An Android based Medication Reminder System based on OCR using ANN

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ABSTRACT
Most of times patients may forget to take the medicines at proper time as per the specified in the prescription which may cause in late recovery from the disease/illness. So it is necessary to take proper medicines in proper quantity at proper time. In this paper we introduce an Android based application for the patients. This application will remind their user to take proper medicines in proper quantity at proper time by automatically setting the reminders in the mobile. These reminders will be automatically set by the application as per the prescription. This reminder will remind their user patient that now it's time to take the medicine.

Keywords- Android, medicine, prescription, disease/illness

1. INTRODUCTION

Any living being can be a patient which may include human beings, animals, pets, etc. The patients under human being category may include businessman, social workers, politicians, teachers, students, etc. These people may busy in their daily routine life schedule. If they are suffering from any kind of disease/illness then it's their duty to take the proper medicines in proper quantity at proper time. If the patient is at home then the family members may remember & reminds patient to take the medicines. But it is not possible for the family members to give reminder by calling them when the patient person is out of home/city. For this purpose there should be some facility for the patients which will remind them about their medicine taken time.

Now days there are large number of mobile phone/smart phone users in the world. The bulky number of variety of applications available in the mobile phone made the luxurious life. Mobile phone companies are providing such a wonderful applications for their users then question arises in mind that why not to use those applications when company is providing them? Out of those applications, Reminder facility in the mobile phone is the most commonly used application which is used for preventing to remember each and every small thing.

Most out-patient medication errors were made when patients bought prescribed medicines from different drug stores and use them at home without guidance. Common causes of these errors include: a)irregular medicine in-takes due to the patient's busy schedule, b) complicated in-take schedules due to the large number of medicines taken by the patient, c) adverse drug reactions caused by un-reconciled prescriptions obtained from different sources, d) lack of knowledge about proper use of medicines[1]

In this paper we are introducing an Android application for the patients which will remind their user to take proper medicines at proper time by automatically setting the reminders in the mobile. These reminders will be automatically set as per the prescription.

2. RELATED WORK

Zao J.K., Mei-Ying Wang, Peihsuan Tsai, and Liu J.W.S. discusses the approach of Wedjat – Smart Phone Application which is based on to help patients to avoid medicine administration errors which are mentioned above.

Fig. 1 Wedjat - Smart Phone Application

Wedjat can perform three primary functions:

a) Issue medicine in-take reminders
b) Provide medicine identification and in-take directions
c) Maintain medicine in-take records[1]

Similarly, Prasad B discusses the approach of Medicine Reminder Pro which is based on reminding medicine schedules.

Fig. 2 Medicine Reminder Pro

This free application supports up to 15 reminders. User can select them in either repeating or non-repeating alarm patterns. Any hourly time interval between alarms can be selected, starting from the minimum of 1 hour. At the scheduled time, application will produce a notification with an alarm, vibration or LED indication. [2]

Also Med Minder approach by David Garland of Garland Systems, which as per their saying, is easy, free, full featured pill and medicine scheduler and medication reminder application.

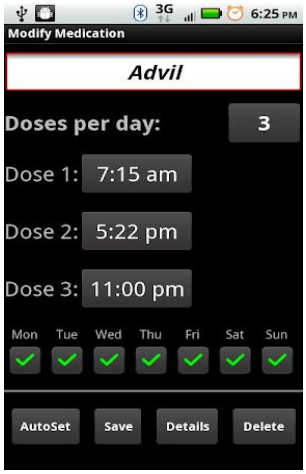

Fig. 3 Med Minder

But this system has lots of manual work and it is much time consuming. [3]

3. ANALYSIS

After studying and analyzing all the above existing popular applications based on Android mobiles, some major findings noticed which reduce their popularity.

A. Findings in existing systems:

a) User has to add the name of the tablet/capsule manually. No facility of adding them automatically.
b) User has to add the quantity/dose of the tablet/capsule manually. No facility of adding them automatically.
c) User has to add the reminder manually about taking the dose i.e. 2 times or 3 times in a day.
d) User has to manually select the week days about the reminder.
e) Existing systems are not providing any facility about end of medicines.
f) They are also not providing any kind of facility about the original prescription.
g) There is nothing happening automatically. Everything needs to do manually.

All these findings demands new application which will reduce the manual work & do everything automatically. Also the existing systems have some major drawbacks which motivate us to develop new system. Those drawbacks are as follows:

B. Drawbacks of existing systems:

a) Reminders are not automatically sets. So every existing system requires manual work of setting the reminder.
b) Existing systems are time consuming because of manually setting the reminders.
c) There is no facility of storing the original prescription in any of the existing system.
d) There is no facility of reminding the doctor's next appointment in the existing system.
e) There is possibility of hanging down the existing systems due to the manual work.

C. Table of Comparison

Table 1: Comparison of Existing System & Proposed System

Parameters	Existing System	Proposed System
Method	Manual	Automatic
Time	More time consuming	Less time consuming
Database	Required	Not required
Original prescription	Not stored	Stored
Reminder of doctor's next appointment	No	Yes
Possibility of hanging down an application	Yes	No

4. PROPOSED SYSTEM

The proposed system is an application for the Android platform mobiles will remind their user about the medicine in-take schedule. This reminder will be set in the mobile with the help of the reminder application. The reminders will be automatically set as per the prescription.

Android is a Linux-based operating system designed primarily for touch screen mobile devices such as smart phones and tablet computers, developed by Google in conjunction with the Open Handset Alliance. Initially it was developed by Android Inc. whom Google financially backed and later purchased in 2005. [4]

The proposed system will be developed for Android mobiles only because the market share of Android is more than other operating systems.

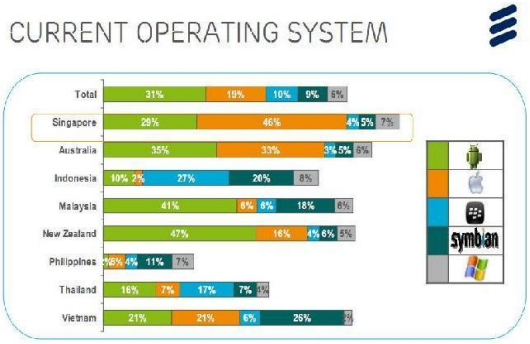

Fig. 4 Comparison of Android & other OS in South-East Asia Market [5]

A. Need of new system:

The existing systems are very useful; they are providing very nice facilities to the user about their medication reminding & scheduler. But as we see in analysis section, the existing systems were developed with lots of major observed drawbacks which need to overcome by developing new system. The existing systems are not fully automatic; there are lots of manual works like adding tablet/capsule name, dose per day, adding weekdays. Also they are not providing any notification about doctor's next appointment, also the end of dose/medicine.

So there is a need of developing such system which will try to overcome all the drawbacks of the existing systems. So we are taking the initiative for developing such full-fledged system which will be completely automatic like the system which we are proposing will automatically set reminder about medicine in-take. Currently we are not providing the name of any particular medicine & its dose in reminder. We will not providing any facility for adding the reminder on weekdays instead reminder will be set automatically as per the requirement mention in the prescription. Our system will also automatically give notification about doctor's next appointment and lots of other user friendly and automatic facilities.

5. SYSTEM OVERVIEW

Figure 5 shows input and output data flows of the proposed system. The input includes user's medicine prescriptions and personal preferences. The mobile application obtains user's medicine prescriptions by taking its pictures. For personal preferences, the user may block time periods such as sleeping hours, religion activities time, etc. Proposed system tries not to insert in-take events into those time slots.

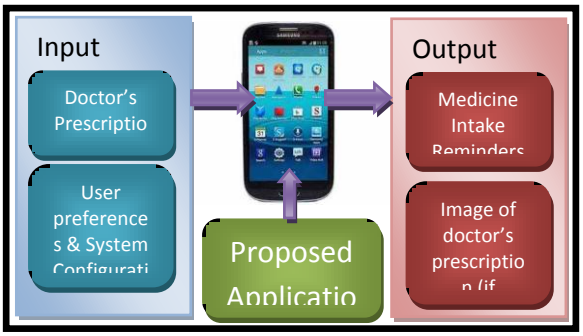

Fig. 5 Input/output Data Flow

The output includes medicine in-take reminders (MIR) and image of the prescription if required. After system produced an in-take reminder, it inserts it into the Calendar maintained by the mobile phone. The Calendar application then sets off an alarm at the proper in-take time. If the patient forgets to take their medicines then our system reminds them about medicine in-take time.

6. MEDICINE SCHEDULING SPECIFICATION

Table 2 shows the medication scheduling specification [1] [6] of the specific medicine. MSS can be divided into three sections containing *prescription, dosage* and *interaction parameters* respectively.

Table 2: Sample Medication Scheduling Specification

Prescription Parameter (PP)	
Medicine Identifier	M
Medicine Dose	g
Medicine Form	Capsule/Tablet/…
Medicine Amount	n
Therapy Duration	T
Dosage Parameter (DP)	
Min. & Max. Dose	[dmin, dmax]
Min. & Max. Separations	[nsmin, nsmax]
Max. Intake B over interval R	(B, R)
Min. Intake L over interval P	(L, P)
Interaction Parameter (IP) <List>	
Interferer Identifier	N
Min. separation from M to N	minToInterferer
Min. separation from N to M	minFrInterferer

A. Prescription Parameter (PP)

PP contains the necessary information of a medicine including its *name M*, the dosage *size g* and the *amount n* to be taken each time (as multiples of the dosage size) and its therapy *duration T* during which the patient should take the medicine. A picture of the medicine is also incorporated to assist patients identifying the medicine.

B. Dosage Parameter (DP)

DP states the minimum and maximum dose sizes [dmin, dmax] and the minimum and maximum separations [nsmin, nsmax] between two consecutive doses. It also specifies the supply rate (B, R), which the maximum dosage B is taken within any time interval R and the demand rate (L, P) and which the minimum dosage L is taken in any time interval p.

C. Interaction Parameter (IP)

A medicine *N* that interacts with another medicine *M* is stated as an *interferer of M*. The IP section of medicine *M* contains an entry for each of its interferers. Two constraints are specified for each interferer: *minTolnterferer* that specifies the minimum separation from medicine *M* to interferer *N* and *minFrlnterferer* that specifies the minimum separation from interferer *N* to medicine *M*. [1] [6]

7. OPTICAL CHARACTER RECOGNITION

Optical Character Recognition (OCR) refers to identifying printed characters as digitally recognizable form (such as ASCII). Traditionally, this was possible only through complex algorithms that had very little tolerance to errors. These algorithms required more computational power and processing time. In spite of these drawbacks, it is extremely difficult to code.

With the advancements in Neural Networks, pattern recognition has had a huge leap. This reduces coding to minimal. There are many algorithms based on ANN to achieve OCR. [7]

7.1 Artificial Neural Network:

A neural network (NN) is a task with variable and tunable parameters. It is an arrangement relating with weighted interconnection between neurons. Generally they are non-linear scalar transformation but can also be linear scalar transformation. The following figure shows an example of 1 hidden layer neural network with 3 inputs.

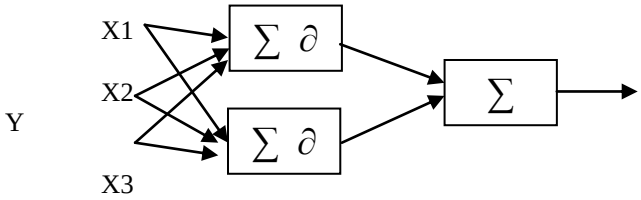

Fig. 5 Feed-forward network with 3 inputs, 2 hidden neurons & 1 output neuron

Artificial Neural Networks (ANN) is a collection of simple & especially interconnected cells. These cells are set in such a way that each cell derives its input from one or more other cells. The information in ANN is always stored in a number of parameters. These parameters can be pre-set by operator the ANN with examples of input & also together with desired output. [8]

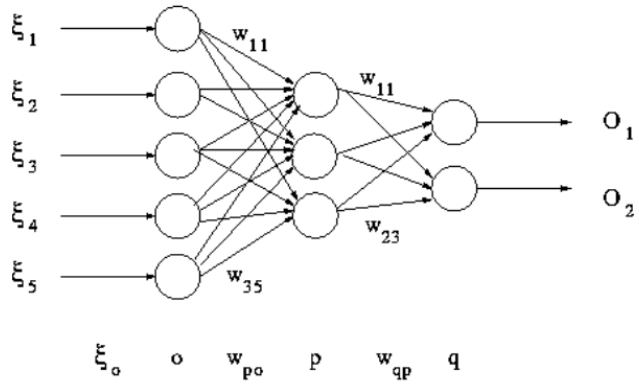

Fig. 6 Multi-layer Artificial Neural Network

7.2 Implementation:

The process of handwritten character recognition can be divided into 3 stages viz. Pre-processing, Feature Extraction, and then passing into ANN for training.

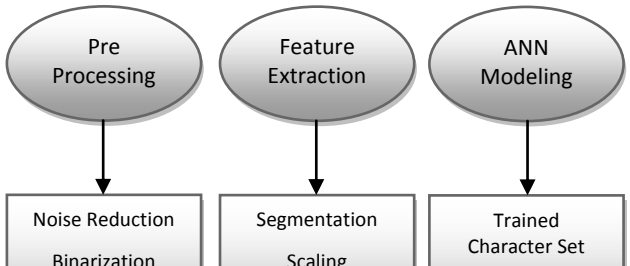

Fig. 7 Stages of HCR

7.2.1 Pre-processing

Directly implementing ANN modeling, it is important that the images should be in good quality which enhances the image and decreases noise and distortion. This helps in achieving higher accurate results. Preprocessing stage must be implemented in any OCR system.

7.2.1.1 Noise Reduction

It helps to decrease the noise in the image by performing a local averaging operation. In order to achieve this, a median or mean filter can be used to achieve minimal blurring.

7.2.1.2 Binarization

Then the process of binarization is implemented on the resulting image. Since the color information of the resulting image is irrelevant, binarization gives us uniformity between the samples. It also reduces the computational power as it has to deal with only 2 colors.

7.2.1.2 Pixel Uniformity

This process reduces the width of similar pixels to uniform pixel which is done with the help of edge detection by Sobel's method. Pixel Uniformity process reduces redundancy and makes the characters uniform. Similarly other pre-processing techniques such as Skew detection/correction, histogram matching, etc. could also be done.

7.2.2 Feature Extraction

Feature extraction in OCR mainly refers to the extraction of each character from the image.

7.2.2.1 Segmentation

Segmentation refers to separation of each character from others. It is done by drawing the smallest rectangle drawn around the characters.

7.2.2.2 Scaling & Binary Matrix Formation

The image thus extracted is scaled into a 32x32 matrix irrespective of the size. The image is scaled up/down to achieve uniformity. Scaling has to be done carefully preserving the vital features which is done by implementing a separate user defined function. If a line passes through a pixel, then corresponding pixel will be given value one (1), otherwise it is taken as zero (0). In this method the numbers of inputs are 32x32=1024 which requires more time to learn and classify the characters.

7.2.2.3 Space Detection

Since each character is segmented by finding the space between them it is not possible to find the actual space between words. In order to detect space, before passing each character to

the ANN, the difference between the x-coordinates of adjacent characters are compared with a threshold value to see if it's an actual space. Threshold value is calculated locally. The spaces between each character is calculated and sorted in descending order. The difference between these sorted values determines which one is an actual space (space between words) and which one is not. The lowest value acts as threshold.

7.2.3 ANN Modeling

The ANN model selected for HCR is Feed Forward Back Propagation Network (FFBPN). The information is passed in Forward direction and Error is propagated backwards. The optimal number of hidden layers and nodes has to be selected based on simulation and training results. Typically the model contains 1 Input layer, 1 hidden layer and 1 Output layer. Input layer consist of 1024 nodes (32x32). No. of Output and Hidden nodes vary according to the situation. Output nodes depend on the separate characters that make up the document.

7.2.3.1 Trained Character Set

The trained character set consists of all the individual letters/characters which are used to create a simple handwritten document. Each handwritten character has its unique feature. And these unique features associated with the characters remains same throughout the same document.

7.2.3.2 Analysis

Analysis of a standard 26 English letters & some commonly used special symbols are done and documented. This can be used as starting point to reduce time.

Number of nodes for ANN can be fixed after creating the final trained character set of all proper letter & special symbols. In this case, there are 1024 input nodes representing each pixel of 32x32 characters. And output pixels can be set accordingly. [7]

7.2.3.3 Result

The image of handwritten document is given to ANN model to check the accuracy of character recognition using ANN. The input to & output of ANN is shown as below,

Fig. 8 Handwritten Characters

In order to recognize the characters, the trained character set was created from the same handwriting. Following figure shows the implementation of preprocessing & feature extraction stages on the above handwritten characters.

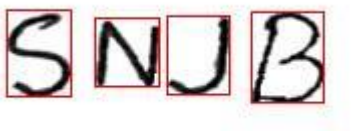

Fig. 9 Preprocessing & Feature Extraction of Handwritten Characters

8. CONCLUSION AND FUTURE SCOPE

Currently there are many medication reminder systems which are operable manually. Due to manual work, the available system becomes more time consuming. So in the given work, an attempt has been made to implement fully automatic medication reminder system based on handwritten character recognition. This is achieved with the help of artificial neural network. Neural network is very effective to decipher any character of any language. The accuracy of character recognition is more important. So accuracy of characters needs to improve by adding probability to each character. For example, a character Q is very less easy to find because character Q is more often mistaken with O in most of the OCR systems. The proposed system will only set the reminders in the built-in calendar application of the mobile. This reminder reminds user about their medicine in-take schedule. The system which we are implementing will also give the reminder about doctor's next appointment. It will also tell the user of the end of the medicines. The scheduled reminder will not suggest any kind of medicine, dose of medicine, etc.

In future, efforts can be made to improve the accuracy of the character recognition. Also the facility of adding names & dose of the medicine will be included in the reminder.

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