International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 3.45 (SJIF-2015), e-ISSN: 2455-2585
Volume 4, Issue 4, April-2018

Review on Intelligent Pillbox: Automatic And Programmable Assistive Technology Device

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Abstract— ***ThisAssistive Technology (AT) maintains and improves the individual's functioning and independence, thereby promoting their well-being. But today only 1 fom each 10 people in need have access to AT due to high costs and a lack of awareness, availability, personal training, policy and functioning. By 2050, more than 2 billion people will need at least 1 assistive product with many elderly needing 2 or more. Elderly make important contributions to the society. Though some people aged well, other become fail, with a high risk of disease. In this paper, we propose a frst approach related the design of AT device. This uses open source technologies and gives a new choice in taking medication dosages. "The Intelligent PillBox" allows the organization of several medication schedules that health disorders presented in elderly need basically. Arduino Mega 2560 was taken as the principal controller. This prototype contains; a programmable alarm system with an automatic opening and closing system, an interactive user interface and a notification system through GSM network. The development of this device is focused in the support of elderly people and other vulnerable groups that may need for an assisted care.***

Keywords— Assistive Technology, Elderly, Intelligent PillBox, Design, Arduino, Internet of Things, Ambient Assisted Living, Medication Schedule

I. INTRODUCTION

Assistive Technology (AT) maintains and improves the individual's functioning and independence, thereby promoting their well-being. But today only 1 from each 10 people in need have access to AT due to high costs and a lack of awareness, availability, personal training, policy and financing. By 2050, more than 2 billion people will need at least 1 assistive product with many elderly needing 2 or more. Elderly make important contributions to the society. Though some people aged well, other become frail, with a high risk of disease. In this project, we propose a first approach related the design of AT device. This uses open source technologies and gives a new choice in taking medication dosages. "The Intelligent Pillbox" allows the organization of several medication schedules that health disorders presented in elderly need basically. Raspberry Pi is taken as the principal controller. This prototype contains; a programmable alarm system with an automatic opening and closing system, an interactive user interface and a notification system through WiFi network. The development of this device is focused in the support of elderly people and other vulnerable groups that may need for an assisted care.

II. LITERATURE REVIEW

In this section, a combination between electronic and mechanical pill boxes or dispensers is presented. It's been included certain traditional pills organizers, which represents a first step in these developments and allowed us to obtain ideas about design useful patterns in development of this solution. In this box presented a pill dispenser which has different prescribed administration schedules. It includes a plurality of pill storage compartments, each of them capable of holding more than one pill. This device has a pill detector and generates a signal to alert patients to take the prescribed medicine. There are twelve storage compartments, arranged in a ring about a vertically rotating wheel. However, this solution has a limitation due to this pill dispenser can only hold doses for 24hours. A current design presented in Cheyenne, shows a device that allows the storing and dispensing of pills and various supplements (i.e., food, drug, supplements, liquids, powders or pills).

This device Works such as an alarm clock and may work with blister packed pills or alternatively uses an encapsulated compartment to hold and dispense loose pills. Also, it can be connected by wireless to external environments (cell phones, computers). However, this device does not allow the management of several dosages and different kind of pills. Another solution is the e-pill. It has in its stock various alternatives to organize and dispense pills, can be mentioned especially two: i) A device dedicated to dispense pills composed by 2 medication trays, and 3 day-dosage discs. It has a circumference shape and it has turning compartments for each dosage time. The dosages are dispensed when an alarm is activated, this device does not use referential diseases, just use dosages per days, and is also not programmable for any schedule; ii) it is a reminder medication product focused on patients, caregivers or medical health professionals. This device locks automatically and includes 2 keys. For patients trying to get medications before it is time there is tamper resistant. This device considers supply pills in one week, four times per day. Also it has alarm and text message reminders disadvantages perceived are to close device by interaction of keeper and is not independent. As far as we know, more than it has been described before, there are many solutions which offers advantages as dispensing or alerting system however they do not provide an automatic reminder system, different alert forms or a study in lot field, besides devices are economically difficult to access. In this work, it is proposed a solution that solves these problems.

Doan B. Hoang, Lingfeng Chen"Mobile Cloud for Assistive Healthcare (MoCAsH)" 2010 IEEE Asia-Pacific Services Computing Conference.

This paper proposes a Mobile Cloud for Assistive Healthcare infrastructure. The infrastructure addresses the limitations of our earlier Active Grid infrastructure, deploys Cloud computing features such as user easy access, elasticity of resources demands, scalability of infrastructure, and metered usage and accounting of resources. The new infrastructure also addresses a number of issues with current Cloud architecture including some security and privacy issues, data protection and ownership. P2P paradigm is deployed to federate clouds that may belong to different administrators to address security, data protection and ownership. Part of the infrastructure has been implemented or migrated from the Active Grid. The first version of the mobile platform was implemented with J2ME on Nokia phones; the platform is being migrated to an Android platform. Part of the intelligent Mobile Cloud Middleware was implemented within an active database. In the next version, part of the middleware will reside in the mobile platform to handle local issues efficiently in terms of speedy response and energy minimization. Part of the component will reside in the Cloud Middleware component to provide rich context analysis, recognition and decision support. A collaborative workflow editor has been developed over the existing Grid, it will be deployed in the newly Cloud infrastructure.

Brianna Abbey⋆, Anahita Alipour†, Logan Gilmour†, Christopher Camp‡, Crys Hofer‡, Robert Lederer‡, Greig Rasmussen‡, Lili Liu§, Ioanis Nikolaidis†, Eleni Stroulia†, Cheryl Sadowski "A Remotely Programmable Smart Pillbox for Enhancing Medication Adherence" 2012 IEEE.

In this paper we have introduced a new medication adherence device in the form of a dosage-based pillbox with removable and transportable columns. As we are producing the first fully functional unit, we are also considering three extensions:
(a) equipping each removable column with wireless capabilities to enable it to autonomously communicate with a mobile phone (or via access points and/or the cellular network directly) to enable the continuous monitoring and update even if the column is detached from the unit, (b) adding Braille numbers beside each chamber to enhance usability by users with sight problems, and (c) enhancing the ability to infer that the medication was consumed by using photo/video evidence triggered when a chamber is opened.

Medication adherence is an important challenge for many patients with chronic conditions, most of them elderly. Technology has an important role to play in this area potentially, with electronic devices equipped with reminder capability and medication intake recording. In this paper, we present a remotely programmable pillbox. This pillbox is equipped with a web application which gives the health professional or caregiver a tool to check and program the pillbox. Also, a mobile application is implemented to establish a connection with the web-application to show pills' daily schedule and pill taking notifications.

Shuai Zhang, Sally I. McClean, Chris D. Nugent, Mark P. Donnelly, Leo Galway, Bryan W. Scotney, and Ian Cleland"A Predictive Model for Assistive Technology Adoption for People with Dementia"

The acceptance of assistive technologies is crucial for healthcare professionals in the provision of such technologies to PwD. In this paper, we characterized PwD features that are relevant to assistive technology adoption. Based on these features, an optimal predictive model was developed through the investigation of a range of classification algorithms, different feature sets, and data resampling to handle class imbalance. The models were evaluated using the multiple criteria of model predictive performance, prediction robustness, bias toward two types of errors, and usability by healthcare professionals. Overall, the model trained using the kNN classification algorithm on data collected from seven features best addressed the four criteria for model evaluation. This predictive model can maximize the opportunity of using assistive technology in order to allow people to stay in their home for longer, thus minimizing the risk of negative impacts on mood and the quality of life for PwD, and financial implications for inappropriate deployment to nonsuitable technology adopters. A limitation to our work is the amount of data available. It was both expensive and time-consuming to collect such data from the PwD using the technology. Questionnaires about the PwD and their user experience were particularly time consuming to administer; caregivers could face additional work checking if the PwD was handling the device well; trials required weeks to complete in order to allow the users to become familiar with the device before deciding whether to adopt it or not. Consequently such trials may be intimidating for the PwD. Nevertheless, a collaborative project is currently underway, which will allow our current approach to be extended to a larger sample size. This collaboration is based around the Cache County Study on Memory in Aging, a large database containing genetic and environmental factors associated with risk for Alzheimer's disease and other forms of dementia. Another interesting future direction is to embed the cost of the two types of error into the classification model in order to minimize the total cost of misclassification.

Huai-Kuei Wu, Chi-Ming Wong2, Pang-Hsing Liu1, Sheng-Po Peng1, Xun-Cong Wang1, Chih-Hi Lin1 and Kuan-Hui Tu1"Smart Pill Box with Remind and Consumption" Confirmation Functions" 2015 IEEE 4th Global Conference on Consumer Electronics (GCCE)

To improve medication safety among the elderly, this paper proposed a smart pill box with remind and confirm functions. The proposed pill box can reduce family member's responsibility towards ensuring the correct and timely consumption of medicines. Because the proposed pill box is based on the medicine bag concept and the matrix bar code printed on the medicine bag simplifies the operational procedure. The remind and confirm functions work well even if internet service is not available, thus reducing implementation costs. Population aging is a global issue that affects many developing countries such as Taiwan. The natural decline in physical function with aging leads to an increase in incidences of various chronic diseases in elderly individuals; most patients with chronic diseases need to take medications over a prolonged period of time in order to stabilize their conditions. Ensuring that the patients consume the right medication at the appropriate time becomes crucial. This paper proposes a smart pill box equipped with a camera and based on the medicine bag concept. The matrix bar code printed on the medicine bags is used to interact with the pill box in order to perform pill remind and confirm functions.

P. Jayashree, S. Shrinidhi, V. Aishwarya, A. Sravanthi "Smart Assistive technologies for aging society: Requirements, Response and Reality" 2016 IEEE Eighth International Conference on Advanced Computing (ICoAC)

Through the use of smart devices and systems, disabled people are well supported to perform routine tasks that are felt difficult otherwise. The feel at home enhanced living style though reduces the burden of care takers and support staff, has some hitches in peoples' adaptability to numerous devices and acceptability to a larger extent. A well connected home is to supplement the lifestyle of the user, delivering an anytime, anywhere, borderless quality lifestyle. In such an environment, all devices work together irrespective of the application (entertainment, home control or energy management). But, this demands security and robustness of the devices and technology. Personal assistive devices are emerging technologies that are indeed developed for the betterment of human life. Through the use of smart devices and systems, disabled people are well supported to perform routine tasks that are felt difficult otherwise. The feel at home enhanced living style though reduces the burden of care takers and support staff, has some hitches in peoples' adaptability to numerous devices and acceptability to a larger extent. A well connected home is to supplement the lifestyle of the user, delivering an anytime, anywhere, borderless quality lifestyle. In such an environment, all devices work together irrespective of the application (entertainment, home control or energy management). But, this demands security and robustness of the devices and technology. Personal assistive devices are emerging technologies that are indeed developed for the betterment of human life.

Vamsikrishna Patchava, Hari Babu Kandala,, P Ravi Babu "A Smart Home Automation Technique with Raspberry Pi using IoT" 2015 International Conference on Smart Sensors and Systems (IC-SSS)

In this paper, we are designing an advanced automation system which has surveillance system and which in turn reduces most of the human interactions, by supporting this system using Internet of Things (IoT). Finally, it is absolutely an affordable system. It can be associated with various other options like energy monitoring systems etc., soon, as an extension to this project a system may be developed which warns the user about the excess usage of energy.

In this paper, we are presenting a proposed system for Smart Home Automation technique with Raspberry Pi using IoT and it is done by integrating cameras and motion sensors into a web application. To design this system, we are using a Raspberry Pi module with Computer Vision techniques. Using this, we can control home appliances connected through a monitor based internet. Raspberry Pi operates and controls motion sensors and video cameras for sensing and surveillance. For instance, it captures intruder's identity and detects its presence using simple Computer vision Technique (CVT). Whenever motion is detected, the cameras will start recording and Raspberry Pi device alerts the owner through an SMS and alarm call.

Rubén Mulero, Aitor Almeida, Gorka Azkune, Patricia Abril-Jiménez, Maria Teresa Arredondo Waldmeyer, Miguel P`Ramo Castrillo2, Luigi Patrono, Piercosimo Rametta, And Ilaria Sergi "An IoT-Aware Approach for Elderly-Friendly Cities" VOLUME 6, 2018 2169-3536 2018 IEEE

This work presents a Smart City oriented infrastructure for unobtrusively collecting and managing data related to elderly people behavior patterns. The infrastructure, developed within the City4Age project, combines the Internet of Things and Linked Open Data paradigms to provide a scalable and responsive system able to provide services to multiple Cities concurrently. This infrastructure allows Cities to integrate their data on different abstraction levels, providing a semantic endpoint that offers an expressive data format for inference and querying purposes. Based on this information, complex risk detection algorithms can be performed in order to early identify potential treats related to the onset of frailty or MCI. Currently, the proposed system is being deployed in six Cities (Lecce, Madrid, Montpellier, Athens, Birmingham and Singapore), part of the City4Age pilot sites, with the aim of verifying the correct flow of gathered data and assessing the usefulness of these data for domain experts (mainly geriatricians) to empower and validate their work.

The ever-growing life expectancy of people requires the adoption of proper solutions for addressing the particular needs of elderly people in a sustainable way, both from service provision and economic point of view. Mild cognitive impairments and frailty are typical examples of elderly conditions which, if not timely addressed, can turn out into more complex diseases that are harder and costlier to treat. Information and communication technologies, and in particular Internet of Things technologies, can foster the creation of monitoring and intervention systems, both on an ambient-assisted living and smart city scope, for early detecting behavioral changes in elderly people. This allows to timely detect any potential risky situation and properly intervene, with benefits in terms of treatment's costs. In this context, as part of the H2020-funded City4Age project, this paper presents the data capturing and data management layers of the whole City4Age platform. In particular, this paper deals with an unobtrusive data gathering system implementation to collect data about daily activities of elderly people, and with the implementation of the related linked open data (LOD)-based data management system. The collected data are then used by other layers of the platform to perform risk detection algorithms and generate the proper customized interventions. Through the validation of some use-cases, it is demonstrated how this scalable approach, also characterized by unobtrusive and low-cost sensing technologies, can produce data with a high level of abstraction useful to define a risk profile of each elderly person.
John K. Zao (SMEEE), Mei-Ying Wang, Peihsuan Tsai, Jane W.S. Liu (FIEEE)"Smart Phone Based Medicine In-take Scheduler, Reminder and Monitor" 978-1-4244-6376-31101$26.00 ©2010 IEEE

In this paper, we presented the desig ideas behind Wecat, a medicine in-take reminder and monitor installed on a smart phone. This mobile computing application combines mobile phone based telemonitoring techniques with real-time scheduling algorithms to offer ubiquitous services to out-patients. Notable accomplishments include the development of OMAT/ ODAT medication scheduling algorithms and the implementation of an integrated mobile computing application. Plenty of work remains to be done afer this initial effort: frst and foremost, a thorough integration of Wecat with electronic medical records (eMAR) and electronic personal health records (ePHR). Advance scheduling algorithms including those that can produce incremental changes to existing schedules should be investigated. The possibility of exercising on-the-fly changes of prescriptions in response to patient's conditions may also be explored.

Out-patient medication administration was identified as the most error-prone procedure in modern healthcare. Most medication administration errors were made when patients acquired prescribed and over-the-counter medicines from several drug stores and use them at home without proper guidance. In this paper, we introduce Wedjat, a smart phone application that helps patients to avoid these mistakes. Wedjat can remind its users to take the correct medicines on time and keep an in-take record for later review by healthcare professionals. Wedjat has two distinguished features: (1) it can alert the patients about potential drug-drug/drug-food interactions and plan an in-take schedule that avoids these adverse interactions; (2) it can revise an in-take schedule automatically when a dose was missed. In both cases, the sofware always produces the simplest schedule with least number of in-takes. Wedjat works with the calendar application available on most smart phones to issue medicine and meal reminders. It also shows pictures of the medicine and provides succinct in-take instructions. As a telemonitoring device, Wedjat can maintain medicine in-take records on board, synchronize them with a database on a host machine or upload them onto an electronic medical records (EMR) system. A prototype of Wedjat has been implemented on Window Mobile platform. This paper introduces the design concepts of Wedjat with emphasis on its medication scheduling and grouping algorithms.

III. PROPOSED WORK

Device Contribution

Improving lifestyle not only in elderly sick people also in general sick people is a main goal of this development; our device involves reliability and usability with a friendly technology. In the case of elderly people as in Marceline. It is well known with the years, the gradual degradation of faculties can affect the ability to cope with machine technology that is nowadays common in public spaces, like telephone cards and ticket machines (which requires physical and mental agility) or automatic tellers (where codes are needed to be memorized and alternatives must be selected rapidly). It is important to understand that these devices could become more an obstacle than an aid. This conclusion obtained through a study using two generations of men and women (aged 55-74 and 75+ years, respectively), giving us a way to focus our priorities in development of a pillbox, considering parameters to interact correctly with elderly users mainly. Achieving an appropriate reminder system combined with a new type of programming dosages inside a device may be a possible solution to currently interface that nowadays are everywhere to interact in a better way with a keeper or doctor who are tied most of the time to keep track from their patients, who can use easily technology interfaces. Give them partially release from that responsibility and focus only in load dosage in device. While the interaction between patient and object won't be deep, is necessary to give a solution which doesn't complicate prospective interaction patient pillbox, even though interact between them through technology is an important contribution which this work looks for.

As following fig. shows, a block diagram which summarizes the contribution of this paper. Here, it is an interaction between keeper and doctor (1) with the pillbox (4) through an interface (3) and a microcontroller. The device (4) sends notifications (5) to patient (6) and keeper (1). When a patient (6) takes the pill, there is an interaction between the pillbox (4) and a sensor (7). Finally, about that interactions are send.

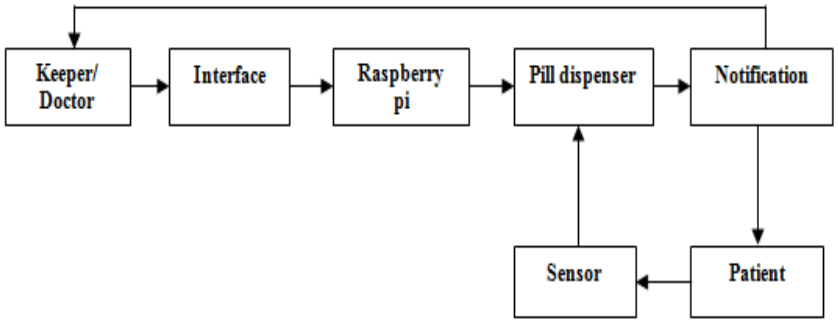

Fig.1: Pillbox Block Diagram

Intelligent pillbox composition

The system is composed by different modules that are controlled by Raspberry Pi Mega. Below fig. shows the Pillbox's block diagram. There are different types of communication of each module. It could be one way or two ways. Therefore the Raspberry sends commands to the modules but also receives data from them. Web page contains the connecting information between the Raspberry pi with the help of WiFi. Keypad plays the general role for changing the information of the requirement. Below figure shows the composition of pillbox.

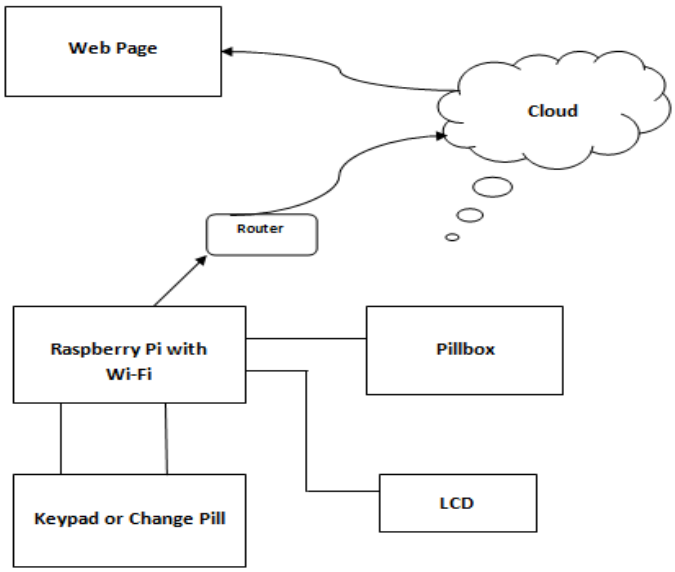

Fig.2: Intelligent Pillbox Composition

LCD

There is a vast array of LCD displays available. Fortunately, a majority of them comply with the HD44780U standard. This standard refers to the LCD controller chip that accepts data from the Micro Converter and communicates with the LCD screen. HD44780 standard LCD screens are available in numerous formats, the most popular of which are the 16 into 2 and 20 into 2 formats. The various commands to control the basic functions of the LCD are outlined in this application note. INTERFACING AN HD44780 LCD The data bus that connects the HD44780 to the Micro Converter can be eight bits or four bits wide; this document discusses the 8-bit data bus. In addition to the data bus, three control lines are needed, requiring a total of 11 pins to interface the LCD to the Micro Converter. The eight data lines that form the data bus are referred to as DB0 to DB7. The three control lines are referred to as EN, RS, and RW: EN is the enable line. This line is used to indicate the start of a transmission of a data byte to the LCD controller. To indicate the start of transmission, this line is brought high. When transmission is complete, the EN line is brought low.

RS is the register select line. This line indicates to the LCD controller whether the data byte is to be treated as a command or as text data to be displayed on the screen. If the RS line is high, the data byte is treated as text to be displayed. If the RS line is low, the data byte is treated as a command. RW is the read/write line. When this line is low, the information on the data bus is written to the LCD controller. If this line is high, the LCD controller can be read to check the status of the LCD. As shown in Figure 1, the eight data lines are connected to Port 0 of the Micro Converter; external pull-ups are required on Port 0. The three control lines are connected to three Ports. And pill box contain the stock of pills for the providing patient.

Raspberry Pi

Didn't think the Raspberry Pi could get any better? You're in for a big surprise! The Raspberry Pi 2 Model B is out and it's amazing! With an upgraded ARMv7 multi core processor, and a full Gigabyte of RAM, this pocket computer has moved from being a 'toy computer' to a real desktop PC. The big upgrade is a move from the BCM2835 (single core ARMv6) to BCM2836 (quad core ARMv7). The upgrade in processor types means you will see ~2x performance increase just on processor-upgrade only. For software that can take advantage of multiple-core processors, you can expect 4x performance on average and for really multi-thread-friendly code, up to 7.5x increase in speed!

That's not even taking into account the 1 Gig of RAM, which will greatly improve games and web browser performance! Best of all, the Pi 2 keeps the same shape, connectors and mounting holes as the Raspberry Pi B+. That means that all of your HATs and other plug-in daughter boards will work just fine. 99% of cases and accessories will be fully compatible with both versions.

IV. CONCLUSIONS

Older people play an important role in the society. They are part of the priority group of healthcare. Therefore, creating new devices using the emerging technology in order to improve their lives quality is necessary. The creation of alternatives of AT devices looks promising and necessary due to that today only 1 of each 10 people in need have access to AT due to high costs and a lack of awareness, availability, personal trainance, policy and financing. The introduction of AT devices in IOT could lead us to a future where important information of patients would be available anytime and anywhere, in order to make a correct treatment and to prevent calamities. Based on open source solutions, a new alternative to remind medicine dosages was raised. Raspberry Pi, as main controller works totally right and gives many other opportunities to develop. The objective of creating a device that allows the organization of several medication schedules, automatic opening system and an effective notification system was reached. IOT is an important aim pretended in this AT device, finding a way to keep pillbox connected to Internet and it will help surely to manage in better form the treatments in patients, mainly in elderly patients.

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