns were learned by discovering the contexts from resident's real life data. The authors evaluated the proposed framework on two public datasets. Promising results were obtained during the experimental analysis.

Enamul Hoque, Robert F. Dickerson, Sarah M. Preum [5], proposed comprehensive anomaly detection system called **Holmes** for predicting user daily activities in home. It considers variability in daily activities. The activities were extracted during different contexts like specific days of the week, at different time periods such as per week, per month. The activities based on temporal, correlation & collective based features were learned by using the proposed system. It also reduces false alarms by learning semantic rules that describes variations of activities during specific situations. The evaluation results illustrated that the Holmes system reduces false positives by 46% & false negatives by 27% compared to the other state of the art prediction systems.

Zong-Hong Wu, Alan Liu [6], proposed a method of leveraging multiple models. The activity which will happen in future is predicted by building a model using Bayesian network. Property filtering is applied to the obtained predicted results to get the final result. To learn conditional probability of resident activities from the

CASAS datasets the Bayesian network model is used. Experimental results reveal that the proposed method provides improved accuracy & coverage in prediction of the activity.

Hapugahage Thilak Chaminda, Vitaly Klyuev [7], proposed a Smart Reminder System for reminding forgotten complex activities, in home environment. The authors focus on subjected complex activities that should be completed after they are initiated & they consider those activities as "Coupling Activities". According to the user's current behavior, current location & past activity patterns the reminders for forgotten coupling activities are predicted. The user's context is identified by using wearable sensors. The proposed reminder system learns the dynamic behavior of the user & also predicts the reason for forgetting the most necessary activities with user's minimum supervision. The experimental results reveal that the proposed system achieves average accuracy rate of 80% for reminder prediction.

Chao-Lin Wu, Yi-Show Tseng [8], proposed an approach that uses semi-supervised learning to adapt activity recognition (AR) model. More useful representative activity instances are discovered by combining both temporal & spatial features.
The effectiveness of the proposed approach was demonstrated by experimental results.

Ehsan Nazerfard, Diane J. Cook [9], proposed an activity prediction approach called CRAFFT that uses Bayesian networks. To predict the next activity features & to predict next activity label a novel two-step inference process is employed. By using the outlier detection & continuous normal distribution the start time of the next activity is modeled by which prediction of the next activity is achieved. Using real data collected from two smart home apartments the proposed model was evaluated.

Chao-Lin Wu, Mao-Yung Weng [10], proposed hierarchical generalized context inference approach to infer the contexts of multiple users. The proposed approach generalizes multiple user contexts. It also dynamically infers & aggregates those contexts with different information granularity. The inference results reveal that the appropriate service was provided by a context-aware smart home. The effectiveness of the proposed approach was demonstrated by the experimental results.

DESIGN OF THE PROPOSED SYSTEM

System design provides a transition from users view to programmers view. It also acts as a bridge between the required specification and implementation phase. The architecture of the proposed system is shown below: It comprises of following hardware & software components using which the activity of the resident is predicted in smart home: 1) Raspberry pi 2) Smart phone 3) Bluetooth module 4) SQL database.

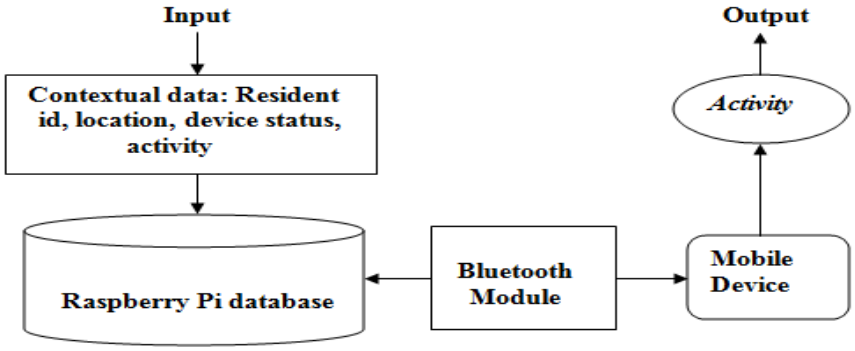

Fig.1 *Architecture of the proposed system*

EXPERIMENTAL SETUP

The experimental setup of the proposed system is depicted in the below snapshots:

Fig.2 *Bluetooth module acting as interface between Raspberry Pi & mobile*

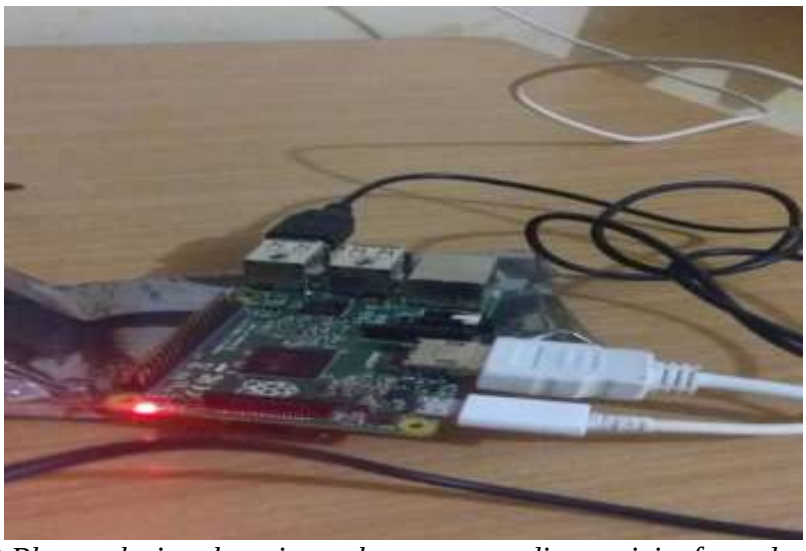

Fig.3 *Bluetooth signal retrieves the corresponding activity from database*

IMPLEMENTATION

A. Procedure for implementing the proposed system

The proposed system is implemented by using the following steps:

- Construct the training dataset with the contextual parameters

- Store the dataset in Raspberry Pi by creating the database with the following attributes: 1) Resident-id 2) location 3) Status of the device 4) Activity
- Start the smart home application in mobile
- Enter RID, location & status of the device
- Retrieve the corresponding activity by executing the python script. Bluetooth module is used to communicate between Raspberry pi & mobile device.

B. Dataset used for implementing the proposed system

The sample dataset considered for predicting the resident activity in smart home is depicted in the below table:

***Table I** Testing Datasets*

Sl.No	Resident id	Location	Device status	Activity
1	112	Living Room(LR)	Light=ON	Reading
2	112	Living Room(LR)	Light=OFF	Sleeping
3	112	Kitchen(KN)	CF=ON	Cooking
4	112	Kitchen(KN)	CF=OFF	Drinking

C. Pseudo code used for implementing the proposed system

Step 1: Importing python library files

- import common gateway interface header file
- import common gateway interface trace back header file
- import MySQL database header file
- import system specific parameter and function header file

Step 2: Retrieving values from android application which is entered by user

- allocate space for the user inputs
- get value of person id from user and store it in variable **var**
- get value of location id from user and store it in variable **loc**
- get status of the device and store it in variable **status**

Step 3: Connecting to mysql database

- con <- MySQLdb.connect("127.0.0.1", "root", "tech123", "actiondatadb")
- establish localhost database connection and store it in the variable **con**
- where 127.0.0.1 local host ip address
- root is a username
- tech123 is password
- actiondatadb is database name

Step 4: Query which retrieves the specific information from database according to user input

- locate current position of database and store it in the variable **curs**
- execute mysql query

Step 5: Execute query to retrieve information from database

select databasename td_action from table training data

RESULTS & SNAPSHOTS

The proposed smart home application prompts the user to enter the values of the three contextual parameters i.e. 1) Person Id/Resident Id 2) Location of the resident 3) Status of the device as shown in the figure 4. After entering the values the user must click on **Get Result** button to obtain the activity of the resident as shown in the figure 5. The contextual parameter values are Resident id: **112**, Location: **Living room (LR)**, status of the device: light=**ON** & predicted activity: **Reading**. The results obtained from the proposed smart home application to predict resident activity are as follows:

Fig. 4 *User Input Page*

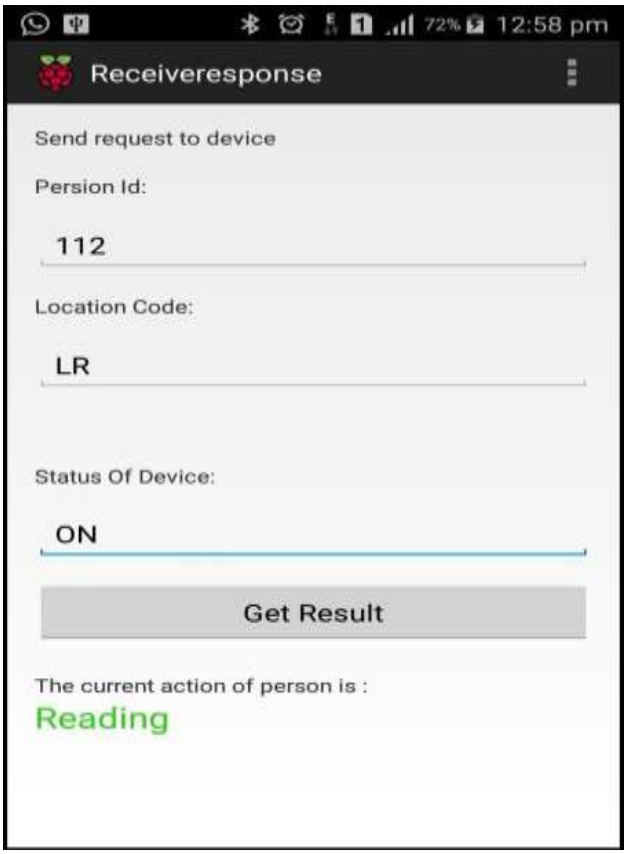

Fig.5 *Current activity of the resident*

CONCLUSION

Prediction of resident activity in smart home has become a challenging task in the field of artificial intelligence. The proposed system involves an android based smart home application that predicts the resident activity by considering the contextual parameters like: resident-id, location & status of the device. The resident activity in smart home can be achieved by using the following steps: 1) Constructing the training dataset with the contextual parameters such as resident id, location & status of the device 2) Storing the captured data in SQL database 3) Retrieving the activity from the database by using Python programming. In retrieving the resident activity Bluetooth module plays a very important role by sending the signal to the database & it also acts as communication link between Raspberry Pi & Mobile phone. Prediction of multi-user activity in smart home by using machine learning algorithms will be considered as future work.

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