Beverages in Dispenser Machine according to Capsule Identification with Barcode

Asmita P. Bodhale
E&TC Deptartment
Pimpri Chinchwad College of Engineering,
Pune, India
bodhaleasmita5@gmail.com

J. S. Kulkarni
E&TC Department
Pimpri Chinchwad College of Engineering,
Pune, India
sanjyot_8@rediffmail.com

Abstract—**Dispenser machines have become an increasingly important distribution channel in public and private sectors. A dispenser machine is an automatic machine that sells food such as canned soups and packaged sandwiches, snacks such as potato chips, chocolate bars and candy with hot drinks like coffee, tea and hot chocolate also cold drinks. This dispenser machine is able to dispense or vends natural water, cool water, cold water, hot water, aerated water and beverages. Also capable to produce many beverages like juice and soft drinks using capsules. Each and every beverage capsule identify with the help of barcode reading depending on barcode sensor, with the help of camera lens which is organized on barcode sensor. This barcode sensor capture barcode image for distinguish different beverages. Barcode includes amount of aerated as well as water will dissolve with crushed capsule.**

Keywords—Vending Machine, Barcode Sensor, User Intereface, Application Control Unit, Barcode Reading and Capsules.

I. INTRODUCTION

Dispenser machine is an automated product dispenser which is normally installed in supermarkets, railway stations, offices, schools and various other public areas. Market feasibility includes switching speed i. e. how system will be fast responded, timing constraint i. e. to perform operations within less time, power and area requirement of dispenser machine which will also be considered. It will also save precious time of employees in companies e. g. at the time of work user wants some water or beverages.

This paper is to design entire control of Beverage dispenser Machine. This machine is able to dispense natural water, cool water, cold water, hot water and aerated water also capable to produce many beverages like juice and soft drinks using capsules. Beverage mixing water and crushed material is also delivered by this product. Crushed material is mixed in the water through air pressure mechanism and the recipes with ingredients proportion is determined by barcode recognition system.

Based on user requirements, beverages are dispensed with interaction between user and machine using UI that is pantry control like touch screen. The user interface board will contain the illuminated display, microcontroller and drivers to drive the display. In this dispenser machine includes beverage capsules. Each and every capsule identify with barcode. This barcode read with barcode sensor and according to barcode capsule identification is done.

This machine is divided into two systems one is user interface (UI) and other is appliance control unit (ACU). The ACU will drive circuits for AC compressor, Pump and Boiler Heater, DC pumps, Valves, Motor Fan and LED Lighting. This is used to control crushing capsules composed by a DC Motor, Solenoid and Switches. All Functions are controlled by a UI, via communicate through commands. Each beverage identify with barcode which is on every capsule. In barcode includes all information according to beverage like how much quantity of water and aerated are required to prepare beverage etc. with deciding water and gas status according to recipe.

II. LITERATURE SURVEY

Different dispensing machines are available in the market in public sector as well as private sector. These dispenser machines perform with different manner like users insert the coin for dispensing the beverages. For dispensing different beverages user raise ticket. User press the option key then dispenses the beverages with different controlled manner and different handling process. An automatic beverages dispensing machine using Finite State Machine (FSM). It has more advantages compared to aspects like timing constraint, power and area used in dispensing machine design which are depending on FSM design. [1][2]

Beverage dispensing machine is an automated product operated with the sequential finite state that is FSM design. Any self-service or an automated dispensing machine offered for public domain i. e. human demanding products to save precious time of human life. Because of automated vending machine dispenses human demanding products or any beverages. With using upon insertion of a coin or token in the dispenser machine, according to coin value dispenses unit servings of beverages like coffee, tea or snacks. [4][5]

Dispensing machine mainly focuses on new technologies or methods which are given to make human life more suitable with saving precious time in human being. The network

978-1-5386-4008-1/17/$31.00 ©2017 IEEE

observes the internal environment of the dispensing machine and adjusts and modifies the taste of beverages according to preference of customer or demand to manage the amount of sugar and powdered milk which are mixed into a cup. The dispensing machine and the smart phone can interchange their information of which beverage and amount of sugar and powdered milk via Bluetooth connection. A lot of customers buy different beverages without knowing the cleaning status of dispensing machine. For cleaning status of dispensing machine to develop and create a wireless sensor and actuator network to group of sensor and actuators connected by wireless medium to perform operation of sensing and actuating task which is install it inside a dispenser machine. [2]

Without automation that means with man power in machine it's time-consuming. It takes too much time to perform operations with designing in dispensing Machines. In dispenser machine due to the contraventions between human behavior and human machine interaction with system design interface. Each step of human's habitual buy situation behaviors on dispensing machine were examined so that the features of operations are removed to save the valuable time of human life. [1]

According to above dispensing machines all are depends on coin or raising ticket. In this project user interact with dispensing machine by pressing main dispenser button and the option key of beverage required. Beverages dispensing depending on barcode identification, barcode pattern mounted on beverage capsule.

III. DISPENSER MACHINE

In this dispenser machine operation totally depending on user interaction with user interface (UI) board like pantry control board. User will select or press any option key from this pantry control board. Start performing operation according to user demand and cover market feasibility. Market feasibility includes switching speed that means how fast system will respond, time, power and space requirement of dispenser machine. It also saves precious time of employees in companies.

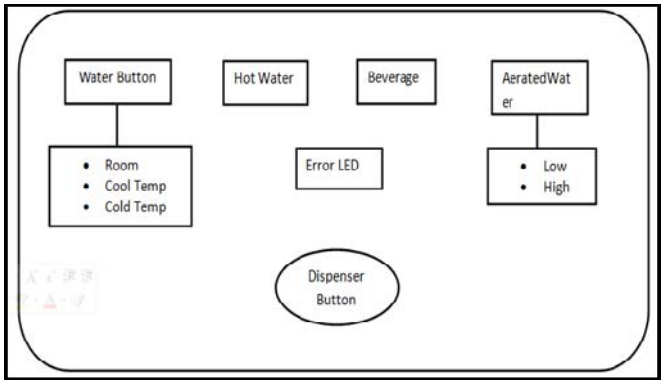

Fig. 1. Pantry Control Board

Figure 1 shows pantry control board i. e. user interface (UI). With the help of Pantry control board user can interact with system. User will press or select any beverage option key from pantry control board. According to selection a control signal are provided to system for performing the operation and dispenses beverages.

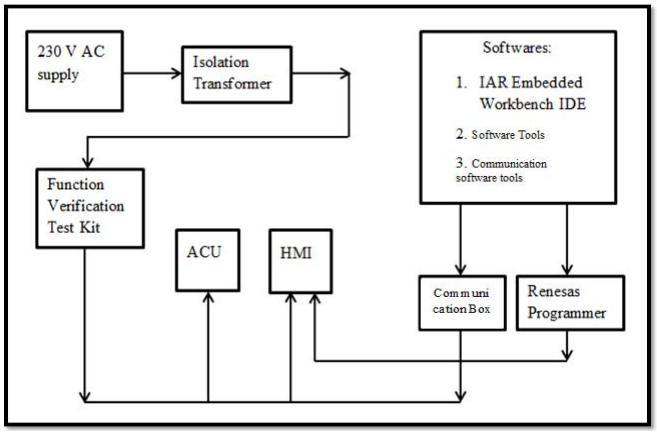

Fig. 2. Design and test code with this flow

Figure 2 shows the how the code will perform with different devices on the actual system. All software tools are installed in PC. With the help of software tools design the codes which are dumped into actual board that is HMI and ACU. Code dumped into actual system with the help of renesas programmer which is used for code compiling as well as debugging for error correction. All are connected with isolation transformer because of it provides current for all devices. Check dumped code is working properly or not with the help of test verification kit.

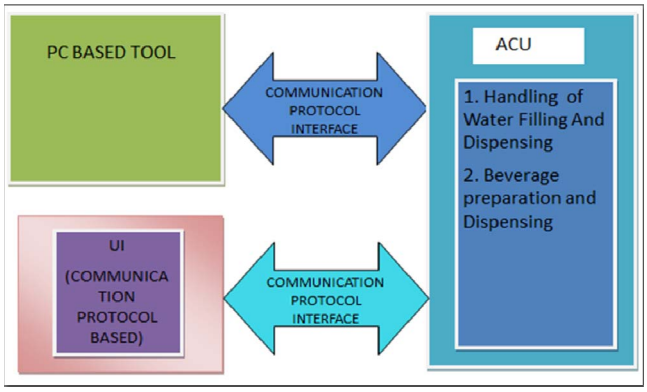

Fig. 3. Block diagram of Dispenser Machine

Figure 3 shows the block diagram to indicate the communication between UI and ACU for performing particular operation depending on user demand or requirement. UI and ACU communicate with communication protocol. User press any option key from UI then it send control signals to ACU for performing operation. UI provides option key for user demand. ACU performs two main operations like handling of water filling and dispensing as well as beverage preparation and dispensing after identifying capsules with barcode. Barcode identification is completed then beverage preparation will start. Because of each and

every barcode includes details which are how amount of water and gas will require preparing beverage.

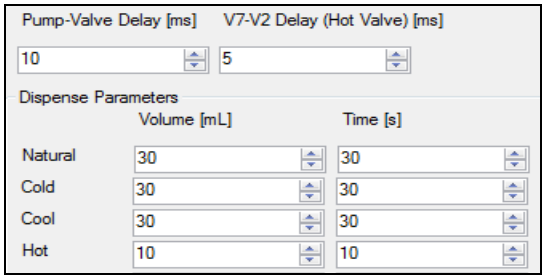

Fig. 4. Software to decide timer and volume for dispensing beverages

Figure 4 shows time and volume of dispensing beverage. Each and every beverage dispenses after user press the option key. So how much amount of water will dispense and for that required time will decide with software tool. This software tool has installed on PC. So volume and timing parameter is set for dispensing beverages.

IV. BARCODE READING WITH BARCODE SENSOR

A barcode is relating to line of sight, data in a binary form like 0 and 1 only that a computer can process easily, representation of binary data which is stored in digital form in barcode with 0 and 1 format after thresholding the analog values; the data normally describes something about the victim that carries the barcode. Originally barcodes methodically represented data by varying the widths and spacings of parallel black thin and thick lines and may be referred to as extended along a straight or one-dimensional (1D). Barcodes originally are scanned by special optical lens scanners called barcode readers includes light ray to capture image. In barcode reader having barcode sensor includes camera lens to capture barcode image.

A. 128x1 Linear Sensor Array with hold TSL1401CL

The TSL1401CL extending along waveforms a straight sensor array made up of a 128×1 array of photodiodes, integrated charge amplifier circuitry and an internal pixel includes data-hold function and circuitry. With switches to manage or handling operation of sample, hold and output depending on integrator and reset circuit that gives simultaneous-integration start and stop times for all pixels with initialization. The array is consisting or generating of 128 pixels, each pixel has a photo-sensitive area or space of 3,524.3 square micrometers. Spacing or distance between pixels is 8µm. Operation is totally depending on internal control logic to manage all operations that requires only a serial-input (SI) signal and a clock.

B. Detailed Description

The sensor made up of 128 photodiodes organized in an extended along a straight array. Light energy influencing or falling on a photodiode produces photocurrent because of light, which is associated by the active integration circuitry having switch and capacitor integrated with that pixel, each pixel having it. During the integration period, a sampling capacitor links to the output of the integrator through an analog switch from input and output of opamp. Integration time is depending or managing on charging and discharging of capacitor. At the time of integration capacitor will discharge for making output with close switch depending on time period. The amount of charge because of capacitor assembled at each pixel is directly proportional to the light intensity and the integration time period.

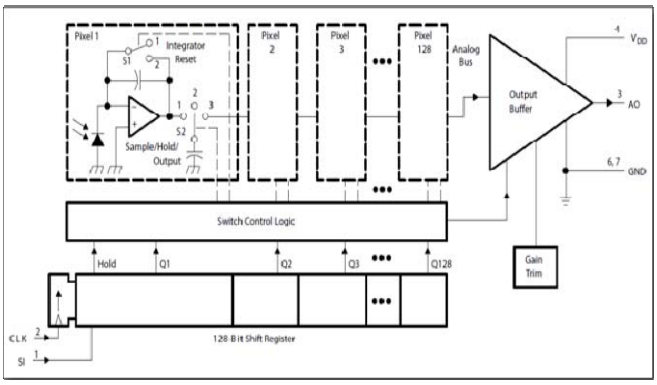

Fig. 5. Barcode Sensor Circuitry [7]

The output and reset circuit or arrangements of the integrators because first 18 cycles are used to reset integration that is initialization is controlled by a 128-bit shift register and reset logic means control logic. The reset logic or arrangement consists of integration circuit includes capacitor for control manner to handle output. An output cycle is initiated or resetting by clocking in logic 1 on serial input depending on switch which is connected parallel with capacitor from input to output of opamp. For proper performing operation, after getting condition for the minimum hold time, serial input must logic 0 before the next rising edge of the clock. An internal signal called hold is generated from the rising edge of serial input with logic 1 of clock and transmitted to analog switches installed in the output side in the pixel circuit. Because of this method conditions all 128 sampling capacitors to be disconnected from their respective integrators doesn't contact between them and starts charging operation at the initial stage. An integrator reset or initialize integration period. As the serial input pulse is clocked i. e. rising edge of serial input and logic 1 of clock through the shift register means control circuit, the charge stored on the sampling capacitors at the time of resetting or initializing integration period is sequentially connected to a charge-coupled output amplifier that generates a voltage on analog output AO.

C. Working with one pixel

Each pixel of the extending along a straight array made up of a light-sensitive photodiode having total 128 pixels of photodiodes. In the photodiode light incident on that and converts light intensity to a voltage. After light intensity incident on photodiode. The voltage is sampled with the help of Sampling Capacitor by closing switch S2 (position 1) (see Figure 6) which is mounted on the side of output. Logic

conditions handle the resetting of the Integrating Capacitor to zero by closing switch S1 (position 2) which is available at the side of output i. e. start capacitor charging process.

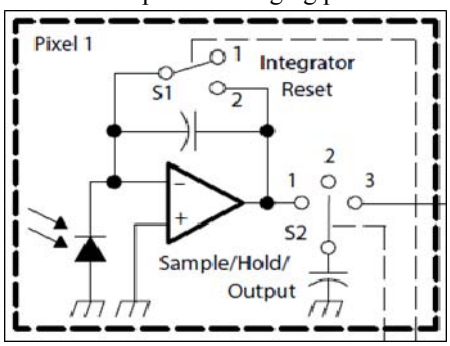

Fig. 6. One Pixel Circuit [7]

At serial input, all of the pixel voltages in the linear array are simultaneously scanned because of each pixel having reset and integrator circuit for initialized process. Pixel voltage held or kept by moving switch S2 to location 2 for all pixels values. In this event, switch S2 for pixel 1 is in location 3. This assembles the voltage of pixel 1 obtainable on the analog output value. On the next clock, switch S2 for pixel 1 is put into location 2 and switch S2 for pixel 2 is put into location 3 so that the voltage of pixel 2 is obtainable on the output value. As a result or output value of the serial input pulse and the next 17 clocks after the serial input pulse is applied. First 18th clock cycles are used or helped for non-integration i. e. reset integration means initialized circuit. The S1 switch for all pixels remains in location 2 to reset and initialized become all is component into at initial location that is having zero value. The integrating capacitor so that it is ready to start or begin the next integration cycle after 18th clock cycle. On the rising edge of the 19th clock, the S1 switch for all the pixels is put into location 1 and all of the pixels begin a new integration cycle because of reset circuit. This integration time period starts barcode reading with serial input and clock interaction.

D. Working of barcode sensor

Concurrently, during the first 18th clock cycles, all pixel integrators are reset with initiating all component having zero value start from beginning and the next integration cycle begins on the 19th clock for reading barcode. On the 129th clock rising edge, the serial input pulse is clocked out of the shift register that is control logic. This condition controls and handles with the shift register or control logic and the analog output AO assumes a high impedance state. Note that this 129th clock pulse is required with need to bring to an end the output of the 128th pixel. Because of 128th indicates involving the barcode reading process will be done and return the internal logic to a known state that is initial stage. This known state is initial state i. e. starts from 0th cycle towards (N-1)th cycle. If a minimum integration time period is required, necessity to start reading process, the next serial input pulse may be given after a minimum delay of tqt it is a pixel charge transfer time period after the 129th clock pulse.

Analog output is an op amp-type output because it is analog output that does not require an external pull-down resistor it's connected with switches and capacitors. These designs allow or permit to a rail-to-rail output voltage swing with considering noise margin like VOH and VOL. According to VDD = 5V supply voltage, the output is generally 0V voltage for no light input, 2V voltage for normal white level and 4.8V voltage for saturation light level. When the device is not in the output phase with checking again and again, analog output is in a high-impedance state. The voltage generated at analog output (AO) is given by:

$$Vout = Vdrk + (Re)\ (Ee)\ (tint)$$

where:

- Vout = Analog output voltage for white condition
- Vdrk = Analog output voltage for dark condition
- Re = Device responsivity for a given wavelength of light given in V/(μJ/cm2)
- Ee = Incident irradiance in μW/cm2
- tint = Integration time period in seconds

V. PARALLEX TSL1401 - DB LINESCAN CAMERA MODULE

The Parallax TSL1401-DB LineScan Camera Module made up of a CMOS semiconductor extended along a straight sensor of 128 pixel having linear array and a mounted lens of 7.9 mm to capture image, these provide a field of view equal to the subject distance for camera arrangement.

A. Camera Signal Interpretation

The camera is a composition of an image sensor and a lens which is installed or mounted on sensor. The light that away from surface after hitting it from plan surface from the environment enters through the lens and the last one deflects light with considering intensity into the sensor. The sensor made up of a microscopic array of capacitors that gain charge depending on light intensity directly proportional to incident light. Therefore all pixel charge includes in the photodiode linear array at the same time, this charges storing in capacitor. The sensor delivers each pixel value from linear array in one output signal depending on capacitor one after the other until all pixel values charges are delivered.

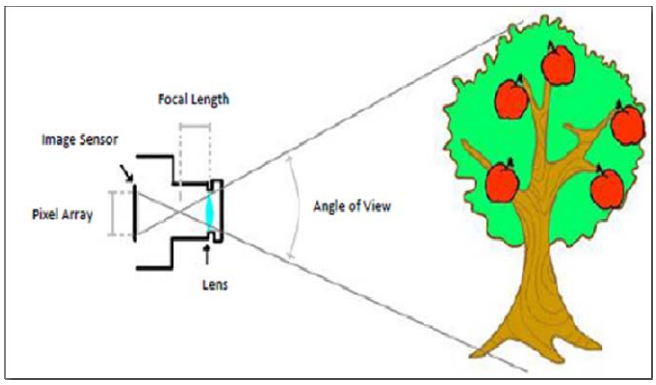

Fig. 7. Adjustment of focal length [7]

Adjust the camera lens according to focal length from object. Because of all view parts of object are captured with the lens which mounted on image sensor. According to all pixel values are mentioned with capturing image from camera.

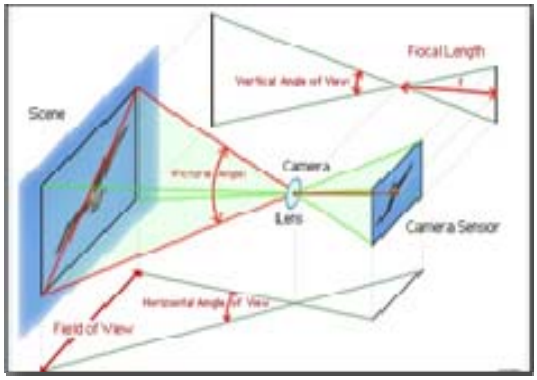

Fig. 8. How the focal length is affect on image capturing process [8]

Because of the camera is using an extended along a straight sensor it is not able to occur to acquire or capture a full view of the aspect or object in a single shot. Therefore it only takes one line of the full object aspect as shown in the next image. Here, the line to be captured is completely dependent on the distance to the lens and barcode pattern image as shown in Figure 8. Finally this image is delivered in an analog signal as shown in Figure 9.

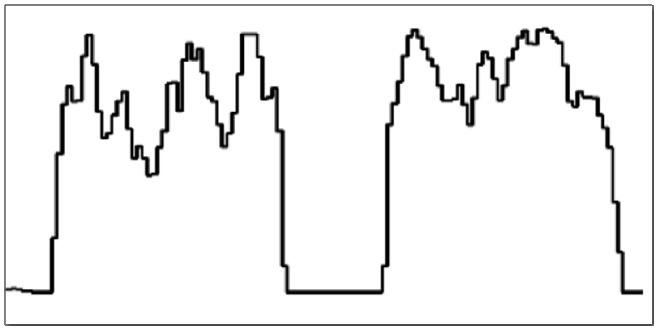

Fig. 9. Example of output waveform of receipe

This is example of analog waveform of receipe. According to these waveforms decide threshold value of perticular receipe. This threshold value helpful for identifying barcode. All waveforms of receipe stored in the database of computer for matching purpose. Whenever user will put the capsule in the POD door the capture the barcode with barcode sensor. Camera capture image with the help of lens and geneate analog waveform. This analog waveform compare with stored one waveform. If receipe barcode waveform is matched with stored one waveform. After matching start beverage preparation process.

B. Signal Processing

For general perform operation of the camera, the user requires means need to take care of the following signals only:
• CK (clock)
• SI (serial input)
• AO (analog output)
Where clock (CK) and serial input (SI) are camera inputs and analog input (AO) is a camera output.

As declared before, the user/customer can organize the frame speed of the camera for capturing images by adjusting clock (CK) and serial input (SI) signals. Faster is the clock (CK) frequency to calculate time period, the faster the camera delivers the pixel analog values. The closer each serial input (SI) is from one another the faster each frame image capture or taken occurs depending on clock and serial input logic 1 and rising edge respectively. It is very important to understand and analyse, the faster the frame captures occur the lower each pixel acquires stored charge. This guides to another important factor, the integration time period.

Integration time period is the time the pixels have to complete its charge with capacitor available in each pixel circuitry in the linear array. With very long integration time period, the pixels will be saturated even if there is low light intensity in the environment and surroundings for capturing image from pixel array. On the other hand with very short integration time period the pixel from linear array will not acquire charge even if there is immoderate light on the environment and surroundings. After 18^{th} clock cycles, the pixels from array begin to charge back again with capacitor mounted in each pixel circuitry from input to output and the output side. After 129^{th} clock cycles all pixels are delivered from the camera lens, this means, from that moment it can send and provide another serial input (SI) pulse to deliver analog input (AO) signal again, but as declared before longer the cycle, the pixels will charge more and user will obtain better pixel quality with control logic circuitry.

Once the complete 129^{th} clock cycles are proceeded that is barcode reading process completed, it is very important to shut down the clock (CK) signal, this will assist the pixels to charge much better than if clock (CK) signal is on repeatedly.

After that barcode image capturing first thing is remove white part and remain only black strips. In that black strips distinguish thick black line and thin black line. Thick black line consider as logic 1 and thin black line consider as logic 0. So according number of thick and thin black lines count the number of 1's. If number of 1's is greater than some threshold limit, it consider as logic 1. If number of 1's is smaller than some threshold limit, it consider as logic 0. According to distinguish the logic 1 and logic 0, we got the hexadecimal number of that barcode.

This barcode value includes all details which are required to prepare any beverage. According to capsule barcode decides how much amount is required to mix the water as well as gas status in with the crushed capsule. After preparing beverage dispensed it according to set the parameters like volume and time.

VI. BARCODE IMPLEMENTATION RESULTS

Following figure shows example of barcode pattern with thick black line and thin black line for each recipe used

for beverage preparation. In the barcode pattern includes thin and thick lines with white background. Considering thin lie is logic 0 and thick line consider as logic 1.

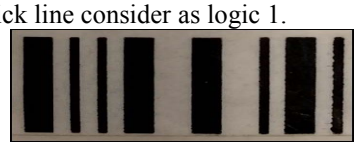

Fig. 10. Barcode Pattern

In that barcode pattern includes information about the quantity of water as well as aerated which are mixed according to recipe detection.

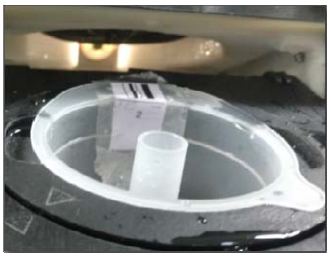

Fig. 11. Arrangement of barcode and lens distance

Barcode strip mounted on capsule but in the figure for testing purpose mounted on capsule cup. After beverage option selection POD door is open and LED glow. According to this light capture barcode and compare with stored barcode pattern (analog waveform) in the database.

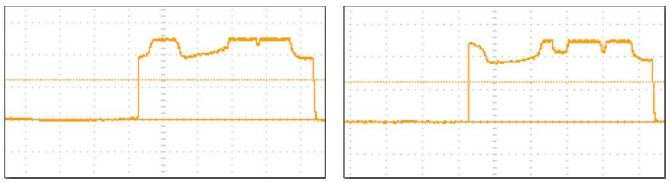

Fig. 12. Output waveform of recipes

These are analog waveforms captured with lens mounted on barcode sensor shows on DSO with threshold value. With the help of threshold value we converted analog value into digital value form of 0 and 1.

Fig. 13. Actual assembly

In this assembly of dispenser machine shows POD door automatically open after beverage option selection. Put capsule into capsule cup and manually close the door. Read barcode with the help of lens mounted on barcode sensor with comparing analog waveform and convert into digital value. Start beverage preparation according to recipe and dispensed it.

VII. CONCLUSION

With the help of pantry control board any user interacts with dispenser machine. Whenever user press the main dispenser button and option key like hot water, cold water and cool water also dispenses beverages like soft drinks by using capsules with crushing them. Each capsule has barcode to distinguish the beverages. These capsules look like tablets. Barcode strip mounted on surface of capsule. Accordingly water and aerated quantity has dissolved in the beverage mentioned in the barcode and dispensed. Details about beverages like water quantity mixed with crushed capsule and dispensed it.

References

[1] Wenshan C., Yanqun H. and Minyang L., “Influential factors of vending machine interface to enhance the interaction performance”, 8th IEEE International Conference on In Intelligent Computation Technology and Automation (ICICTA), Jun 14, 2015, PP: 486-489.

[2] Vaid V., “Comparison of different attributes in modeling a FSM based vending machine in 2 different styles”, IEEE International Conference on In Embedded Systems (ICES), Jul 3, 2014, PP: 18-21.

[3] Kim K., Park D. H., Bang H., Hong G. and Jin S. I., “Smart coffee vending machine using sensor and actuator networks”, IEEE International Conference on InConsumer Electronics (ICCE), Jan 10, 2014, PP: 71-72.

[4] Krishna V. V., Monisha A., Sadulla S. and Prathiba J., “Design and implementation of an automatic beverages vending machine and its performance evaluation using Xilinx ISE and Cadence”, IEEE Fourth International Conference on In Computing, Communications and Networking Technologies (ICCCNT), Jul 4, 2013, PP: 1-6.

[5] Zhang W. and Zhang X. L., “Design and Implementation of automatic vending machine Based on the short massage payment”. 6th IEEE International Conference on In Wireless Communications Networking and Mobile Computing (WiCOM), Sep 23, 2010, PP: 1-4.

[6] Lin F. C., Lee Y. S., Hsu C. H., Chen K.Y. and Weng T. C., “Service component architecture for vending machine system in cloud computing infrastructure”, IEEE International Conference on Ine-Business Engineering, ICEBE'09, Oct 21, 2009, PP: 591-595.

[7] http://ams.com/eng/Products/Light-Sensors/Linear-Array/TSL1401CL

[8] https://en.wikipedia.org/wiki/Focal_length