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The information furnace: consolidated home control

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Abstract The Information Furnace is a basement-installed PC-type device that integrates existing consumer home-control, infotainment, security and communication technologies to transparently provide accessible and value-added services. A modern home contains a large number of sophisticated devices and technologies. Access to these devices is currently provided through a wide variety of disparate interfaces. As a result, end users face a bewildering array of confusing user-interfaces, access modes and price structures. In addition, as most devices function in isolation, important opportunities to exploit synergies between their functionalities are lost. The information furnace distributes data, provides services, and controls an apartment’s digital devices. Emphasis is placed on accessibility and on exploiting the synergies that inevitably come up when these technologies and services are housed under a single roof. The prototype implementation I outline integrates on a FreeBSD server the distribution of MP3-encoded music to DNARD/NetBSD thin clients, an answering machine, a burglar alarm, an Internet router, a fax server, a backup server, and intelligent control of a PBX.

Keywords Automation · Consumer electronics · Home-control · Multi-modal interfaces

1 Introduction

Although our complex lives are not necessarily improved by each new technological widget we adopt, uncooperative devices and appliances with deficient user-interfaces can certainly conspire to frustrate us. Over the past three years I have experimented with a number of technologies that gave birth to the information furnace concept: a basement-installed PC-type device that integrates existing consumer home-control, infotainment, security, and communication technologies to transparently provide ubiquitous access and synergistic value-added services. In the following sections we will examine the devices and appliances lurking in the modern home, overview the problems associated with the current breed of devices, and go over the basic elements of the information furnace concept and its prototype implementation. Further implementation details on technologies behind the system we describe can be found in Spinellis [1]; this paper focuses on the system’s concept, architecture, and evaluation.

2 The modern home

A modern home contains a large number of sophisticated devices and technologies. Current and near future technologies and respective devices can be roughly categorised into the categories of home control, infotainment, security, communication and special-purpose devices.

2.1 Home control

Contemporary central heating systems are regulated by one external and a number of internal temperature sensors in conjunction with a control unit occupants use to set the desired room temperature. The system compares the internal room temperature to the setting of the control unit and, using the external temperature as a compensating factor, regulates the temperature of the water produced by the local heat-generating plant or the valve bringing remotely-heated water into the home. Burners often have their own control circuits based on target temperatures for the burner and the circulating pump, but we can regard them as a black box for the purposes of this article. Convenience elements associated...
with control units involve the ability to maintain different temperature settings for day and night, manually set the system to day, night, or absence mode, keep a weekly schedule of automatic switchovers between these modes, and switch-off for the prescribed duration of a trip.

Instead of a burner, some systems are based on a heat pump and air circulation. They are controlled by the same principles, but can also lower the building’s temperature during hot days. Split-type wall-mounted room air conditioners feature an integrated opaque control circuit adjusted individually through a remote control.

The provision of hot running water to the bathrooms and kitchen is often controlled together with the central heating system. The added complications this brings into the picture involve the possibility of heating the water on sunny days through a solar panel, an electrical heater being used as a backup measure, a circulating pump to pass water through the solar panel, and a second pump to bring hot water near the taps. The first pump operates through a thermostat comparing the temperature difference between the hot water storage tank and the solar panel; we can again regard the system as a black box that absorbs solar energy. The operation of the second pump is more tricky: its intention is to save water by bringing the hot water close to the taps. When the central heating system is operating, having a secondary warm water circulating circuit in the house does not hurt; the floors and walls where the running hot water pipes run act as secondary radiators. When however the central heating is switched off (on warm days or during an absence) the circulator actually cools the stored warm water by continuously running it through the house. In my experience modern heating controllers do not deal with this complication.

The natural light entering a building is often controlled through external blinds or stores. These also play an important role in regulating the heat flowing into or out of the building. In addition, a heliostat device can be used to track the sun movement and actively reflect sunlight into the building. Artificial lighting can be electronically controlled through a system such as X10 or LonWorks in the United States and the European Installation Bus (EIB) in Europe. Perversely, in the case of the EIB at least, it is currently cheaper to control lights using 230V switches and individual switch-to-appliance power-carrying cables than to use a signal and power bus, cheaper control switches, and the associated electronics. This is clearly a case where the silicon economy has not yet done its work. Other interesting elements of modern artificial lighting include light fixtures with integrated motion and light detectors that are increasingly used outside homes as burglar deterrents, time switches used for the same purpose inside the house, and ‘economy’-type light bulbs that may take up to five minutes to reach their rated light output.

A case where the silicon economy has worked is exemplified by the availability of affordable devices to control plant and garden watering. These often sport a bewildering array of daily and weekly watering programs (apart from the one you really require, that is), can be directly fitted into a watering hose, or can control multiple valves, and can receive additional feedback from a soil humidity sensor.

2.2 Infotainment

The array of devices used for servicing our entertainment and, supposedly, our information access needs (covering the so-called ‘infotainment’ category) is bewildering. It involves CD, MP3, and DVD players, radios, the (increasingly digital and interactive [2]) television, tape or hard-disk based video recorders, digital photograph and video cameras, game consoles, and networked personal computers. Across those devices we typically witness a gratuitous duplication of functionality, and a lack of standardisation; both are exemplified by the growing array of remote controls adorning the typical lounge table. The last problem has spurned research [3] and development of universal, configurable remote controls.

2.3 Security

Home owners not wishing to trust their security of the prized possessions I outlined in the previous paragraph to the watchful eye of the local cop or a bona fide menacing animal often end-up contributing to the bottom line of the burglar alarm and home monitoring industry. A modern burglar alarm consists of a control unit, an array of sensors, and facilities for alerting whomsoever the owner can afford. The sensors used include motion detectors based on passive infrared (PIR), microwave, or hybrid technologies, magnetic contacts that detect the opening of doors and windows, and glass vibration sensors. Sensors placed under mats and carpets, and light beam detectors are less often used. Contrary to the popular perception promoted by Hollywood films, visible red intersecting laser beams used to test a burglar’s agility are not a popular sensor option.

The control unit is typically an overpriced, and underpowered microprocessor-controlled contraption. It monitors the sensors (due to a dearth of input ports, these are often or-wired into ‘zones’), which allows the owners to activate and deactivate it using a PIN, distinguishes between a normal entry (e.g. through a door) that provides a delay for deactivating the system, and an unexpected event (e.g. motion, entry through a window) that immediately triggers an alarm, offers a facility for operating with the occupants inside the house (‘night mode’), and controls the alarm triggering and rearming process. Alarms in most cases sound an internal siren that is supposed to frighten the burglars (but will in most cases only frighten the poor owners when set-off in a ‘night-mode’ operation), activate an external siren, often coupled with a strobe light, that passers-by typically try...