ANALELE UNIVERSITĂȚII
"EFTIMIE MURGU" REȘIȚA
ANUL XXVI, NR. 1, 2019, ISSN 1453 - 7397

# Sensors failure detection and fault tolerance in the complete AAL system

Kristijan Cincar

*Ambient Assisted Living (AAL) systems help people to stay active and have a decent life with the help of continuous monitoring for healthcare. Sensors help us to monitor, but the activity of sensors to false positive or negative decay of these monitoring and the status of worships.This work we analyzed detection and tolerance for event triggering sensors in AAL systems.*

***Keywords**: smart home, ambient assisted living, fault tolerance, fault detection, sensor*

## 1. Introduction

Ambient Assisted Living (AAL) are systems that allow third-age individuals to be independent, these systems monitor all life signs providing healthcare.

Non-intrusive sensors are a link that allows elderly people to live safe and free. These sensors can trigger false information - whether possible or negative - that could lead to compliance with the monitoring of the actors. In this work we try to make some analysis of several AAL systems that are equipped with different types of non-contact sensor technologies.

The aging population doubles over the next 20 years according the World Health Organization. These demographic changes affect the health care system of a country, and it is desirable to increase medical and social capacities that in their place increase the cost of health [1]. The system must be based on healthy aging as an essential investment costs greatly increase for people who are immobile with serious health problems need specialized care. To make life easier, we make use of new technologies for a normal life [2].

When we want to make a part of the monitoring sensors, we can do it in two groups:

- Intrusive sensors such as video cameras, microphones, multi model touch input display;

- Non-intrusive sensors, such as motion, pressure, video, object contact, and sound sensors.

In this work we identify a problem in the fail detection in AAL systems, the mistakes that are made by reading data from sensors; they have a very important role in the lives of old people, [3]. In fact, installed sensors in elderly home can produce wrong negative and positive information. A mistake or error can cause the mistaken recognition of activities at the elderly's location, which in turn can lead to inconvenience to the elderly 's health, [4].

**Analysis . Sensory failure in AAL and Smart Home**

An error in the system can be defined as an abnormal element that causes a system failure, the element's ability in the system is caused by a fault, a malfunction can or cannot lead to system bloating [5]; in other words, the fault leads to the error that can be positive or negative.

In AAL, a fault with sensors affects the whole system or part of the system and leads to erroneous interpretation of events.

In AAL terminology there are two categories of malfunction:

- An operational malfunction when the sensor stops responding.
- A nonfail error that tells us that the sensor is still working, but the values represented are valid only and the detection actions.

The analysis is work dealing with sensor faults, the tolerance of errors in AAL is in its initial phase, and in the future it will inherit as many approaches to solving.

The most used approach (presented in Figure 1)

| Gold standard disease present | | Gold standard disease absent | |
|---|---|---|---|
| Test positive | Test positive (TP)<br>a | False positive (FP)<br>b | Total test positive<br>a+b |
| Test negative | False negative (FN)<br>c | True negative (TN)<br>d | Total test negative<br>c+d |
| | Total disease<br>a+c | Total normat<br>b+d | Total population<br>a+b+c+d |

**Figure 1.**

Comparing a new diagnostic test in detecting errors in sensors can be explained: TP-true positive (the date is positive when the information is positive, The reported FP-false positives date is positive but the values are negative,

FN-false negatives reported data are negative but positive values,

TN-true negatives data reported are negative but negative values. (Figure 2)

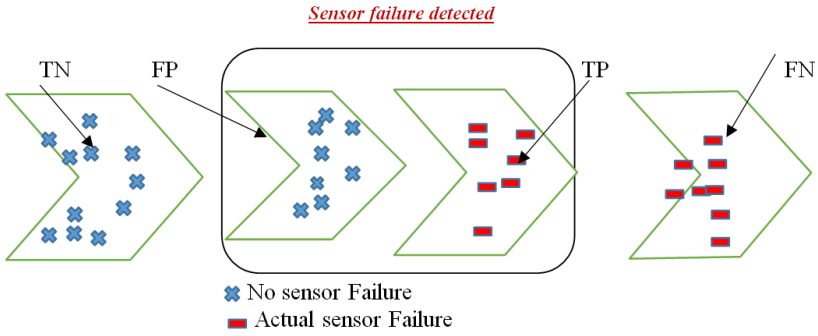


**Figure 2.** Sensor failure detection system terminology.

### 3. Examples

DOMUS system describe in [6] of patient localization is explained here, sensors already installed in an intelligent house to track and locate the patient. The system accurately locates the patient in housing and if false information is received from sensors that may appear for various reasons. This situation is possible by fusing the sensors using the latest sensor information and known position. The system used in the DOMUS apartment was installed various non-intrusive sensors such as: pressure sensors and contact sensors, infrared sensors. An example was performed on a total of 14 patients and the results were 85%.

Another approach based on Fuzzy logic which indicates the user's location was proposed in [7] is based on the use of multiple sensors used at nodes. The system is conjured from nodes and sensors based on phased array sets. The home is divided into areas with several types of ambient sensors. The information from the sensors is transmitted regularly, and the values of each resident in different areas are calculated. The higher the value of the inhabitant where it is found. We used DPWsim simulator on a case study evaluating different sensor errors. This test demonstrates the accuracy is 88 % of the proposed ULD method in correctly detecting a user's location.

User Location Discovery (ULD) as seen in [8] will play an important role in smart homes for user's privacy, fault tolerance and accuracy. In the smart home, we use ULD methods that can be implement into two different user groups. A cooperative user who actively interacts with the system using body sensors or mobile phones is called Device-Based Localization (DBL) method or the user is not cooperative and does not use personal devices but is recognized after moving using the video surveillance system this method is called (DFL) Device-Free Localization as seen in [9]. This test demonstrates that the accuracy is 85 % of the proposed ULD detecting method for user's location.

## 4. Conclusion

Detecting sensors failure is a big problem to have the most accurate results, propose AAL systems have a winning score of 85-88%, the limitation is that they do not recognize patients and the application does not do their duty, Sensor`s error detection methods are at the beginning of development, we want to try to develop a sensor detection and diagnostics system for AAL, so we can improve the score in the future.

## References


[1] World Health Organization. *Global Strategy and Action Plan on Ageing and Health*; World Health Organization: Geneva, Switzerland, 2016.

[2] Al-Shaqi R., Mourshed M., Rezgui Y., *Progress in ambient assisted systems for independent living by the elderly*, SpringerPlus 2016, 5, 624.

[3] Anghel Drugărin C.V., Spunei E., Muscai C., Piroi I., *Records of Failures to Railroad Safety Installation*, International Symposium on Fundamentals of Electrical Engineering, ISFEE, Nov. 1-3, 2018, Bucuresti.

[4] Danancher M., *A Discrete Event Approach for Model-Based Location Tracking of Inhabitants in Smart Homes*, Ph.D. Thesis, École normale supérieure de Cachan-ENS Cachan, Cachan, France, 2013.

[5] International Organization for Standardization (ISO). 26262–1: 2011 *Road Vehicles Functional Safety*; International Organization for Standardization: Geneva, Switzerland, 2011.

[6] Rahal Y., Pigot H., Mabilleau P., Location estimation in a smart home: System implementation and evaluation using experimental data, *Int. J. Telemed. Appl.*, 2008.

[7] Ahvar E., Lee G.M., Han S.N., Crespi N., Khan I., Sensor network-based ad user-friendly user location discovery for future smart homes, *Sensors*, 2016.

[8] Viani F., Robol F., Polo A., Rocca P., Oliveri G., Massa A., *Wireless architectures for heterogeneous sensing in smart home applications: Concepts and real implementation*, Proc. IEEE. 2013,101, pp. 1–16.

[9] Wilson J., Patwari N., *Radio tomographic imaging with wireless networks*, IEEE Trans. Mobile Comput. 2010, 9, pp. 621–632.



*Address:*

- Phd Candidate Kristijan Cincar, West University of Timisoara,
  Bd.V.Parvan, Nr. 4, Room F109, 300223, Timisoara,
  kristijan.cincar80@e-uvt.ro
  Profesor Školski centar "Nikola Tesla" Sterijina 40, Vršac, Serbia.