Automation Across Interconnected Smart Homes

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ABSTRACT

This paper presents an affordable, open-source approach to enable interconnected smart homes, with emphasis on facilitating new modes of ambient interaction to address loneliness. Our system is designed to minimize dependence on the user's technical skillset while maximizing versatility and customizability, leveraging the well-established Home Assistant ecosystem and cloud storage platforms.

1 INTRODUCTION

The subject of loneliness among the elderly has been a growing issue in many countries with an ageing population. This issue was only exacerbated during COVID-19 when families had to stay in their homes and travel was limited. We demonstrate that existing smart home technology can be used to connect people more intimately regardless of distance. We aimed to design a system that any users of the open-source home automation system Home Assistant could set up to establish communication of local smart home systems over different networks using existing IoT (i.e.- Internet of Things) infrastructure. Interactions can be triggered by any sensor inputs and activate any outputs the user integrates with their Home Assistant instances, enabling customizability and broad exploration of new modes of ambient or robotic interaction with distant loved ones. For example, a light in each home's kitchen might indicate to each user when the other is in their respective kitchen, providing a sense of shared presence and a prompt towards incidental interaction.

2 SYSTEM DESIGN AND ARCHITECTURE

The open-source smart home platform Home Assistant was used for this project, owing to its relative maturity, ease-of-use, and freedom from specific vendors. When connecting one instance of Home Assistant with another the use of Google Drive API

in conjunction with Home Assistant was utilized. The Google Drive API [3] enables interactions between Home Assistant instances without introducing dependence on any home-based server, which can be less reliable. In the cloud-based approach, many cases of intermittent web connection may simply result in delayed rather than missed interaction. While latency or connectivity challenges, affecting the immediacy of interactions, may be a potential issue for users with less reliable internet connections, a delayed interaction is still preferable to a missed interaction. Additionally, the dependence on third-party services such as Google Drive may limit the level of cybersecurity afforded to users. The graphical representation of this system can be seen below in Figure 1.

3 DEMO AND POTENTIAL

When a user in one of the smart homes triggers a door sensor (i.e. Hall Effect Sensor), the state of the sensor is stored locally on the smart home instance using the export notification to file functionality [1] on Home Assistant. This local data store is then uploaded to google drive via Python script that is running on that instance Home Assistant. This data store on Google Drive is updated at regular intervals (1 second in the case of our demo implementation). Google Drive also authenticates the instance, which for the purpose of our demo is only done once and covers both houses.

Then in another house, a separate instance of Home Assistant is running a Python script that reads from Google Drive. If it detects that the door sensor state has changed from "off" to "on", it writes to a file in the Home Assistant instance. This triggers Home Assistant's folder watcher functionality [2] which is coupled with an automation that triggers a smart light to turn on and off.

Future work will focus on integrating this approach to interconnected smart homes with ROS (i.e.- Robot Operating System), for both ROS 1 and ROS 2. Since this approach stores sensor data locally, ROS based systems will be able to access the data stored on the Home Assistant instance or directly from Google Drive, opening up opportunities for deeper interaction between smart homes and robots.

This proof-of-concept demo demonstrates the feasibility of a connection between smart homes via established web infrastructure. There is scope for expansion of this system to create a variety of different interactions and applications. Some commercial applications could include having users in one country trigger automation for a house in a different time zone. For example, by triggering the door sensor in your house a notification could be sent to your parent's smart home in a different country/time-zone informing them that you have come home, and it is a good time to call you.
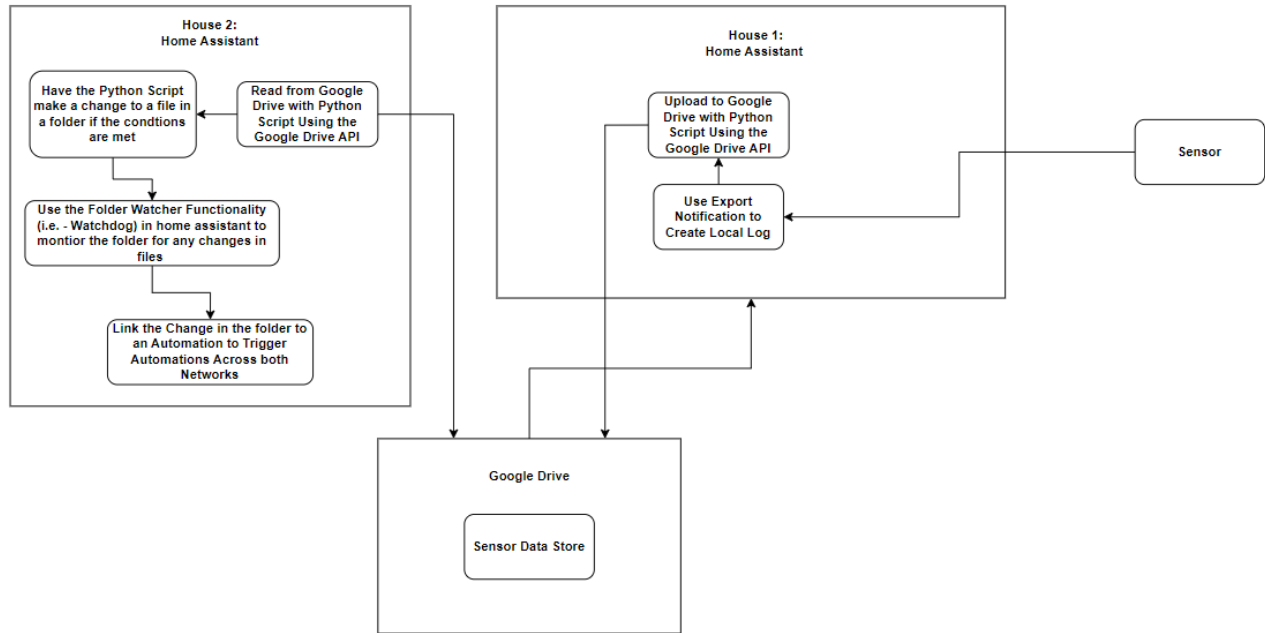
Figure 1: System Design for Interconnected Smart Homes Demo

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