

# **DOLLHOUSE-SMART HOUSE INTERFACE: AGE 3+ OPERATES HOUSEHOLD APPLIANCES.**

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**ABSTRACT** Household appliances are indispensable in daily life. However, it is generally hard for small children to operate household appliances. On the other hand, small children can play with a dollhouse which contains some toy household appliances. Thus, we hypothesize that small children have a potential to operate actual household appliances. We developed a controller in a form of a dollhouse and toy household appliances. Small children can operate actual household appliances in their environment with the controller. In the system, when children touch a NFC tag attached to a toy house appliance in a dollhouse, the corresponding actual household appliance is operated by an ECHONET Lite message. Our proposed system is composed of a dollhouse, toy household appliances, NFC tags, an Android smart device supporting NFC as a controller, a plush toy case for a smart device, a wireless router, a single board computer, and household appliances as target devices. We implemented Java applications running on the controller and the target devices for communication between both of them. For implementation of the communication, we used the OpenECHO in order to send/receive ECHONET Lite messages via the wireless router. Significance of our proposed interface is as follows. First, all of the components of our proposed system are commercially available at low costs. Second, the NFC tags can be attached anywhere. Third, necessary ability to use our proposed interface is only to play with a dollhouse. In our proposed interface, the dollhouse is nested in the smart house and it provides feedback from the toy home appliances to the actual home appliances. Thus, in terms of the feedback and the recursive structure, our proposed interface might nurture children's cognitive development through usage of the interface.

## **INTRODUCTION**

Household appliances are indispensable in daily life. However, it is generally hard for small children to operate household appliances. They can neither reach switches of the household appliances nor understand how to use remote controllers of the household appliances. On the other hand, small children can play with a dollhouse which contains some toy household appliances. Typical toys are suitable for children over three years of age. Thus, we hypothesize that small children have a potential to operate actual household appliances.

In this paper, we proposed a controller in a form of a dollhouse and toy household appliances (named dollhouse-smart house interface). We expect the interface to evoke relationship between playing with the toy household appliances and operating actual household appliances corresponding to the toys, in the sense of Gibson's affordance. We developed a prototype of the controller, shown in Figure 1. In the system, when a child touches one of two labels (on or off) attached to one of two toy household appliances (a toy desk lamp or a toy desk fan) with a plush toy in a dollhouse, a corresponding actual household appliances (a desk fan or a desk lamp on a shelf) is operated (turned on or off). We assumed household appliances are compatible with ECHONET Lite<sup>1</sup> [1].

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<sup>1</sup> ECHONET Lite is a communications protocol developed by ECHONET Consortium in Japan. The protocol aims to build reliable, low-cost and extensible home network that can be installed easily in existing homes. Layer 1 to 4 in the OSI model are not specified in this protocol, so developers can implement it using any low-layer protocol such as Ethernet, Bluetooth, ZigBee or any other proprietary protocols.



Fig. 1 A dollhouse-smart house interface.

## IMPLEMENTATION

Our proposed system is composed of a dollhouse, toy household appliances, NFC tags (NXP Semiconductors N.V., NTAG203), an Android smart device supporting NFC as a controller, a plush toy case for a smart device (Sanrio Company, My Melody flat doll pouch), a wireless router (BUFFALO INC., WZR-300HP), a single board computer (Raspberry Pi Foundation, Raspberry Pi model B+), and household appliances (a desk fan and a desk lamp) as target devices. We implemented Java applications running on the controller and the target devices for communication between both of them. For implementation of the communication, we used the OpenECHO<sup>2</sup> in order to send/receive ECHONET Lite messages via the wireless router. Our proposed system works in the following steps. Communication flow of our proposed system (switching the desk fan in this case) is illustrated in Figure 2:

1. A user touches an NFC tag attached to the toy household appliance in the dollhouse with the plush toy case (Figure 3).
2. The application on the controller parses a URI scheme written on the NFC tag. To work properly,

URI scheme should contain at least three types of information in our implementation: (i) the tag is for this system, (ii) which household appliance is an operation target, (iii) how the target device should work.

3. The controller sends an ECHONET Lite message to all nodes which join an ECHONET Lite network.
4. One of the nodes specified in the message selectively receives the message. In our implementation, the single board computer which is connected to each of the target devices receives the message.
5. The application on the single board computer controls its GPIO pin.
6. An output of the GPIO pin on the single board computer turns on/off an AC power switch of target device corresponding to the miniature household appliance via a solid-state relay (SSR) which is connected to the GPIO pin directly.

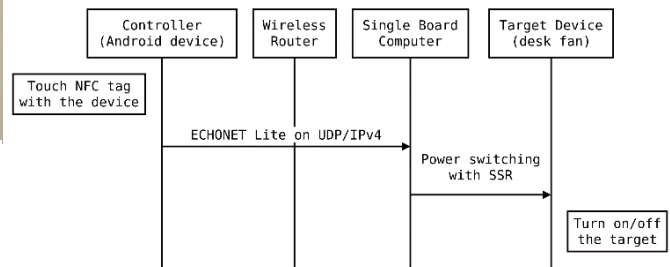


Fig. 2 Communication flow of our proposed system (switching the desk fan in this diagram).



Fig. 3 A user touches an NFC tag attached to a toy household appliance in a dollhouse with a plush toy case.

<sup>2</sup> OpenECHO is an open-source Java library that implements ECHONET Lite protocol developed mainly by Sony Computer Science Laboratories, Inc. It enables applications to communicate ECHONET Lite messages easily in the UDP/IPv4 stack. The OpenECHO is freely available on GitHub at <https://github.com/SonyCSL/OpenECHO>.

## DISCUSSIONS AND CONCLUSIONS

We developed a controller in a form of a dollhouse and toy household appliances with which small children can operate actual house appliances in their environment. Significance of our proposed interface is as follows. First, all of the components of our proposed system are commercially available at low costs. Second, the NFC tags can be attached anywhere. Third, necessary ability to use our proposed interface is only to play with a dollhouse.

Recent studies reported that a dollhouse system (it provides feedback from sensors attached to the dollhouse to computer graphics shown in a display) enhances communication skills of children who play with the dollhouse [2]. It is also reported that intelligence for handling recursive objects is nurtured by a recursive structure provided in a habitat [3]. In our proposed interface, the dollhouse is nested in the smart house and it provides feedback from the toy home appliances to the actual home appliances. Thus, in terms of the feedback and the recursive structure, our proposed interface might nurture children's cognitive development through usage of the interface. Our future work is to assess whether and how children use our proposed interface.

## REFERENCES

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