

Smart Houses in Cloud4all: From Simulation to Reality

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Abstract. The Global Public Inclusive Infrastructure (GPII), which is being developed by the Cloud4all project and several other R&D projects, is a framework to ensure that everyone who faces accessibility barriers due to disability, ageing, etc. can use computers, mobile devices, the Internet and all the information and services available through these media. One of the goals of the Cloud4all project is to investigate this "auto-personalisation from preference sets" (APfP) in a domestic environment. To this end, the project is developing an online simulation of a smart house containing several devices with adaptive user interfaces such as a multimedia system and a washing machine with a display. For demonstration purposes, the simulation allows visitors to select the preference sets of seven personas with a variety of disabilities, i.e. visual, auditory, cognitive and motor impairments.

The Smart House Living Lab is a real accessible house equipped with the usual services of a conventional house where different ICT technologies (sensors and actuators) are distributed extensively in the living lab technical areas such as ceilings and walls, remaining invisible to users. It is managed by the Life Supporting Technologies Group of the Universidad Politécnica de Madrid; and it is also a member of the European Network of Living Labs [4].

This paper shows the Smart Houses online simulation developed within Cloud4all and its integration with the Smart House Living Lab at UPM.

1 Auto-personalisation from Preference Sets in Cloud4all

Cloud4all uses "preference sets" (known as profiles in some other contexts) to identify the needs and preferences of its user. These preference sets might be generic or specific to the context of a given application, device, platform, or environment. Based on the preference set, the Cloud4all system determines the best assistive technologies and user interfaces that will make IT systems and content accessible. In the case of the Smart House online simulation, we want to demonstrate how various user needs can be accommodated by typical home appliances.

We have targeted a wide variety of disability groups to show the capabilities a Smart Home can achieve with the help of Cloud4all. Re-using personas defined in the AEGIS [2] and ACCESSIBLE [1] projects, we have determined the needs and

preferences for various user types. Some excerpts from Cloud4all's preference sets for these personas are shown below.

Paulina Reyes

```
{
  "http://registry.gpii.org/common/adaptationType": [{"value": ["audio
description", "audio representation", "tactile representation"]}],
  "http://registry.gpii.org/common/language": [{"value": "es"}],
  "http://registry.gpii.org/applications/uk.co.jads.android.speechRate":
[{"value": 5}]
}
```

Maurice Nalobaka

```
{
  "http://registry.gpii.org/common/genericFontName": [{"value": "sans-
serif"}],
  "http://registry.gpii.org/common/fontSize": [{"value": 18}],
  "http://registry.gpii.org/common/foregroundColor": [{"value":
"#FFFFFF"}],
  "http://registry.gpii.org/common/backgroundColor": [{"value":
"#000000"}]
}
```

Nitesh Sarin

```
{
  "http://registry.gpii.org/common/language": [{ "value": "en-GB"}],
  "http://registry.gpii.org/common/magnification": [{ "value": 2.0 }],
  "http://registry.gpii.org/common/invertImages": [{ "value": false }],
  "http://registry.gpii.org/common/tracking": [{ "value": "mouse" }],
  "http://registry.gpii.org/applications/com.aisquared.zoomtext.application
Priority": [{ "value": 0 }],
  "http://registry.gpii.org/applications/com.microsoft.windows7.themes": [{
"value": "Windows 7 Basic" }],
  "http://registry.gpii.org/applications/com.microsoft.windowsphone7.backgr
oundColour": [{ "value": "#FFFFFF" }],
  "http://registry.gpii.org/applications/com.microsoft.windowsphone7.foregr
oundColour": [{ "value": "#000000" }],
}
```

Edward Hodgins

```
{
  "http://registry.gpii.org/common/language": [{ "value": "en-GB"}],
  "http://registry.gpii.org/common/visualAlert.usage": [{ "value": "pre-
ferred" }],
  "http://registry.gpii.org/common/visualAlert.systemSounds": [{ "value":
"window" }],
  "http://registry.gpii.org/common/voiceRecognition.microphoneGain": [{
"value": 1.0 }],
  "http://registry.gpii.org/common/voiceRecognition.volume": [{ "value":
1.0 }],
  "http://registry.gpii.org/common/voiceRecognition.dictation": [{ "value":
true }],
  "http://registry.gpii.org/common/voiceRecognition.commandAndControl.vocab
ulary": [{ "value": "Natural" }],
  "http://registry.gpii.org/common/adaptationPreference.adaptationType": [{
"value": "visual representation" }],
  "http://registry.gpii.org/common/adaptationPreference.language": [{ "val-
ue": "en" }]
}
```

Mikel Vargas

```
{
  "http://registry.gpii.org/common/onscreenKeyboard": [{ "value": true }],
  "http://registry.gpii.org/common/-provisional-initDelay": [{ "value":
0.120 }],
  "http://registry.gpii.org/common/cursorSpeed": [{ "value": 0.850 }],
  "http://registry.gpii.org/common/cursorAcceleration": [{ "value": 0.800
}],
  "http://registry.gpii.org/common/-provisional-mouseEmulationEnabled": [{
"value": true }],
  "http://registry.gpii.org/common/stickyKeys": [{ "value": true }],
  "http://registry.gpii.org/common/-provisional-slowKeysEnable": [{ "val-
ue": true }],
  "http://registry.gpii.org/common/slowKeysInterval": [{ "value": 0.4 }],
  "http://registry.gpii.org/common/-provisional-debounceEnable": [{ "val-
ue": true }],
  "http://registry.gpii.org/common/debounceInterval": [{ "value": 0.20 }],
```

```

"http://registry.gpii.org/common/language": [{ "value": "es-ES"}],
"http://registry.gpii.org/common/-provisional-speechRecognitionOn": [{
"value": true }],
"http://registry.gpii.org/common/controllerWindow": [{ "value": "show"
}],
"http://registry.gpii.org/common/microphoneGain": [{ "value": 1.0 }],
"http://registry.gpii.org/common/dictation": [{ "value": false }],
"http://registry.gpii.org/common/mouseControl": [{ "value": false }],
"http://registry.gpii.org/common/automaticDelay": [{ "value": 0.0 }],
"http://registry.gpii.org/common/automaticScanRepeat": [{ "value": 3 }],
"http://registry.gpii.org/common/scanSpeed": [{ "value": 0.5 }],
"http://registry.gpii.org/common/keyHeightRelative": [{ "value": 5 }],
"http://registry.gpii.org/common/keyWidthRelative": [{ "value": 3 }],
"http://registry.gpii.org/common/keySpacingRelative": [{ "value": 1 }],
"http://registry.gpii.org/common/doubleClickSpeed": [{ "value": 0.4 }],
"http://registry.gpii.org/common/absolutePointing": [{ "value": true }],
}

```

Peter Vandezande

```

{
"http://registry.gpii.org/common/language": [{ "value": "en-GB"}],
"http://registry.gpii.org/common/screenEnhancement.magnification": [{
"value": 2.0 }],
"http://registry.gpii.org/common/screenEnhancement.invertImages": [{
"value": false }],
"http://registry.gpii.org/common/screenEnhancement.screenMagnification":
[{"value": "ZoomText" }],
"http://registry.gpii.org/application/ZoomText.priority": [{ "value": 0
}],
"http://registry.gpii.org/common/mouseEmulation": [{ "value": "Keyboard"
}],
"http://registry.gpii.org/common/voiceRecognition.microphoneGain": [{
"value": 0.5 }],
"http://registry.gpii.org/common/voiceRecognition.dictation": [{ "value":
true }],
"http://registry.gpii.org/common/voiceRecognition.commandAndControl.vocabulary":
[{"value": "Natural" }]
}

```

The purpose of these preference sets for the chosen personas is to cover a wide range of user needs – so that we can see how they apply in a domestic environment. To this end, we have also carefully selected a range of appliances and devices that appear in almost every home. When defining the adaptations for each appliance, we have tried to be as realistic as possible – e.g. washing machines don’t usually have a big display, but it is not uncommon for it to be touch screen. Similarly, we have tried to make the interfaces presented as close as possible to real products on the market – while still allowing a certain level of customization that might not be currently available. Table 1 below shows the personas chosen, the devices chosen, and a mapping of appliances that support adaptations for the needs of a given persona.

Table 1. Target groups and device adaptations

Target group/device	Blindness	Night blindness	Low vision	Hearing impairments	Motor problems	Cognitive limitation
Persona	Paulina Reyes	Maurice Nalobaka	Nitesh Sarin	Edward Hodgins	Mikel Vargas	Peter Vande-zande
Multimedia system	X	X	X	X	X	X
Smart phone	X	X	X	X	X	X
Air conditioning remote	X	X				
Kitchen appliances	X	X	X	X		X
House sensors		X		X	X	X

It is easily seen that the simulation covers a wide range of needs, even for devices with small displays, such as AC remotes. Thus its users are able to get a better idea of how Cloud4all’s auto-personalisation from preferences applies to a domestic environment.

2 Smart Houses Online Simulation

The Smart Houses online simulation provides a graphics interface depicting a typical house (Fig. 1). A user is able to choose a room, which is followed by an animation that slowly transitions to that room. The devices and appliances in the room are highlighted and the user can pick any of them to be transferred to the device interface.

Each device shows a default user interface that can later be adapted to the user needs (Fig. 2) – such as increasing the font size, applying high contrast theme, changing the volume, etc.



Fig. 1. The home page of the Smart Houses online simulation

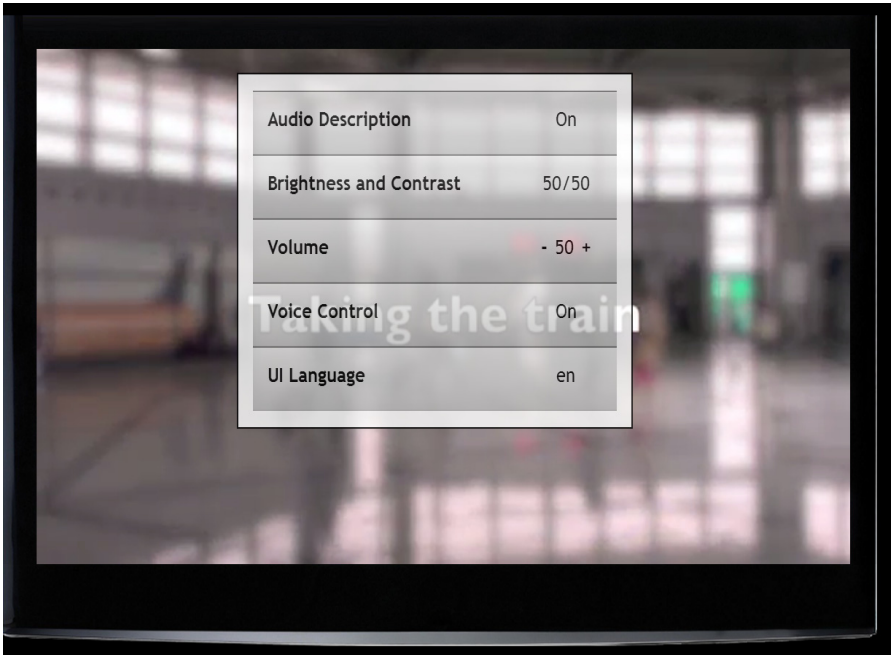


Fig. 2. The multimedia system menu

There are two ways to explore the simulation – you can either type your Cloud4all token to determine the best setting for you on each of the devices, or choose one of seven predefined personas. They allow visitors to easily get an impression of the adaptive interfaces in the simulation without going through the process of creating their own preference set. The simulation will not only be of value to the Cloud4all project but also to other smart home projects that may take advantage of the open-source simulation to explore and show different smart home features and functions. Beyond that, the online simulation is connected to the Smart House Living Lab of the Universidad Politécnica de Madrid (UPM), one of the Cloud4all partners.

3 Smart House Living Lab at UPM

The Smart House Living Lab at UPM serves as a research and development environment in the Ambient Intelligence context of technology and services to prevent, care and promote the health and welfare of people, support for social inclusion and the independent living of fragile and dependent groups, in all stages of the value chain: training, experimental research, technological development and technology transfer.

With an area of over 150 m², it features modern control technology, monitoring and regulation of the environment. It consists of 3 distinct areas:

- User area: approximately 100 m² where currently a house is simulated (with kitchen, bathroom, bedroom and living room), but it is an open space where any scenario required can be simulated.
- The Control room: which has a unique view of the user through a one-way mirror and holds the communication and monitoring systems and server technologies.
- Area of Interaction in Virtual Reality: used for studying both, the user interaction with devices prior to prototyping in reality and for training them in their use. It serves for rapid prototyping of new services.

The Smart House Living Lab appliances are controlled through KNX [3]. Different technologies are used and can be applied to develop new applications and services. The Smart House Living Lab provides infrastructure for interaction with ICT technologies in the fields of communication, interaction, security, control and comfort.

The Cloud4all Smart House online simulation provides an innovative accessible user interaction model, taking advantage of Cloud4all accessibility features, to access and control the smart house appliances of the Smart House Living Lab.

Conclusion

The Smart House online simulation developed within the Cloud4all project and its integration with the Smart House Living Lab at UPM provide a glimpse into the future, when technology will be accessible to everyone everywhere – starting from their own home. They also show the power of Cloud4all to make accessibility easier for everyone – with no need for repeated complex configurations on every device.

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