

Smart Shelf: Report

Md. Abdul Kadir
Saarland University
Saarbrücken, Germany
maktareq@gmail.com

Kevin Denk
Saarland University
Saarbrücken, Germany
denk.kevin@web.de

Atika Akmal
Saarland University
Saarbrücken, Germany
atikaakmal19@gmail.com

ABSTRACT

We are on the apex of interaction technology integration with every analogue system that is used in our daily life. Working in big lab with lot of consumable equipments or finding a product in a supermarket is really a big deal. It's really hard for a person to find an object from a gigantic shelf. Also, it's hard to keep supply continuous of consumables by checking every individual slots. Sometime, it's impossible. To ease the hard work of management and user we introduce *Smart Shelf* that will bring smoothest interaction between shelf and human. Here, we present the overall framework, related work and the time line to implement a prototype of *Smart Shelf*.

ACM Classification Keywords

H.5.m. Information Interfaces and Presentation : Human Computer Interaction

Author Keywords

Smart Fabrication, Smart, Shelf, Drawer, HCI, Human Computer Interaction, Physical Computing

INTRODUCTION

Today the word *Smart* is almost everywhere. There are *Smart Homes* and *Smart Fabrication*. But from the last few years, HCI researcher have developed new interactive interfaces, synthesize from different perspective of humans for example Psychology, Economically and Social that can be integrated with modern technologies (Ubiquitous technology). People prefer to use these technologies but sometimes face problems to obtain desired results. For example, most of the time people don't like to use shelves, because it is hard to find something. By using ubiquities technology, combined with technologies of the *Smart Home* and *Smart Fabrication* domain an interactive shelf, called *Smart Shelf*, can be developed. This shelf can enhance the utility of regular shelves. This report describes the approach of the implementation of the *Smart Shelf*. The report discuss different approaches of the interactive design, how the *Smart Shelf* is implemented and how to interact with it. One focus is the interaction of users and operators with the shelf. In the end there is an evaluation of the design decisions regarding the project and an outlook for further work.

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than the author(s) must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from permissions@acm.org.

© 2017 Copyright held by the owner/author(s). Publication rights licensed to ACM. ISBN 978-1-4503-2138-9.

DOI: [10.1145/1235](https://doi.org/10.1145/1235)

Problem

Most people when they hear about a shelf they think about their bookshelf or some shelves in the kitchen. Almost everyone who have a bookshelf searched at least one time in his/her life for a book in it and wished to have a guideline how to find it the fastest way. Imagine big shelves with a lot of small drawers. Every drawer is only labelled with a small name that describes what is in that drawer. Searching for items in these shelves can be hard and cost a lot of time. An additional scenario is if you apply this concept to big warehouses with hundreds of shelves and more drawers or places where you can place items. Finding an item in such a warehouse can be still harder.

Shelves used in companies or research institutes bring more problems to the surface. Often there are shelves used for storage of electronic components ¹ for example. The drawers contained in these shelves are often a lot and small. Searching for a specific item/drawer in such a shelf with for example fifty drawers can be exhausting. But this is not only one problem. Is the searched drawer found, the contained items are maybe out of stock and the user wasted his/her time. This is not only exhausting, it is also wast of time if the user could directly see if the searched item is out of stock.

Not only warehouses or storage rooms with shelves have those problems with the inefficiency in finding items or the premise if one item is out of stock. The same problems appear in retail. Customer which can't find their favourite product in a shop are unsatisfied. Maybe they go to another shop and don't come back. This problem can be tackled with *Smart Shelves*, too. The shelf itself could detect if some products in it are only available in a small amount. In this case the shelf could order new products or at least send an information to an operator who can order supplies. With this strategy there will be no more empty shelves in shops and customers can find their favourite product all the time.

Smart Shelf should be a solution for these problems. It could observe the amount of items in itself, help people to find products and also order supplies if the amount of items is low. The project described by this report tries to give a solution for the mentioned problems.

RELATED WORK

There are several development work happened last few year in human computer interaction(HCI), home automation and embedded technology. A big set of these work is giving intelligence to rigid objects and allow human to communicate

¹e.g. Resistors, Capacitor, Micro Controllers or Integrated Circuits

with them and vice-versa by applying noble HCI techniques. Moreover, post-WIMP devices also offer some features that can be integrate with the modern computer technology development(Ubiquitous computing). However, this post-WIMP GUI concept only applicable if there is a metaphor available in digital or analogue world. For example, searching the meaning of a word in digital dictionary(e.g:Smart phone dictionary). We want explain decent amount of successful research work that overlap at least in certain area with our Smart Shelf framework; However, there is no implementation or ground work fully overlap with our concept. A technical definition of our project is "Combining different interaction technique to innovate a device that follow the guideline of ubiquitous computing".The most related topic that are already known by design community are: QR code for presenting information, Automatic amount calculation, Controlling device.

QR code for presenting information

Now a days application of QR code become very popular and common due to the smart phone technology. Now people don't need to type search. Pressing a key is enough to get information based on QR code. A very innovative application is using QR code in library management. In a case study 'Application of QR Code Technology in providing Library and Information Services in Academic Libraries" by Sandeep Kumar Pathak showed that important information can be presented by QR code and user can easily get all those information by scanning QR code. We are implying this idea in to completely different perspective. In our case every drawer will have individual QR code. Each code will represent individual information about items stored in the drawer.

Automatic amount calculation

One major objective our implementation is representing empty or not empty drawer. As it's a very ground level work of many automation project, there are many project information available regarding weight measurement. However, in our project we are counting the objects based on the overall weight. We don't see this sort of work is not very common to automation community.Although, the most related work to that sub task is counting weight based on resistive sensor. An example of this work presented in *circuitdigest.com*:Arduino Weight Measurement using Load Cell and HX711 Module. Here they use Load Cell, but we will use resistive load sensor to calculate the weight signal.Also, their project does not include counting.

Controlling Device

The most important human to machine interaction task in this project is giving command to the system. There are several way to build up the this interaction system:one could be developing from scratch and another is building up over existing individual system. It's very common in Internet of Things (IoT) community to to use a smart phone for controlling a electronic system.For example there are lot of projects that use android devices for home automation. However, Our approach is similar but objective is completely different.



Figure 1. Example for used Shelf as prototype.

We see there are many existing work happened in granular level, but here we are bringing these granular ideas to build completely a new noble system.

CONCEPT

The Smart Shelf is able to recognize low storage of items. Additionally, it should support user to find the searched item in a shelf and show the location of it. This section will explain further details of the Smart Shelf. A description of what features the shelf will provide and how it works will be covered in this section. This work will provide a prototype of a smart shelf which is representative for a bigger application. For the prototype a shelf similar to the shelf in figure 1 will be used.

The Smart Shelf contains drawers with several products/items. With a smart phone app or another mobile device the user can search for a specific product which may contained in the shelf. Is the item contained in the shelf, a light mounted at the drawer which contains the item, will switch on. This indicates where the user can get the item. There is no need to scan the whole shelf for the searched item. The amount of items in one drawer can be measured with the weight of one item. With this information the Smart Shelf can display the amount of items in a drawer and also if it is empty. An empty drawer is indicated with a red light mounted on the drawer.

To design the Smart Shelf „smart“ it uses the information of the amount of items for trigger a so called *low stock alarm*. This results in emails send to configured addresses. The receiver can subsequently order supplies of that item.

Assumptions

To realize this prototype we assume some preconditions which are listed in the following.

All items in the shelf are either without packaging or with packaging. There will be no drawer where items be mixed. Furthermore, at any time there is only one sort of items in one drawer. Every drawer contains a different item.

Determine amount of Items

The amount of items in a drawer will be determined with the weight. In an initial step to all drawers an item will be assigned. This includes some information of the item as well as the weight of it. Measuring the overall weight minus the weight of the drawer itself one can compute the amount of items. This amount can be prompted by an user interfaces, in this case an app, explained in the next section.

Another solution to determine the amount of items is with the help of RFID. Every item is mounted with a RFID chip which can be tracked. However, for the prototype this is not feasible. Because item size there is not enough space to mount such chips. Nevertheless, this solution can be applied to bigger shelves like in warehouses or retail. This provides additional advantages. The RFID chips can be tracked and also wrong places items can easily identified and tracked.

App

To search for specific items a smart phone app is used. The keyword can typed into a text box. If found, subsequently the interface will show information about the searched item and the Smart Shelf will indicate with the green light in what drawer the item can be found.

The app provides an additional feature in scanning QR codes mounted on each drawer. By scanning a QR code the app will display the contained item and additional information (description, amount).

Correct inputs are displayed with appropriate messages on the screen.

Inputs

The system prototype needs different inputs. These are listed in the following.

- Search word for an item.
- Weights of the items in a corresponding drawer.
- Scanned QR-code on the drawer to get more information about the containing item.

Outputs

The outputs of the system are the following.

- Green lights on the drawer which indicates in what drawer the searched item can be found.
- Red lights on the drawer which indicates if the item contained in that drawer is out of stock.
- Email to configured email addresses as „low stock alarm“ to signal if there is only a low amount of items in a drawer or the item is out of stock.
- By scanning the QR-code the app shows information about the item contained in the scanned drawer.

IMPLEMENTATION

This section describes the different features the prototype of the Smart Shelf will provide. User are able to search with keywords for specific items may contained in the shelf. If the item is there the appropriate drawer will be highlighted with a green light. If there is only a low amount of items left in a drawer, a so called *low stock alarm* will be triggered. This results in an email to configured email addresses. In further iterations this can end in an automatic ordering. So that all items in the shelf will be always available. However, is a item still out of stock the appropriate drawer is marked with a red light.

The QR-Codes mounted on every drawer can be scanned by a smart phone app. This app will display information about the item contained in the scanned drawer, order information and amount of items left.

TIME PLAN

We divide our whole project into 5 to 6 life cycles (every cycle is about 1 week). We are expected to complete whole project the end of January. In first cycle, Make a smart phone application or may be use another to search a specific product which may contained in shelf. Apart of this, we will make a trigger called “low stock alarm”, will activate or either red or green light blink if the product will in shelf or wouldn’t be in. Observe the amount of items in each box and will display quantity of items on the screen. The screen will be located outside on each box, will be finished in second cycle. In the third cycle, we will complete functionality related to QR code scanning and develop a prototype. The last but not the least, if items stock will have been finished, sends notification email to administrator for acknowledgement. Most important will do unit testing to examine Is it the result is according to the desire requirements or not. In the last cycle, it is expected to remove bugs again and will do system testing to achieve desire results.

EVALUATION

FUTURE WORK

This section provides an outlook and what further improvements can be applied to the prototype.

As mentioned earlier, for warehouses or retail products and items can be mounted with RFID chips. This provides more accurate information about where products are and how one can find them. Additionally, the product itself can carry information about itself which can directly scanned by users. With mounted RFID chips one can imagine, if the item is placed on a special plate which can recognize the RFID chip, automatically information about it can be shown on a display. So the item itself serves as tangible user interface.

Further improvement can be applied in putting items into the shelf. Sometimes for people it is not obvious what item they have and where to put it into the shelf. With help of image recognition or RFID chips this can be improved. RFID chips can simply scanned and the app can tell where to put the item. Image recognition can scan the item itself and determine

where to put it.

For warehouses there is also the possibility to lead the user to the correct shelf. This could be done with light on the floor, directing the user, or with augmented reality. For this the user can use a HoloLens or the smart phone camera which display information about the direction to the correct shelf.

CONCLUSION

Basically, the idea of this project is to build interactive system, control by giving command to system i.e. through the use of smart phone. Smart shelf system will provide more interactive

future. For example user will be able to search with keywords for specific item may contain in the shelf. The trigger “low stock alarm” will be activated if there is very low number of items in any drawer. Similarly, green light glows if the searched item is available and empty drawer we represent with red light. Most interactive future is, the QR-Codes mounted on every drawer can be scanned by a smart phone application. This application will display information about the item contained in the scanned drawer, order information and amount of items left.

REFERENCES