Ambient Assisted Living (AAL) setup to determine the wellness of a person living alone in their own home

Dr. N. K. Suryadevara
Senior Member IEEE
Professor and Head-Computer Science & Engineering
Geethanjali College of Engineering & Technology
Hyderabad-India
It’s not just hype
New Science could lead to very long lives

This Baby Will Live to Be 120. National Geographic May 2013

This Baby Could Live to Be 142 (TIME) March 2015
Importance of Research

![Graph showing the increasing percentage of old population from 1950 to 2030.](image)

- **Year**
  - 1950
  - 1960
  - 1970
  - 1980
  - 1990
  - 2000
  - 2010
  - 2020
  - 2030

- **Old Population %**
  - 0
  - 5
  - 10
  - 15
  - 20
  - 25
Independent Life
Need Assistance........
How does someone die alone in their home without anyone realising?

Life of learning: Lewis Clarkson discovered his passion for learning late in life but wasted no time in gaining qualifications through extramural study at Massey University.

Dinner discussions: Mr Clarkson at home in Christchurch.

Resting place: The Crewe Cres house where Lewis Clarkson was found dead after a neighbour noticed flies gathering at a window.

Photos: SUPPLIED
Their Needs

Help with Activities of Daily Living (ADL)

Health Monitoring

Reducing the burden from Caregiver
Ambient Assisted Living Setup

Smart Home Monitoring System
My Research

Health Informatics System

- Activities of Daily Living Monitoring
- Physiological Monitoring
- Environmental Monitoring
- Wellness Determination

Unobtrusive

Provide Assistance/Advise

Wearable and Non-Wearable

Non-Invasive
Health Informatics System collects more data

- Plenty of Data Collection methods/tools

✔ More resources are required for Analyzing the data
  
  - Proper Information can be gained from the analysis (translation) of data
  
  - Important indications for proper decision-making
  
  - Notify policy development

Our Solution:

Web-based reporting tool to analyze and infer right decisions
My Research

- AAL Services (Energy Consumption) (Human Physiological)
- Recognition of Human ADL’s
- Human Wellness Determination $\beta_1, \beta_2$
- Domestic Objects usage Trend through Time Series Data Mining

Smart Home Monitoring System

- Sensors Data Acquisition
- Remote Interoperability
- Internet
- Data Base
  - Health Care Provider/Relatives/Tele-Care Services

WSN
Better Solution-Technologies

Instrumentation
Sensing Objects

Wireless
Communication

Information
Processing
Sensors Integrated with Everyday Objects
Sensing Units-HMS
## Monitoring Basic ADL

<table>
<thead>
<tr>
<th>ADL</th>
<th>α</th>
<th>Household Appliance Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation of Food (Breakfast, Lunch, Dinner)</td>
<td></td>
<td>Microwave, Water Kettle, Toaster or (any other item used regularly in Kitchen)</td>
</tr>
<tr>
<td>Sleeping</td>
<td></td>
<td>Room Heater</td>
</tr>
<tr>
<td>Toileting, Self Grooming</td>
<td></td>
<td>Television/Radio</td>
</tr>
<tr>
<td>Dinning</td>
<td></td>
<td>Bed, Couch, Chair, Toilet</td>
</tr>
<tr>
<td>Relax</td>
<td></td>
<td>Any other appliance used as habitual</td>
</tr>
<tr>
<td>Watching TV (while sitting on Couch)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Passive Infra Red (PIR) Sensors:** Mobility (Movements monitoring)

Smart Sensor Deployment Layout

2D View of Old House with Smart Sensors

Sensing Systems
- Electrical
- Force
- PIR
- Room Temperature

Temperature
Sensor activity status

Subject #1

Subject #2

Subject #3

Subject #4

• Domestic objects are used at regular time intervals in the day to day life

• Usage durations and the frequency of use are varied

• “Human behaviours in constant contexts recur, because the processing that initiates and controls their performance becomes automatic”

• “Frequency of past behaviour reflects the habit strength and has a direct effect on future performance”
Wellness Determination
\[ \beta_{(1,\text{old})} = (1 - \frac{t}{T}) \]
\[ \beta_{(2,\text{old})} = 1 + (1 - \frac{t_a}{T_n}) \]

Sensor Event
Level-0

Context Recognition
Level-1

ADL Recognition
Level-2

\[ \beta_{1,\text{new}} = e^{-\frac{t}{T}} \frac{(T_n - T_a)}{T_n} \]
\[ \beta_{2,\text{new}} = e \]
Improved Wellness Function ($\beta_{1,\text{new}}$)

$$\beta_{1,\text{new}} = e^{-t/T}$$

Suryadevara N.K, Mukhopadhyay S.C, “Determining Wellness through an Ambient Assisted Living Environment,” IEEE Intelligent Systems-May 2014,Page(s):30-37, ISSN:1541-1672
Improved Wellness Function ($\beta_{2,\text{new}}$):

$$\beta_{2,\text{new}} = e^{\frac{T_n - T_a}{T_n}}$$

**Suryadevara N.K, Mukhopadhyay S.C, “Determining Wellness through an Ambient Assisted Living Environment,” IEEE Intelligent Systems-May 2014,Page(s):30-37, ISSN:1541-1672**
To Minimize “False Alarms”

Regular or Irregular

Behaviour Detection

Wellness Indices
Forecasting
Sensor Activity Pattern

Wellness Determination

Fig 9(a) Toilet usage Trend for 70 days

Fig 9(b) Toilet usage (Ninth week forecast pattern)

Fig 9(c) Toilet usage (Tenth week forecast pattern)

Fig 9(d) Chair Usage Trend for 70 days

Sensor Activity Pattern

Discovering Interesting Patterns in Data

Cluster of Similar Instances

Perform Classification of New Data based on Training Data

Associations

Sequential Patterns/Rules
(Finding inherent regularities in data)

With Time Constraints

Top-K Sequential Rule Mining
(Redundant/Non-Redundant)
Conclusion

WSN Assisted Intelligent Integrated Healthcare Platform for Wellbeing and Independent Living

The healthcare platform consists of

1. Appliances Monitoring Unit
2. Physiological parameters monitoring unit
3. Human Posture and Position Detection Unit
4. Human Emotion Recognition Unit
5. Automatic Medicine Dispenser Unit
6. Power Management Unit
7. Robust Supervisory Control Unit
8. Safety Box Unit
• A WSN Assisted and Embedded Processing based smart home to care elderly people.

• The integrated system is able to support people who wish to live independently.

• The developed system is robust and is possible to develop at a low cost due to indigenous development.

• The technology assisted home will alert the caregiver in advance about the trend of the health status, so that necessary precaution can be taken.
Thank you

suryadevara99@gmail.com