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# Role of Ambient Intelligence in Pandemic (COVID-19)

**Dr. T Archana Acharya Mr. P. Veda Upasan**

[1] Vignan's Institute of Information Technology (A), Duvvada, Visakhapatnam, Andhra Pradesh, India.
[2] Andhra University College of Engineering (A), Andhra University, Visakhapatnam, Andhra Pradesh, India.
taamphil@gmail.com, vedaupasan142@gmail.com

**Abstract:**

Digital era is tailoring many episodes of technology-based devices to the real-world complexities. The complexities call for the replacement of humans with human-like interfaces. The Pandemic (COVID – 19) characteristics show high levels of transmission from one person to another through the droplets where the importance of human-like interfaces can be understood. Ambient Intelligence (AmI) is one such branch of tailored intelligence which addresses the issues through human-like interfaces. This paper is aimed at understanding the technicalities of the Corona Virus and in response to the technicalities, the tailor-made development of various devices using AmI.

Keywords: Ambient Intelligence (AmI), Applications, Covid-19, Human-Computer Interaction (HCI), Intelligence, Pandemic, Sensors, Real-Life environment, Real world complexities, User-friendly

## 1. Introduction

*"Prevention is better than cure."***- *Desiderius Erasmus***

Ambient Intelligence (AmI) is an upcoming practice which refers to electronic and computer systems that are sensitive and can sense the presence of human and respond to their interactions. It is an evolution from early electronics, telecommunications, embedded devices. Based on the intuitive information and intelligence these devices support and help individuals to carry out their daily tasks, activities and rituals by forming a network of connected devices called as internet of things (IoT). These devices are smaller in size with high connectivity and can be simply integrated into this extremely wide environment. It is influenced by user-centered design.

## 2. History

"Ambient Intelligence" was introduced by Eli Zelkha, Simon Birell in 1998 to come across different scenarios. The mechanism of AmI transforms the high-volume consumer electronic industry to user-friendly devices. In 2000, AmI were planned based on usability and feasibility. Parallelly many developments were initiated in view of this vision. To develop AmI information many societies like Information Society and Technology Advisory Group (ISTAG), Commissions like European Commission - Information, Society and Technology (IST) came up with launch of FP6 (sixth framework). A critical role has been played by European commission in the development of the AmI.

## 3. Objectives of the Study

1. To know about Ambient Intelligence
2. To understand rationale of AmI in Real-life environment
3. To study the role of AmI in Covid-19 scenario

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## 4. About Ambient Intelligence

Ambient intelligence transforms electronic information into user-friendly information through small devices like sensors which builds upon soft computing systems like ubiquitous computing, pervasive computing, context awareness, profiling and human-centric computer interaction design.

AmI system is characterized by technologies that are:

- embedded context-aware
- personalized
- adaptive
- anticipatory

### *4.1 Architecture of AmI*

Intelligent Systems Research for Ambient Intelligence (ISyRAmI), its main aim is to develop an architecture for Ambient Intelligence (AmI) that implements the human intelligence on 42 computers and integrates it into the system.

In the architecture of AmI, four modules include data/information/knowledge acquisition, storage, intelligent reasoning, decision support which is shown in the figure 1 and the process is explained in the following Table 1

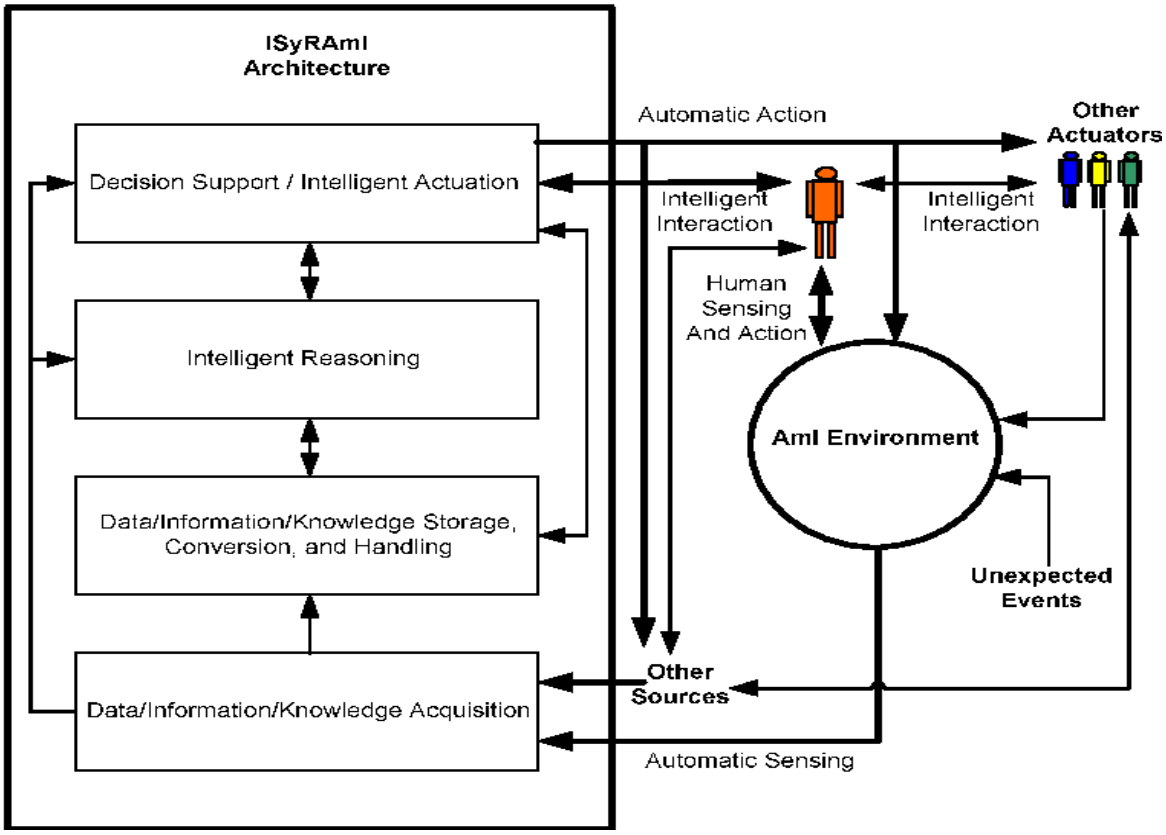


Figure 1. Architecture of AmI Systems

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Table 1. Modules in Architecture of AmI Systems

| ***Module*** | ***Function*** | ***Process*** |
|---|---|---|
| **First module:** *Data / Information / Knowledge Acquisition* | Takes input. Does not check whether the data is vague or not. | Takes input from the different environment sources through sensors, friends, experts, web, etc.<br>- Words are converted into text.<br>- Images<br>- Human facial expressions for emotions.<br>Human gestures. |
| **Second module:** *Data storage, Conversion, Handling* | Analyzes data driven from the conclusion of 1st module for errors, missing or uncertainty. | Prepares data, which can be used by reasoning component. Joins data, so that it will validate the conditions in the expert system rules. |
| **Third module:** *Intelligent reasoning* | Performs high level reasoning processes using planning and knowledge discovery systems. | Draws conclusion, using IF – THEN rules. |
| **Fourth module:** *Decision support* | Deals and plays a vital on taking actions on the environment. | Tasks are assigned to user and AmI system. AmI system presents and explains the list of actions. Finally, the user should finalize the action. |

### *4.2 Contributing Technologies*

Figure 2. Technologies involved in AmI Systems

#### *4.2.1 Sensing*

In the AmI system, sensors are used to detect the changes in the environment and produce outputs according to input. These are very small in size and can be embedded in any environment or device. Some of them are:

- Audio Visual Sensors
- Passive Infrared sensors (PIR)
- Radio Frequency Identification
- Multimodal

AmI system can have a wearable's dispersed model. In a compact modal or data is sent to the server compact model - the dispersed model - the and analyzed. In the sensor has

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computational power; therefore, they can be locally processed in the sensor network.

*4.2.2 Reasoning*

In the AmI system, the reasoning is done by using algorithms. The different types of reasoning are discussed below.

- Modeling
- Activity Prediction and recognition
- Decision making
- Spatial and Temporal Reasoning

*4.2.3 Acting*

In AmI systems, the systems can sense and act – means to perform some actions.

*4.2.4 Human-Computer Interaction (HCI)*

In AmI, the interfaces used must be human-centric - natural and context-aware. Basic features of the user like context, behavior, emotion, and so on are taken into account.

*4.2.5 Secure*

To ensure security, AmI systems considers some factors – channel reliability and security, sensor data security.

## 5. Applications in Real-Life Environment

Ambient intelligence environment can be developed at home, public spaces, workspaces, and hospital environments. Figure 3 shows the different applications of AmI in real-life environment and Table 2 shows the usage of AmI applications in different scenarios.

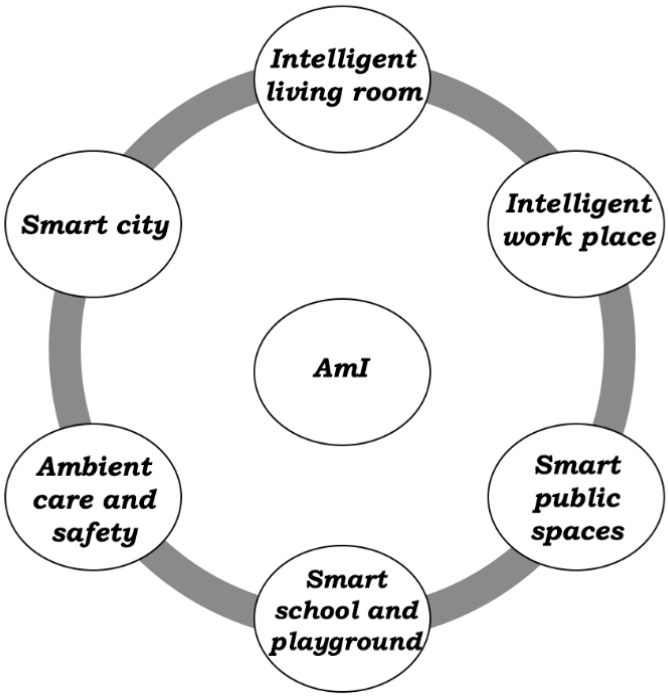


Figure 3. Applications of AmI

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Table 2. Usage of AmI Systems in Different Scenarios

| ***Area*** | ***Sensors*** | ***Use*** |
|---|---|---|
| Smart Home | Motion Sensor | unauthorized motion inside your property, the exterior siren will sound- Security of home |
| | Water Sensor | To identify leaks, breakages, and user negligence |
| | Doorbell Sensor | To alarm unknown visitor at the door step before they ring the door bell |
| | Temperature Sensor – inside and outside (garden) | To maintain inside and outside by adjusting the room temperature |
| | Weather Sensors | To forecast weather condition |
| | Light Sensor | To save electricity and improve your home's security |
| Hospital room | Motion and field sensors | Patient is monitored for health and security reasons |
| School | Vibration sensors | to trigger predictive maintenance orders |
| | Mileage sensors | track work required on school-related vehicles |
| | Water-level sensor | To alert maintenance personnel for leaky toilets, water pressure discrepancies, or water build-up in a rarely used basement area |
| Underground station | Location sensors | to track the location and to calculate time for connecting two locations |
| Fire Brigade | Personal alert safety system (PASS) | to measure passage of traffic within the areas through which the fire brigade truck might travel to reach out emergency |
| | optical sensors | for detecting flames. |
| Public Surveillance | Novel sensor - CCTV cameras | Monitoring on street or on transport |

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## 6. Role of Ami In Covid-19 Scenario

### *6.1. What is Covid-19?*

COVID – 19, 'CO' Corona, 'VI' Virus, and 'D' Disease. This is also referred as '2019 novel coronavirus' or '2019-nCoV.' It belongs to virus family causing common cold and respiratory problems like Severe Acute Respiratory Syndrome (SARS). This disease is a non-living component surrounded by a layer of Fat which gets activated when it enters the human body. It gets transmitted via respiratory droplets and other contact routes from the infected person to others thus forming a contagion. Once the virus enters it stays around 6-7 days in throat from where it enters the respiratory system (Lungs) where it tries to establish a network. Once the network is established the severity reaches highest levels where the infected person will be suffering with shortness of breath. The prominently observed early symptoms include: Fever, tiredness, dry cough. The other symptoms include headache, body pains and aching, sore throat, conjunctivitis, diarrhea, loss of taste or smell, discoloration of fingers or toes, skin rashes etc. So, to detect, treat and also prevent, many systems or products are being used.

*6.1.1. For Preventing transmission:*

- Non-Woven Face Mask
- KN95/FFP2 Face Mask, 5 Layers Non-Woven
- Disposable SMS Isolation Gown
- Disposable Protective Coveralls with Shoe Cover
- Disposable Cap, Non-Woven
- Sticky Mats to remove Contaminants/Infection at doorstep
- Disinfectant Sprayer
- Hand Sanitizer
- Disposable Face Shield
- Protective Goggles, Sealed, Anti-Fog Type
- Safety Key
- Body Packaging Bags

*6.1.2. For Treatment:*

- ICU Ventilator, With Pressure & Volume Control
- Duo-Level Non-Invasive Ventilator

6.1.3. *For detection using AmI:*

- Medical Infrared Thermometer
- Automatic Mist Based Sanitizer Dispenser
- Disinfection chamber
- Currency Notes/Mobile/Keys Sanitizing Machine
- Throat worn wearable
- Thermal glasses
- Aarogya Setu App

### *6.2. Response developments of Ambient Intelligence to COVID -19 Scenario*

AmI is a tailor made interface which has come up with various applications to the pandemic. In the table 3 the detail of the product, the sensor used and the working utility of the product is explained.

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Table 3. Usage of AmI Systems in COVID -19 Scenario

| ***Product*** | ***Sensor*** | ***Utility*** |
|---|---|---|
| Medical Infrared Thermometer | Infrared (IR) temperature sensors | Non-contact temperature measurement<br>Can measure ear, forehead, or skin temperatures |
| Automatic Mist Based Sanitizer Dispenser | Waterproof non-contact Ultrasonic Sensor | Ensures zero touch, high operational precision to completely disinfect both hands at once |
| Disinfection chamber | Passive infrared sensor (PIR sensor) | Controls spray of sanitizer through intelligent touch free sensing of person approaching through the tunnel/chamber |
| Currency Notes/ Mobile/ Keys Sanitizing Machine | UVC, Proximity sensor | Automatic and contactless drawer opening and closing mechanism. |
| Throat worn wearable | Motion sensor | Measures coughing intensity and patterns, chest wall movements, respiratory sounds, heart rate and temperature, according to researchers |
| Thermal glasses | Infrared sensors, Thermographic cameras – (2 types) – uncooled & cooled | Sensing, signal extraction, processing, and comprehension |
| Aarogya Setu App | Bluetooth, location | Contact tracing, Syndromic mapping and Self-assessment |

*6.2.1. Medical Infrared Thermometer*

A device that measures the temperature from a distance, without having a contact with the object/body. Temperature is calculated by the movement of molecules in the object/body. It is based on black body radiation, that is any object/body having a temperature above zero, there is a movement of molecules. The movement of molecules produces infrared radiation, the faster the molecules move the higher is the temperature. For catching these radiations from a distance, a lens is equipped to focus and absorb infrared light from the object. It sent onto a detector, called Thermopile which specifies the temperature of the object/body. For best results, ideal distance should be 6 inches from the object/body, and must have an emissivity of 0.97. Usage: It must be kept perpendicular to the unobstructed forehead and maintain a specified distance. The forehead must not be exposed to sunlight.

*6.2.2. Automatic Mist Based Sanitizer Dispenser*

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A device that sprays mist-based sanitizer on hands without having any contact, in any public places, hospitals, offices, etc. This works with a waterproof non-contact ultrasonic sensor, which detects the target object/hands by sending out high-frequency sound waves and also checks the distance of the object/hands. If the target is within the specified range then using mist atomizer it sprays the sanitizer about 60o cone angle, and for 12 seconds. It also optimizes the use of sanitizer, from normal use 20-30ml to mist form use 5-6ml.

6.2.3. *Disinfection chamber*

A device meant to decontaminate a person, a full-body disinfection chamber. This is also called Personal Sanitation Enclosure (PSE). This is equipped with Passive Infrared (PIR) motion sensor at the starting and end of the chamber to detect the movement of individuals and prevent wastage of sanitizer. Inside the chamber, mist sprayers are equipped to spray the sanitizer or disinfectant and connected to tanks in which the disinfectant is filled accordingly. These can be kept at the entrance and exit of the hospitals, offices, shops, supermarkets public places, etc.

6.2.4. *Currency Notes/Mobile/Keys Sanitizing Machine*

These machines are equipped with Ultra Violet C (UVC) light lamps or germicidal lamps and proximity sensors. The proximity sensors are used for opening and closing the drawers or boxes without any contact. And sanitization process is done by UVC light lamps, its short wave ultraviolet light destroys the DNA base pairing and leads to the inactivation of viruses, infections at the speed of light. These are also used to sanitize the rooms in many hospitals.

6.2.5. *Thermal glasses*

A wearable device equipped with a special lens that focuses on infrared light, infrared sensors, and thermographic cameras. These use black body radiation; the movement of molecules produces heat and the temperature will be above zero. These are used to detect the temperature of the body/object.

6.2.6. *Throat worn wearable*

Throat worn wearable is based on custom algorithms used to measure rate of respiration, sounds and activity. It is thin, flexible, soft and wireless device of postage stamp size. This is to be placed below suprasternal notch (pit at the base of the throat). This device gives a continuous monitoring (24X7) of the throat activity like intensity of cough-its patterns, movements of chest wall-irregular breathing, sounds of respiration, rate of heart and temperature of body – fever. This information is transmitted to a protected cloud (Health Insurance Portability and Accountability Act HIPAA), further the algorithm automatically summarizes graphically the information for remote and rapid monitoring.

*6.2.7. Aarogya Setu App*

Technology of contact tracing is used in Aarogya Setu App. The purpose of designing this app is to track symptoms or positive cases of users and alerting other users who came into the range of user who is either positive or having symptoms. The working of the app is that using Bluetooth of the phone it records all Aarogya Setu users and capabilities of GPS are used to log all the places that the device had been at 15-minute intervals. If any user declares symptoms or tested positive through self-assessment survey in the app then the recorded information in the phone is uploaded to the server and necessary measures are taken. This app was proposed by the Government of India.

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## 7. Conclusion

Real-world complexities in general and COVID-19 in particular are calling for more improved and developed systems where the intervention of human beings is minimized. COVID-19, a pandemic posing a challenge to existence of human race on the mother earth. The AmI systems not only improving the standards of living, comfort, and safety of people but also are efficient enough in handling pandemic conditions in prevention, detection and treatment of infected individuals. Thus, it can be concluded that the AmI developments are having a significant role in providing quality health care not only for the front-line medicos but also to common lay persons in a easy and efficient manner thus reducing the possibility of infections rates to minimum.

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