Dynamic price generation and distribution system using ECA rules and ink labeling

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Abstract

New forms of commerce require novel methods of management. Dynamic pricing is a new way to get a increase in the buyers interest and improve their customer experience. As it is a complex procedure to take into account elaborate algorithms to generate and distribute new prices to products, in this paper, a system for autonomous price management and distribution is presented. The use of ECA rules eases the administration procedure to manage a complex dynamic price system. Configure a global price system can be done in a visual manner using a ECA representation tool. The developed software allows to predefine the aspect of the price label and send updated information to a selected e-ink display. The global system uses a novel distribution infrastructure to provide information to several displays, distributed along various nodes. The result has been built and tested in the group laboratory.

Keywords: retail, dynamic pricing, ECA rules, labeling system

1 Introduction

A few years ago, and more recently with the expansion of new commerce methods , variable price systems has been a powerful strategy of optimizing earnings. As a part of an overall marketing strategy, various areas and industries used dynamic pricing to generate interest. One of the first indications of this new form of pricing came out from airline companies[4]; their objective was to respond to emerging and changing patterns of consumer demand. Consumers started to see how their possibilities of manage their purchases growing as a function of the strategies taken trying to encourage and in addition, provide a new shopping experience. Until now, these new market strategies were difficult to take place, either by the lack of resources or material complications. New forms of on-line commerce and a more flexible traditional markets enable the expansion of this new ways of selling to other business areas which until now, it couldn't be done. New technologies can make possible novel selling techniques previously only feasible on bigger industries with a high profile of business and revenue [1].

Introduction of new elements like Electronic ink, as seen in his functional aspect fits perfectly in this new ecosystem. Providing unattended displays and labels we won't worry about old problems like wasting paper every time a price needs a change or a new product become offered. Avoiding energy problems is a necessary feature that E-ink can supply. Reducing the use of the battery to a minimum values and increasing lifespan of the goods will be important to the new dynamic system.

As these new ways of information move forward, we think it is necessary to re-search a new way of processing sells and price establishments to provide to the big or small commerce tools they can use to take advantage of this new ways of information. Using and improving new forms of offer people more selective products with the help of the new technology systems, retail companies will see the benefits of automated processing. It eases the dynamic price and selectiveness labour and working together with

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intuitive software, managers will be able to provide all necessary information to the system to work in an autonomous way. The software process, guide the price changes with no external help, taking down the costs and improving revenues [9].

The use of new algorithms, a price for a exclusive product could vary in a more suitable way, getting more customers, attracting more interest in a certain time and following marketing strategies. Implementing new stock control methods and providing information to the systems, retail managers will obtain more client support and new ways of vending. All together for a more intelligent scenarios.

The rest of this paper is structured as follows: we start in Section 2 with an analysis of related work and introducing the technologies used here. In Section 3 we introduce the concept of ECA rules and its relation to the system. In Section 4 we present our architectural proposal of the system. Section 5 is dedicated to the software internals and Section 6 we develop the necessary infrastructure. Conclusions and future work will be discussed on Section 7.

This paper is an extension of the proceedings lecture conducted at Workshop on End-user Service Provision for Ambient Intelligence (EUSPAI), Belfast 2014. The contributions to this extension have been a more detailed explanation about the model of information distribution and the newly status of the graphical user interface used in the administration console of the system.

2 Related Work

Mathematical procedures designed to maximize profits deriving the optimal price for each sale and production and stock levels offer the ability to produce a valuable tool for markets managers in the price establishment's tasks [2]. Smart dynamic pricing can benefit from being able to include in the business rule processing, algorithms designed to make better use of all involved variables. This may lead to take the most appropriate sale strategy at certain times, with the ability to change parameters on the fly if the expected revenues are not obtained.

Price stands out as a influential factor, relating it to selected factors enhance the dynamic pricing to several types of algorithms; fixed prices, sales, promoted discounts and purely dynamic prices[6] are the most improved ones.

These decisions can have a complex operation for the user who is not used to these aspects, or that non-technical user should know. Therefore, the use of ECA rules adapted to these decisions and the use of protocols established before in a defined marketing strategy will make it easy for the end user configurations of these techniques based on events [5].

Automated algorithms were used into intelligence environments to provide best choices and improve the user satisfaction along the system count on enough information of the clients. Agent based social simulations helps create a proper notion of the customer desire and roles [10].

The process of information exchange has been executed until now in a traditional and manual system. Automated processing has open a new window and allowed to perform complex operation. The events in which information needs to be updated are set by the agents involved in the sale process and often this information has to be changed manually at the point of sale. New specialized technologies supporting information are helpful in this process [3]. Facilitating the task of updating information by reusing these infrastructures avoid a waste of material and time in these procedures.

3 Pricing management using ECA rules

3.1 Backgrounds and definitions

ECA refers to the Event condition action, being a shortcut to the structure of active rules in event driven systems. The fundamental construct of ECA are relative rules of the form On Event If Condition Do Action. Each rule consists of three parts:

The event: it specifies the signal that triggers the invocation of the rule. The events can be received by system inputs from the external environment. The type of an event can be based on a time basis or triggering by a changed input value, likewise real time events can be implemented as inputs.

The condition: it is a logical test that, if evaluates to true, causes the action to be triggered. In some scenarios, a false evaluated condition will conduct a different action. Complex operators can be added to the condition defining complicated tests to be executed to obtain a result.

The action: it consists of updates or proceedings which have to be performed to complete the rule. Actions that are triggered by reactive rules may also be complex.

The simplicity of an event- condition- action schema leads us to provide an easy tool directed to non technical users for a product prices control. A typical use case can be the normal price variations in a temporary stock of products, in which a dedicated ECA rule performs the action of varying the price automatically, saving time and resources.

An ECA rule determines what actions are performed if a certain triggering event occurs and a certain state condition holds. This can be seen as the new algorithm generation in new commerce environment. Managers create different rules for each behaviour they want in his markets.

In the next section we focus on the main use cases our system can be helpful.

3.2 Application scenarios of dynamic pricing

For the simplicity of our software prototype, we focus the self-acting capacity on two mainly settings. A "happy hour" time period and external variables of control.

External variables

As we discussed on Section 2, product expiration date is an important factor of the product life cycle. As the expired products can't get sold, it is crucial to trade up them before that date. New pricing systems can pull the users for a quick dispose if the price changes according to expire dates. ECA rules again are useful for letting the manager operate price algorithms.

Happy hour

This appellation refers to a marketing campaign based on discount a fixed percent of the price for a limited time period, getting increase encouragement of the clients to buy a selected product. As it is a simple marketing strategy, in practice it is difficult to effectively perform real time changes on the prices of the chosen products. The use of an ECA rule and a real time price changing system, take out all the ravels of the proceedings.

3.3 Using ECA rules to manage pricing

Once we discussed how an ECA rules work, based on the previous use examples the use of the rules in a dynamic pricing scenario can be benefit of the simplicity of a rule system[8]. Applying this technology to the environment of supermarkets, the primary use of pricing will be applied in commercial areas to attract customers; we can establish different procedures for an implementation in an efficient and satisfactory way. For a more in depth detail on how we can use these rules, here are some of the uses for which the system may be appropriate:

A Price - A rule

Implying a new rule per item shown. In this option, an administrator must create a new rule for each product added to the system. Each product will have its own do-main of action and shall verify the status of each individual product to make way for the planned action. In contrast, if the scenario is very large, we take the risk of ending up having a too complex system and large to be effective to manage and verify many rules at once. A large number of rules can also affect the speed of the system. Trying to cover many articles involve loss of control on individual products. To solve this problem, and trying to take advantage this apparent drawback we can apply the following rule format.

ECA rule against list

In this format, a rule is created to be applied to a certain number of products. The rule will be evaluated and subsequently applied to all products that fall within the whole set. One of the major improvements that this format entails is to reduce the total number of rules that are managed by the system administrator, with the corresponding increase in productivity. An example of ECA rule against a list can be observed in the next code snippet:

```
{
"id":"rule01",
"appliesTo": ["productN01", "productN02"],
"eventExpression": {"timeExpires":"timer01","eventTarget":"event01"},
"conditions":["conditionRule"],
"actions": ["changePrice(newPrice)", "updateList()"]
}
```

4 Solution and architectural design

In this section we propose a system design to provide the necessary tools for an autonomous dynamic price system. The system overview can be seen over the next figure.

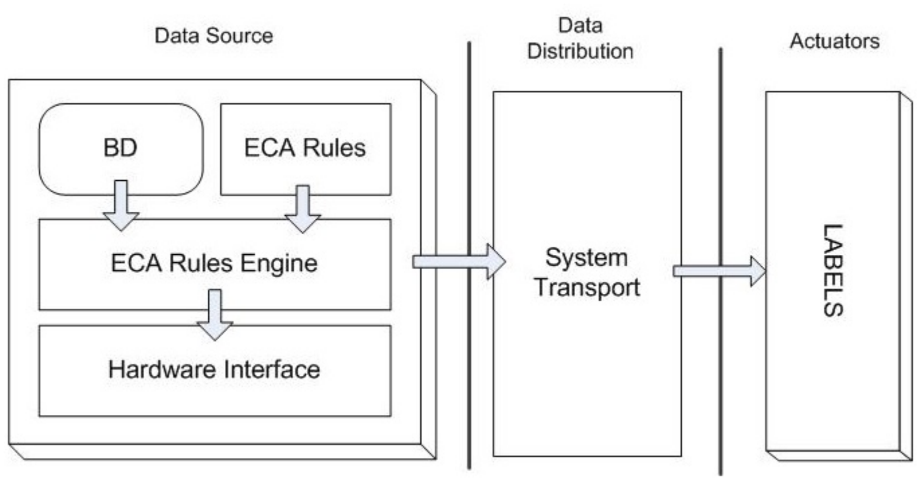

Figure 1: System overview

The system is divided in several components (see Fig. 1) contributing to provide information to the actuators.

4.1 Data source

Data collection and processing are the first phase of the process, which centers on generates the price changes actions. The software gathers data both from the product database and the ECA rules inserted by the market manager. Databases provide essential information such as regular prices and expiration, used by the ECA rules to induce the price updates. Once the actions are triggered, the hardware interface delivers the information to display through the system transport to the labels.

This package is the main component of the dynamic management software in-stalled in a dedicated computer on the required location. It is connected to the actuators over an exclusive link to the actuators, relaying the communication in an eligible transfer technology.

First phase is the data acquire and configuration of the system. A data base keep updated the actual prices of the products to show in the actuators, or labels. An administrator configures the system by adding ECA rules and establishes the relations between the stored data and the available labels.

After a certain condition fires, the information should be updated. The data sent through the hardware interface is composed by the destination label and the image to be updated. The image is created in the ECA rules engine, gathering all displayed data from the data base and drawing a image canvas with a predefined template.

4.2 Data distribution and actuators

Data distribution relay the transfer of information between the source to the actuators, and it is responsible of manage the multiple labels connected to. It has to discern between all actuators and display the information only in the desired label. We will discuss our hardware solution in chapter 6.

5 Implementing ECA rules in a retail environment

In this section we explain the software solution that we have developed to offer a relative simple interface to manage ECA rules and its implications to the generation of the proper triggers for a price change[7]. The software will present a graphic interface in which the qualified personal has to model the rules they want to apply in the labels connected. A relevant factor designing the product algorithms, is the fact the pricipal user won't be a technical person, instead a regular retail manager will be the responsible person who monitors the implementation.

In addition, proposed software was design to comply with the principles of Software as a Service (SaaS) architectures. A web browser can be used to performs modifications in the managed software, allowing to provide real time integration over the Internet and reporting any changes to the indicated user. Therefore, the main capabilities we have considered in this design are distributed architecture and event-driven architecture.

Human agents and software agents can, consequently, interact with this architecture creating events in a live environment. The software automatically performs the required events and the conditions are evaluated continually to provide real time actions to the actuators.

System interface consists in two differentiated sections: a static information sender and a real time events configuration. This second section hosts the ECA rule engine for the dynamic price functionality.

Fig.2 shows the relationships between all major components in the software module. The main engine which controls all incomings events is the rule manager, as it is responsible of the condition evaluations to generate the triggers.

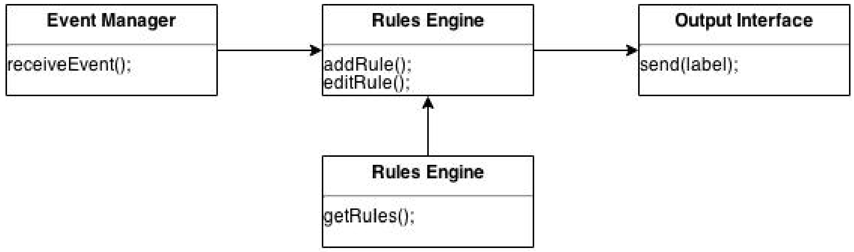

Figure 2: Component view

Once an event reaches the system, the rule engine checks its database to perform corresponding ECA validations and send the information over the output interface. Events can be received from several ways. In this prototype we are focusing on time based and user inputs events. A time based event will be generated when a certain amount of time has passed, causing the rules engine to check for new incoming changes of the information.

6 Developed infrastructure for e-ink displays based information provision

We present here a novel data distribution system to provide the required tools for a working dynamic price scenario. In Fig. 3, a diagram shows the necessary components needed in the labeling system. In addition to show the different modules of the system, each of one will be explained and its process described for a better understanding of the model.

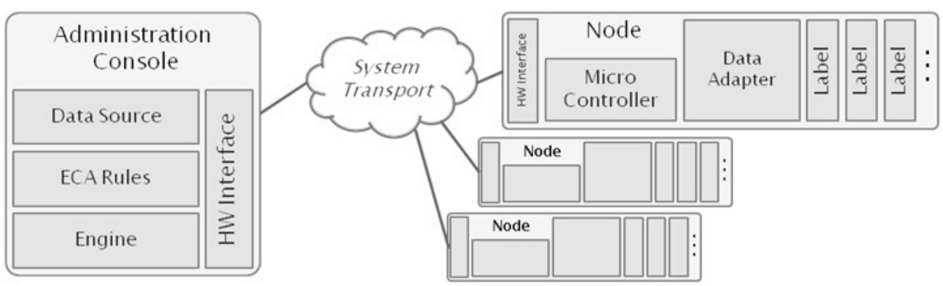

Figure 3: Modules

1. *Administration Console*

   At the beginning of the process, it is necessary to provide an administration panel in which the manager can set the desired rules and edit the existing ones. It involves the data source gathering and classifying over the corresponding categories. This will ease the creation of new lists and its use in ECA rules parameters.

   An ECA rules panel is available to provide an user graphical interface to the manager and facilitate the administration process. The GUI is filled with the data collections and allows select which items are desired to be the final destination for each label installed in the system.

   The process is in charge of going over the created rules and evaluates each for a true condition. It will trigger the action and send the corresponding parameters to the system transport network over the hardware interface.

Figure 4 shows the application interface in alpha version. The main window allows to connect the communication channel with the corresponding COM port and initiates data flow to configure the state of the node.

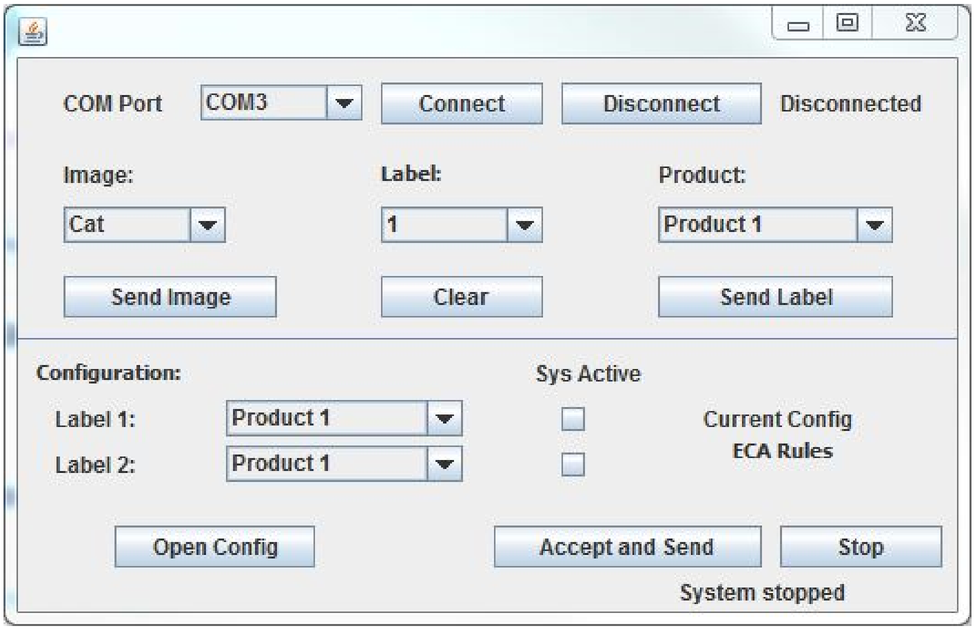

Figure 4: Administration console

The alpha state of the software allows two functional modes, in whose the user can decide the trigger event for the label changes. A first mode enable the static representation of information in one of the connected labels. The user can send and update the content in a static method. For a more complex operation, ECA rules can be activated and the label will be updated according with the actual configuration. The user can schedule the label updates as specified by a timer based rule or any allowed input.

2. *System transport*

   Once we have the action triggered and the new data is ready to be sent. Administration console is able to communicate to the nodes through a system transport network.

   At this moment the transmission technology is not fixed, so it can be adapted to the specific needs. Our working prototype is using a wired network with USB protocols.

3. *Micro-controller*

   As the information chain is completed, labeling system need a computer based controller to provide some intelligent actions. This component is responsible of discern between all installed dis-plays and send the adequate information to the desired one. Furthermore, it supplies the pc interface to the software agent. This connection is optionally made through different communication channels, and also can be made wireless if the controller is capable of it. In our prototype we chose an Arduino Mega with an USB interface to the manage program.

   We use the available Arduino SPI interface to communicate with the connected displays, the connection establishment is made by four main digital I/O and three extra wires in order to be able to select the final destination label. By using a common bus and a selection signal we are capable of select the final display in which the information will show up. SPI consists in a bidirectional connection, using two signals wires, one clock and one chip-select wire in order to pick out the desired receptor in a shared bus.

A battery can be used to power the micro-controlled, as the amount of energy used by the system is kept down at idle times and only used when a new display change is received.

4. *Signal adaptation*

   Output signals are meant to be compatible between relative components. Using multiple displays to show information connected to a single micro-controller, requires a middle component in charge of discern the final path of the information.

   For a correct work of the signals between micro-controller and e-ink displays, a selection and adaptation module has to be placed. Arduino digital outputs are 5 volts [v] powered, while display input ports are 3v. A level-shifter is needed in order to connect them to the main controller.

   In addition, we also use the signal adaptation module to unlink the e-ink displays whenever there is no information being transmitted, decreasing the power impact of the energy source.

5. *E-ink display*

   Labels have been designed to show essential information to market customers, they use a e-ink technology providing a paper like look and minor power consumption. Manufacturer “Pervasive Displays Inc.” supply 2,7” displays which we use in the prototype.

   An e-ink label is composed of an e-ink display and a “Timing Controller” module, which allows us to link up the displays using a SPI interface

   Figure 5 shows the working node prototype.

7 Conclusion and Future work

This paper describes a proposal infrastructure to generate and distribute price product information using electronic ink displays with the help of ECA rules. Using ECA rules we are able to reduce the complexity of the configuration and allows non technical users to set a dynamic pricing scenario in a natural way. In addition, lists as a form of selective label destination ease the complexity and a novel infrastructure based on e-ink displays helps the automatic price change duty in order to allow real time price information to the customers.

Scenarios tested include two labels connected to one node receiving the information sent from an administration computer. An interface permits to configure the system and adding ECA rules to schedule changes of information.

Further tests are planned including the improvement of the configuration console to allow more data inputs and support of more complex rules, as described in data gathering from external variables description.

Using wireless protocols as an alternative of the USB cable used will permit a proper autonomous work. The inclusion of a battery allows the standalone function in isolated places and the use of compression algorithms will be studied to analyze the impact of the power consumption in the transfer process.

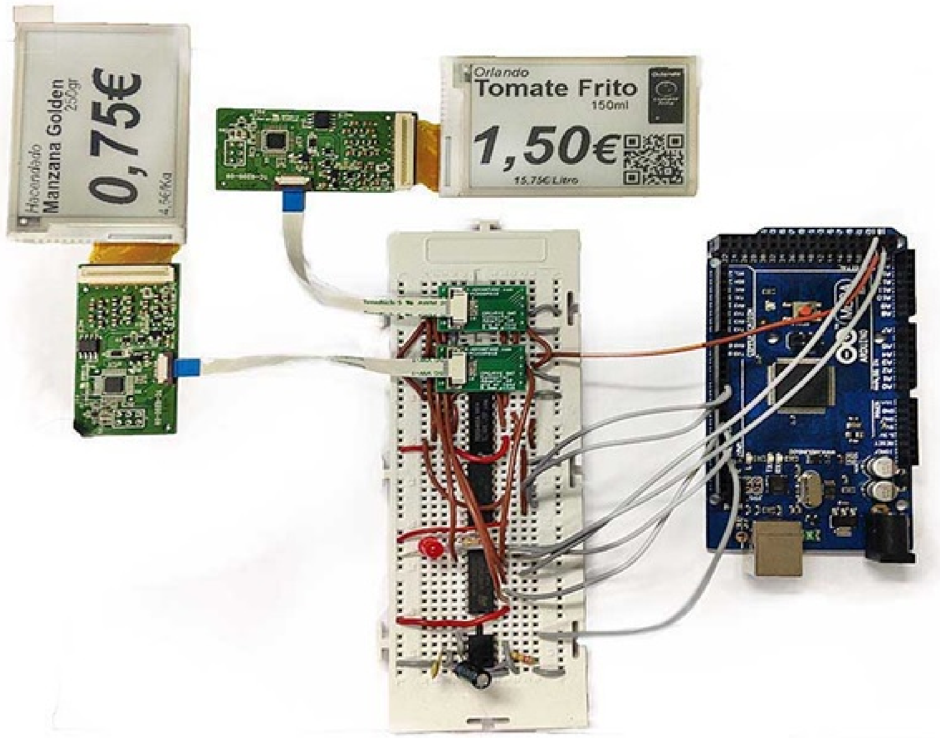

Figure 5: Physical Model

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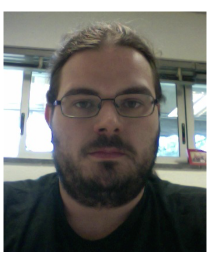

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