携帯情報端末を用いた労務管理

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Original Paper

A Labor Management Application Using Handheld Computers

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Abstract

We have developed a labor management application for handheld computers. It is mainly aimed at large agricultural companies with a number of employees. The users, employees, input their labor data: name, operation, date and working duration, using handheld computers every day. The labor manager of the company transfers the data into a database in a personal computer regularly. The application has been improved based on an evaluation that the employees of one agricultural company cooperated with us to conduct. The application reduces time involved in labor management and makes it very efficient. We discuss why we focused on the labor data of a big company and how these data can be integrated with the other data. We also discuss the result of applying a web-based system using a cellular phone to this labor management task.

Keywords

labor management, handheld computer, agricultural company, rice

Introduction

For farmers, it is very important to record their farming activities and analyze the data in order to improve their performance and reduce environmental impacts. Recording the farming activities every day is critical for that purpose. However, it is one of the most bothering and tedious tasks and demands patience after a long hard day of fieldwork.

Among the data that describe farming activities, this study focuses on the labor data of a large agricultural company. When the number of employees in a company increases, the employees become much specialized, such as a combine operator, country elevator operator, radio controlled helicopter operator and so forth. They also divide work. As a result, all of the employees do not always know information on crop management such as input materials, its amount and output yield of each field. On the other hand, in an individual farm run by family farmers, a master farmer usually knows everything about farming activities. That is a big difference between a large agricultural company and a small farm. In addition, the labor data is produced every day even after harvesting, while crop management data is not produced after harvesting. The labor data contains not only lots of data related to crop management, but also lots of data that are not related to the crop, such as machine maintenance, deskwork and so on. Therefore in the company, the labor data can be separated and managed differently from the other farming data related to crop management. Of course, one could pursue a uniform data handling for all the data, but it is not the case in this study. See the discussion section for a further discussion.

Actually, when one of the authors visited a company with 21 workers, which grows rice in paddy fields of more than 300 ha for landowners, it was found that they did separately record their labor data every day, but in a notebook. That was mainly for accounting of labor productivity. One worker who is responsible for the data took a whole month to transfer all the data in the notebook into a desktop computer and

summarize them in the post-harvest season. It was clearly inefficient. If the data would be stored directly into a database, the manager wouldn't have to do such inefficient work. A tool that records the labor data of many employees is keenly needed.

There is a Japanese commercial application to record farming activities (Sorimachi 2002). It works on a personal computer and records both operations and applied materials through a single interface. It is designed mainly for an individual farm, not for a company with many employees. If it was used in such a company, the employees would have to wait in line to input their data. Otherwise, the company has to prepare a number of computers and software licenses. Kobayashi *et al.* (1996) developed a field management system for a large-scale agricultural company. It features management of a single field using a field map. Inputting farming data is similar to the previous one.

To process the inputting load in parallel, an Internet-enabled cellular phone can be used. Sugawara (2001) developed a web-based recording system. A user accesses the site and inputs farming data by their cellular phone. In this study we have tested a cellular phone system to compare it with a handheld system developed. See the evaluation and discussion section. Similarly, Yokoyama *et al.* (2001) developed a web-based case base system with a cellular phone. A number of farmers participate and record and share their farming activities. But, that takes a quite different approach and there is no obligation to record. That is a kind of volunteer information sharing system.

This paper presents a labor management application implemented on a handheld computer, which is a labor record inputting application for a number of employees in an agricultural company. The object of the study is to make the labor management efficient. Before having started software development, we interviewed users and discussed system requirement, necessary functions, user interface, data structure, data types and etc. After a prototype was developed, the users evaluated a prototype and suggested some points of improvement. Then we refined the application.

The following sections are divided in 4 parts: the next section describes the application. The evaluation section describes the results of a seven-month evaluation. In the discussion section, we discuss some points from the results, including the integration of labor management data and other farming data, and a test of a cellular phone system. And we conclude the study in the last section.

A Labor Management Application

System requirement

At first, we describe a company that collaborated in this study. Both a pre-development interview and an application evaluation were performed with the same company. It is an agricultural production company, which mainly grows rice by contract with paddy-field owners. The total area in commission is more than 300 ha. The number of employees is 21. When one of the authors visited the company, they managed labor data as follows: In a morning meeting, a labor management employee asked every employee about their operations and working hours on the previous day, and the manager recorded the data in a notebook. In winter, after harvest, the manager transferred the labor data into a desktop computer in order to summarize them. This task took about a whole month. The manager was seeking an efficient alternative way.

Based on the interview, the software requires the following conditions:

a. Users of the software are all employees. They record their labor data by themselves.
b. The software is easy to use.
c. The software lets users input operation data (name, operation, and working duration every 30 minutes).
d. The software manages lists of employee's names and operations.
e. The software stores the data in a database in the desktop computer.
f. The users do not have to wait in line to use it. A number of inputting devices are supplied.

As shown in condition c, they need to record

working duration for each operation. They don't need exact starting and ending time of the operation. The condition d is necessary because the lists may change later. The last condition is important. Because there are many employees, they would have to wait in line if only one inputting device was available.

Platform selection

To satisfy the condition f, there are some options for platform selection: desktop computer, Internet-enabled cellular phone and handheld computer. In consideration of cost, the desktop computer was not selected. It will cost much when numbers of computers are to be prepared. It was possible to use the cellular phone because employees already have their own cellular phone for their communication in the field. We presented a web-based recording system by the cellular phone for an evaluation. But no one liked to use it, because they did not like to pay for Internet connection fee by themselves. See the discussion section for more details. Therefore we selected a handheld computer as a platform, and tested handheld computers with Palm OS. Price of its low cost model is less than ¥5,000 or $40 as of October 2002. That is cheaper than Windows EC or Pocket PC machines. The Palm OS handheld quickly gets ready to use after the power button is pushed. The user does not have to wait for the startup time, which is a major difference from a PC.

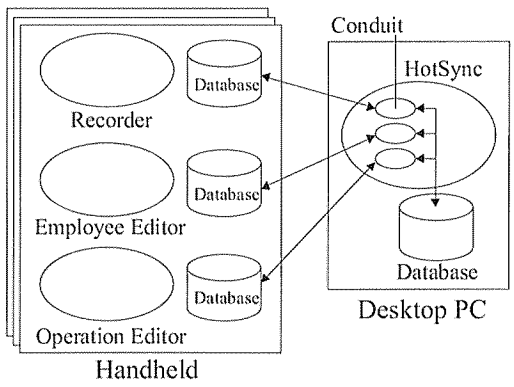

Figure 1 A schematic diagram of the application.Rectangles indicate hardware, and ellipses indicate software applications. Lines with arrows show data flow. There are three sub-applications in the handheld. The database in Palm OS in the handheld corresponds to a file in Windows OS.

Developing environment

For development of software that works on the Palm platform, we used a software environment, Code Warrior for Palm OS Platform 7.0J. There is another software, a conduit, which transfers data back and forth between handheld and desktop computer. For development of a conduit, we used a development kit, Conduit Development Kit Windows Edition 4.03 and an environment, Visual Studio Version 6.0. A prototype was evaluated in the company and revised based on the evaluation result.

Structure and features

Figure 1 shows a schematic diagram of the application. The application consists of five parts: a recorder, an employee editor, an operation editor, conduit modules and a database. The first three work on the handheld computers and the last two work on the desktop computer. The editors edit the data of employee and operation. These data are updated sometimes, while the recorder is used to record labor data every day. The labor manager transfers data on the handheld computers into the database on the desktop computer. The data transfer is performed by the HotSync procedure of Palm OS. The process starts when a HotSync button on the cradle is pushed. The cradle is an adapter that connects the handheld with the desktop computer. The process calls conduit modules that access the data in the handheld and transfer them into the database in the desktop. There are three conduit modules corresponding to each data. For example, the operation conduit reads data on the handheld, converts string into ID, generates a record ID, and saves the data into the database of the PC. The database in PC is a MS-Access 2000 database.

Data

The database has three tables: an employee, operation, and labor record table. Figure 2 shows a

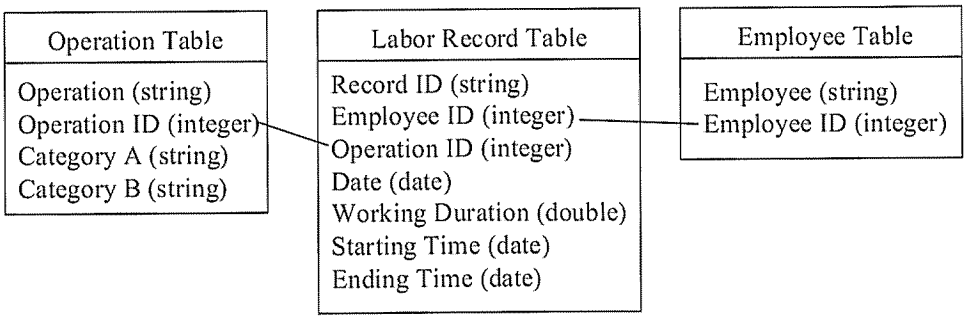

Figure 2 Labor data structure.
The word in the parenthesis indicates data type

structure of each table. The operation table stores operation name, two categories, and operation ID. The category A is an upper category of the category B. The category B is an upper category of the operation. The employee table stores ID and name. The labor record table stores operation ID, employee ID, date, working duration, and record ID. The table optionally stores starting time and ending time of the operation. Tables are related to each other by employee ID and operation ID. The number of operations amounts to more than 130 in the latest list of the company.

Software description and user interface

Figure 3 shows a handheld computer and icons of three sub-applications. The handheld is small enough to hold with one hand. Each application starts when its icon is tapped by a pen or the tip of a finger. Figure 4 shows user interface of the employee editor. This is an English version. There is a Japanese version as well. These designs were determined based on users' feedback. Using interface a, users can add new employee's name and ID by tapping the Save button after inputting data in the text fields. Interface b shows a saving confirmation dialog. When the button 'Show the list' is tapped in interface a, interface c appears

Figure 3 A device and the application icons.

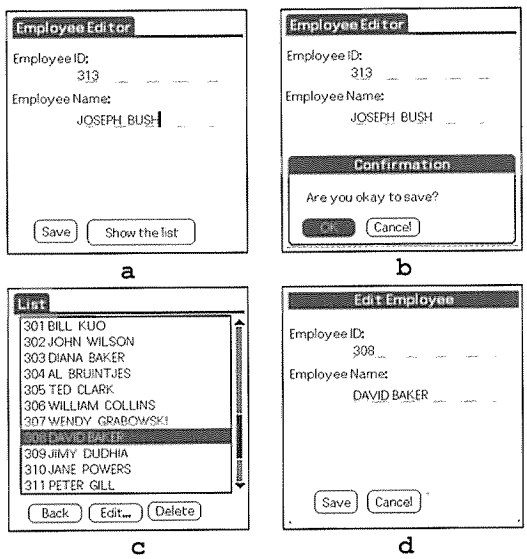

Figure 4 Employee Editor.

and shows a list of employee's name and ID. When the button 'Edit' is tapped after selecting one of the names in the list, interface d appears. The selected data can be edited here. The recorder refers to the employee's data. By a HotSync procedure, all the data can go back and forth to the database in the desktop computer.

Figure 5 shows user interface of the operation editor. Using interface a, users can add a new operation name and its categories. The interfaces are almost similar to those of the employee editor. A difference is that there are triggers in interface a, which are shown as filled triangles upside down. When the trigger is tapped, a popup list with existing items, operations or categories, appears (interface b). If one of the items is selected, the character string is copied into the text field (interface c). When the top category A is changed, the other popup lists for the category B and the operation are changed automatically. Also when the category B is changed, the popup list for the operation is changed automatically (interface c). These functions enable user to save time in both finding existing items and inputting characters.

Figure 6 shows user interface of the recorder. Using interface a, users input their labor data only by selecting the items in the popup lists. When the software starts, the default values are set to those saved most recently (interface a). When the name is changed, all the other values are set to that employee's latest values (interface c). When the button 'Show the list' is tapped, a list appears showing only the selected employee's labor data (interface b and d). Others' data are hidden. Therefore the system appears to only handle the data of a particular person. The software is personalized. Like the other two editors, saved data can be edited by tapping a button 'Edit'. Interface e is the one for editing.

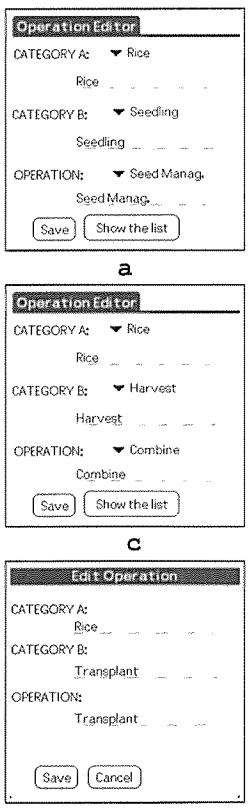

Figure 5 Operation Editor.

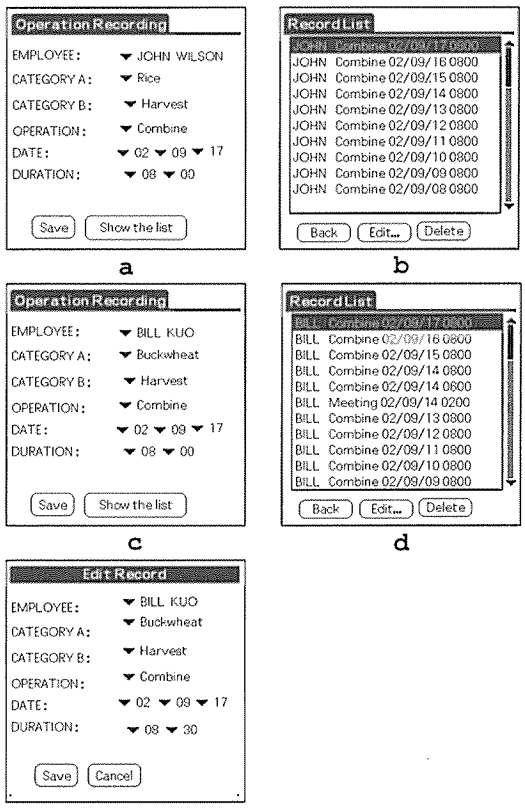

Figure 6 Recorder.

Evaluation

An agricultural production company cooperated in conducting an evaluation. The evaluation term was 7 months. The Japanese version was tested. The results are:

A. Two out of 21 employees did not use the device because they did deskwork and their labor data did not change.
B. The ages of the employees ranged from 25 to 56. Three were female and sixteen were male.
C. Nine handheld computers were used for 19 employees. The rate of employee per device is 2.1. Each employee used the same handheld every day.
D. All employees had no difficulty in using the handheld.
E. The employees inputted data after work every day.
F. Once a month, the labor manager transferred all the data into the database in the desktop.
G. Sometimes an employee input a new operation using the operation editor.
H. But mainly the labor manager edits the operation table in the desktop and updates the data in the handhelds by repeating the synchronization process. The manager updated the operation data 7 times.
I. They wanted to personalize the data.
J. They wanted to enlarge the font in the popup list.
K. They wanted to reduce number of tapping while inputting the data.
L. They complained of difficulty in finding an appropriate operation from the complicated large operation list.
M. They complained that it was troublesome to input Japanese strings for a new operation.
N. They liked the handheld more than a cellular phone system because of the cost.
O. They think that a suite of handheld applications is useful.
P. They use the handhelds operationally after the evaluation.

Based on the evaluation results, the problems related to I to K were fixed by changing the implementation. The software was personalized as described in the software description section. The font was enlarged. Tapping number was reduced by using the popup trigger and list, as described in the previous section. The complains about the large operation list weakened as they got used to the operation list. Also the list continued to be updated, so that the users did not have to register a new operation (related to L).

Discussions

Efficient labor management

This application is designed especially for the use in companies with many employees. We focused on efficiency in inputting and storing labor data. Before using the application, the labor manager spent about one month, 2 hours a day to transfer the data from the notebook and summarize them. By replacing this approach with the new method, the manager has got away from the transferring task. The application has made the labor management very efficient.

We also developed a labor accounting tool working on a personal computer, which uses the labor tables. That is a function of a farm management application (Otuka 2001). The tool calculates working hours for each operation and category per employee, month or production year, which gives labor productivity for each crop. The summarized data is exported in CSV format, which a spreadsheet application can read and use to make a variety of graphs. Those data and graphs are used to improve the company's management.

In general, there are many agricultural companies and agricultural service entities in Japan (Ministry of Agriculture, Forestry, and Fisheries 2001). The total number, which is increasing, sums up to 21420 in 2001. That includes business entities on a variety of management scale. The large-scale entities among them are possible users of the application.

Other crop management data

We divided all farming data into two parts: one is the labor data related to human, the other is all remaining data related to crop and field management, such as seeding date, transplanting date, fertilizer and

its applied amount, pesticide and its amount, and so forth. In our project with the company, the latter data are inputted by using the map-based field management application (Otuka 2001). The user inputs crop management data by clicking the fields and item lists. The data are stored in the database. On the other hand, as shown so far, the labor data are inputted using the handhelds. Although the interface is different each other, all the data is finally stored in the same database. Therefore what we divided actually was only a path where each data flows, not the data itself. After having stored in the database, all the data will be utilized for the management analysis in the same way.

Handheld and cellular phone

The employees in the company did not like to use the web system using the cellular phone. In fact, they use their private cellular phone to communicate with each other in the fields. They have no option better than the cellular phone to communicate in the fields. Without the phone, they cannot conduct field works smoothly. They also unwillingly pay for its voice fee by themselves. This was a situation before the test of web-based cellular phone system started. The reason why the employees did not use the web system is simply cost. They did not want to pay for extra Internet fee for the company's work. They could not find any benefit beyond the cost in this case. The benefit mainly belongs to the labor manager. It could be possible if the company paid for the fee. But, both to discriminate connections for company from private ones, and to pay back would be still bothersome. Moreover, the cellular phone system features a real time recording; a user can input the data whenever a farming event happens, no matter where the user is. In the labor management, the real time processing is not necessary. Also maintenance of the web server seemed a mental obstacle for the labor manager, which is related to the requirement b in the requirement section.

Future works

As described in the system requirement section, the employees don't want to wait in line for data input, because, in a hard economic condition of rice production, they don't afford many expensive PCs in the rest room where the employees return for data input after fieldwork. Therefore we took an approach that uses multiple cheap input devices. And also the cellular phone system was tested. But if the same interface as that of the handheld application was provided on the personal computer, what would happen? The result would depend on agricultural companies with different size and different labor management. Therefore, that is an open question which will need a wide range of user evaluations. We will provide a tool with the same interface here in the farm management system (Otuka 2001) and keep the evaluation.

As described in the preceding sections, a user can create its own operation items. The handheld application may be used in an individual farm too. However, in case of an individual farm, the farmer might want to input all the farming activities at one time, because the farmer knows everything about their farming. There are some handheld applications that record all farming activities (Settler Computer Technologies 2002, Satcon System 2002, Mangold(1) 2001, Mangold(2) 2001). Because they are made in United States or Germany where their farming is different from Japanese one, an application must be different from them. Therefore we need a further study to develop a new handheld system suitable for Japanese farmers.

Free source

The source code of the application will be available under GNU General Public License from our institute's site: http://agri-it.narc.affrc.go.jp/.

Conclusion

We have developed a labor management application for an agricultural company with a number of employees. Using handheld devices, they input their labor data: name, operation, date, and duration. Regularly, the labor manager transfers all the data on the handheld computers into the database in a desktop

computer. The data will be used to summarize for labor productivity in the company. The application was evaluated to be useful and it is now operationally used.

Reference

Kobayashi, H. and Y. Sakai (1997) Development of the Computer System on Field Management of Paddy Farm, J. Japanese Agricultural Systems Society, 13(2):96-103. (In Japanese)

Mangold, G. (1) (2001) Palm OS puts power in palm of your hand. agInnovator column, February issue of Successful Farming, http://www.agriculture.com/default.sph/AgInn.class?FNC=News__Ahtnews_html___11140, browsed on May 1, 2003.

Mangold, G. (2) (2001) Windows CE Applications for Agriculture. agInnovator column , March issue of Successful Farming, http://www.agriculture.com/default.sph/AgInn.class?FNC=News__Asearch_list_html___11156, browsed on May 1, 2003.

Ministry of Agriculture, Forestry, and Fisheries (2001) 2001 Agricultural Structure Statistics-Farm Investigation and Agricultural Company Investigation, Agriculture, Forestry and Fisheries Statistics Prompt Report 13(1).

Otuka, A. (2001) A production management system for a lager agricultural company, Agriculture Informatics, 3:79-80. (In Japanese)

Settler Computer Technologies (2002) Field-Mate, http://www.field-master.com, browsed on May 1, 2003.

Satcon System (2002) Palm Timer, http://www.satconsystem.com, browsed on May 1, 2003. (In German)

Sorimachi Inc. (2002) Farming Diary V6, http://www.sorimachi.co.jp/products_nougyou/nissi6/index.shtml, browsed on May 1, 2003. (In Japanese)

Sugawara, K. (2001) Farming Diary System Using Internet-enabled Cellular Phones, Internet Workshop 2001 Proc. II Applications, 247-252.

Yokoyama, K.(2001) A Real-time field information collecting system using Internet-enabled cellular phone, Bulletin of Hokkaido Agricultural Media and Information users' Networking Group (Haming), 11:66-68. Naganuma, Hokkaido. (In Japanese)

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携帯情報端末を用いた労務管理

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要旨

携帯情報端末を使う労務管理アプケーションを開発した.これは多くの従業員がいる農業経営体用である.従業員は自分の名前や作業名,作業日,作業時間の労務データを入力する.労務管理者は定期的にデータをパーソナルコンピュータのデータベースに転送する.このアプリケーションは農業生産法人による評価試験に基づいて改良をされた.評価の結果から,このアプリケーションは労務管理にかかる時間を減らし,効率的にする.また携帯電話を用いたWebシステムをこの労務管理に応用した結果も議論する.

キーワード

労務管理　携帯情報端末　農業生産法人　水稲