IOSR Journal of Engineering (IOSR JEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
PP 13-21

Smart Refrigerator

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Abstract: *Refrigerator is one such innovation which has helped people in many ways. It helps to keep the food fresh even if it is kept for more than a day. In such a modern technology, people expect the smart and improvement in technology. So a smart refrigerator using a LCD display, GSM module , sensors and many more must be designed to make it a smart refrigerator and lead in the improvement of technology. It would further help people in many ways like reminding about the vegetables, displaying the temperature in the refrigerator and reminding one about the absence of a particular thing missing and many more things.*
Index Terms: *Liquid Crystal Display(LCD), Global System for Mobile Communication(GSM), Light Emitting Diode(LED), Radio Frequency Idenification(RFID), velostat.*

I. Introduction

Presently traditional methods are used to buy daily need product like groceries, vegetable fruits etc. Earlier, these products were bought on day to day basis. With the invention of refrigerator, stocking of these items are possible. With the rapid developments in technology, options for buying and preserving various commodity products was possible and made easy when compared to that of the methodology used before.

A refrigerator is a machine that helps in keeping the things cold inside.People put food, fruits and drinks in it, to keep the items cold or good (unspoiled) for a longer time. A refrigerator has a heat pump that takes the heat away from the air inside the refrigerator. The heat gets added to the air outside the refrigerator. The electric motor is usually used to drive the heat pump.

There are also some components in the refrigerator that do not make use of the electric power like the ice boxes, since they are filled with ice to provide the cold temperature. They are called coolers. When the electricity was not available in the early years, refrigerator sized iceboxes were used as shown in the figure 1

A refrigerator is a an appliance that consists of a thermally insulated compartment and a heat pump (mechanical, electronic or chemical). The heat pump transfers heat from the inside the refrigerator to its external environment. This keeps the internal environment of the refrigerator cold when compared to the ambient temperature of the room. The lower the temperature is, the lower the reproduction rate of bacteria, so the refrigerator reduces the rate of spoilage. A refrigerator

Fig.1. Smart refrigerator

maintains a temperature a few degrees above the freezing point of water. Refrigeration is an essential food storage technique used popularly. We find a refrigerator in almost every house today.

A. **Motivation**

Advancement in physical computing is changing the way we interact with the environment. This change can influence us to get better in each and every field including food organization, since food is the essential source of our existence. Let us now try to explore the connection between the physical and digital world, and merging of these two!!! For example, suppose the milk at home kept in refrigerator is over. The quantity of milk remaining or emptied has to be informed to the owner or the shopkeeper. The same applies to all the beverages kept in refrigerator (ketchup bottle, soft drinks, water bottle,emptied egg slots etc).The identification of its threshold levels is necessary because sometimes the content of above quoted example cannot be examined continuously by a human being. Hence, considering all these parameters, the work has been proposed regarding alert system. This work can be extended for the vehicles like an alert system for getting to know the water content in a bottle that is kept in the water bottle holder of a car.
Considering all these parameters we have designed the system known as SMART REFRIGERATOR.

B. **Objectives**

The objectives are given as:
To design sensor which gives weight measurement.
To give alert message with content of material to the owner or the shopkeeper.
To display LED high with its contents.

II. Literature Survey

After going through many papers the working of refrigerator and improvising it in a smart way was known. The conclusions of certain papers and their approach are given as below.

The paper discussed a method to monitor the grocery items that are kept in a home refrigerator. Using load sensors mounted under a shelf of refrigerator, the method used matches the groceries that are put into and taken from the refrigerator. [1] Prototype load-sensing board uses four load sensors to get the weight and position of the grocery items kept inside, and use this data to re-identify the groceries later. Detailed experiments of this model have shown that this feature can accurately re-identify the particular grocery items and thus provide constant monitoring of contents in the refrigerator.

In the paper, [2] there is no system of monitoring the materials or food items automatically. A refrigerator can be made smart or intelligent if it possesses self-monitoring capability of food items or materials with minimal or no human intervention. Such a product should have the capability of detecting and alerting the consumer automatically for the need to restock or replenish dwindling supplies. In this system, the refrigerator keeps the track of the amount of empty space automatically, and therefore the amount of items in refrigerator compartments. It will automatically inform the owner or the shopkeeper about the status of the refrigerator through short message service (SMS) and also through the fast Ethernet network. The system also has an LCD display screen and a buzzer on the door of the refrigerator. The LCD display screen displays the message when the items are over and at the same time buzzer is also on, which is an indication to the members of house about the stock of refrigerator.

Paper tells about how the [3] intelligent appliances with multimedia capability have been emerging into our daily life. Kitchen is one such place where the intelligent appliances have been used. The existing models of the refrigerators use barcode scanner or RFID scanner to keep the track of stock or items kept inside the refrigerator. The main motto of Smart Refrigerator module is to design an existing refrigerator into an intelligent cost effective appliance using sensors .The smart refrigerator is capable of sensing and monitoring the contents. It is also able to remotely notify the user about scarce products via SMS (Short Message Service) and email. It also facilitates the purchase of scarce items by providing a link of the online vendor of that particular item. Additional functionality includes the acknowledgement of a placed order to avoid the purchase of the same item by different users.

The paper discusses that, with the enhancement of technologies in various fields our lives are directed to the intelligent and smarter regime. They are following newer technologies rather than old approaches [4]. Thus the devices ought to be smart to recognize the needs of people. Since the current life style is driving people to spend less time on preparation of healthy food at home, it can be supported with a smart kitchenware such as a smart refrigerator. It deals with the designing of a smart refrigerator which senses the quantity as well as quality of the food items kept inside it. With smart sensing technology, this system will keep a check on the expiry of food products and the spoilage of eatable items. It will notify the current status of food items through an android app on mobile phones, and will develop a reminder about the items that are going to spoil before they

actually get rotten. Thus it will be financial and reduce the food wastage as well as help us to live a healthier and a smarter lifestyle.

In the paper it has been discussed about the design of an efficient and effective micro controller weight based alarm system that can be used in industries to monitor products during packaging [5]. A package is placed on the weighing system, if it exceeds 50kg; an alarm system is triggered indicating a faulty package. The weight of the package is displayed on a screen and is simultaneously sent to a remote computer or device for storage. Micro controller was used to control the system. To program this micro controller, the integrated environment used was MATLAB. WinQcard and Proteus were soft-wares used to develop circuit diagrams and come up with the printed circuit board. After implementing the components on the circuit board and programming the microchip, the system worked as expected.

The author has proposed the work with development of the Highway Transportation and Business Trade, vehicle weigh-in-motion (WIM) technology that has become a key technology and a trend of measuring traffic loads [6]. A novel capacitor flexible weighing sensor was applied in the vehicle WIM system. The sensor used is light in weight, has a smaller volume and is portable. The dynamic behavior of the sensor is modeled using the Maxwell-Kelvin model because the materials of the sensor are rubbers that belong to visco elasticity. A signal processing method is used to overcome the effects of rubber mechanical properties on the dynamic weight signal. The results showed that the measurement error is less than 10 percent. After a lot of analysis it demonstrated that appliance of this system is feasible and is convenient for traffic inspection.

The paper [7] proposes the work that load cells are used to measure force or weight. They are basically transducers. A variety of load cells are present and most of these transducers are used in the weighing industry. These sensors are based on strain gauges. An s-beam load cell based on strain gauges was suitably assembled to the mechanical structure of several seats of a bus under performance tests. It was used to measure the resistance of their mechanical structure to tension forces applied horizontally to the seats. The load cell was put in a broad band noise background. It had the unwanted information and the relevant signal and sometimes shared a very similar frequency spectrum. The performance was improved by using cursive least-squares (RLS) lattice algorithm. The experimental results are satisfactory. It gained significant improvement in the signal-to-noise ratio at the system output of 27 dB achievement. It was the good factor for judging the quality of the system.

The paper tells about results from an investigation on a special [8]optical fiber. The fiber is a load sensor for application in Weigh-in-Motion (WIM) systems that measure wheel loads of vehicles. The vehicles can be traveling at a normal speed on highways. This fiber has a unique design with two concentric light guiding regions of different effective optical path lengths. It enables direct measurement of magnitudes and the locations of forces acting at multiple points along a single fiber. The optical characteristic of the fiber for intended sensing purpose was first assessed by a simple fiber bending experiment and by correlating the bend radii with the output light signal intensities. A simple laboratory load transmitting/fiber bending device was then designed and fabricated. It had the main function to bend appropriately the optical fiber under applied loads in order to make the fiber work as load sensor. The device with the optical fiber was tested under a universal loading machine and an actual vehicle wheel in the laboratory. The test results were satisfactory and showed a good relationship between the magnitude of the applied load and the output optical signal changes. The results also showed a good correlation between the time delay between the inner and outer core light pulses and the distance of the applied load as measured from the output end of the fiber.

The paper discusses about an automatic garbage collection and information gathering system . This system is based on image processing and on GSM module [9]. The main concept of the proposed model is that a camera will be placed at every garbage collection point along with load cell sensor at bottom of the garbage can. The camera will be taking continuous snapshots of the garbage can. Comparison of the output of camera and load sensor is done by setting up a threshold level . A micro-controller is used to compare it. After various analysis of the image, they get an idea about the level of garbage (that is if the can is full, or half empty) in the can. From the load cell sensor, they get to know the weight of garbage. The information is processed accordingly. The micro-controller checks if the threshold level has been exceeded or not. The controller sends a message with the help of GSM module to Garbage collection local central office. It notifies the office about garbage can whether it has exceeded its capacity and disposal of waste is required. Accordingly, the office authority sends to clean the garbage can by sending a vehicle to collect the garbage. The mechanism that it follows is robust.

III. Methodology

A. Block Diagram

Figure 2 shows the block diagram of the proposed work and the application of the same is explained as below.

1) Power Supply: The power supply unit is the piece of hardware that's used to convert the power provided from the outlet into usable power for the many parts inside the computer case.The power supply used is 0 to 10 volts.
2) Arduino: The Arduino Uno is a micro-controller board based on the ATmega328 (data-sheet). The arduino has 14 digital input or output pins. Out of these pins, 6 can be used as PWM (Pulse Width Modulation) pins and 6 are analog input pins, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything that is needed to support the micro-controller. The connections of the arduino board are pretty simple. Connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The arduino is given with 3.3 to 5 volts.

Analog pin A0 to A7 is used to read a voltage from sensor which is analog value then arduino will convert it to digital value. This value is displayed on serial monitor. In the proposed work, arduino analog pins are utilised to read the valued from the different materials. For example: bottle, milk vessel etc.,

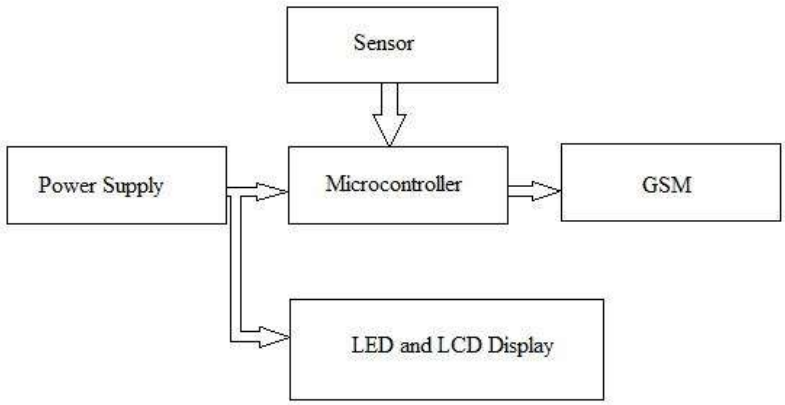

Fig. 2. Block diagram of the proposed work

3) Sensor module: In our work, the sensor module used, gives the output in terms of voltage. As the weight is high, the output voltage will be high and vice-versa. The sensor is of very low cost and is operated between the range of temperature -35 degree to 40 degree, which is feasible for our work.
4) LCD Display: A liquid-crystal display (LCD) is basically a flat-panel display or other electronic visual display that uses the light-modulating properties of liquid crystals. Here we are using 16X2 LCD display. In the work, LCD display is used to display how much quantity of material is left in the container which is kept in refrigerator by its percentage.
5) GSM Module: GSM (Global System for Mobile Communications). In our work, we are using GSM with 800MHz frequency to alert human regarding quantity of material that remained in refrigerator.

B. Working Principle

Figure 3 shows the block diagram of smart refrigerator proposed by us. It consists of Power supply, Weight sensor, Arduino board, GSM module, LCD display.

In proposed work, using sensor module we are detecting the weight (gross weight) and trying to estimate the content of the material(milk, water bottle, eggs, injections) that are placed in the fixed space within a refrigerator. For example, water bottle has to be placed in a refrigerator slot which is fixed at the door. At every fixed space, sensors will be embedded with fixed threshold value. Then calculate its threshold value and display the contents remaining in it. When the content of the bottle get near to 20 percent, a red LED on the door will be blinking and also a message with the percentage of remaining will be sent to the user using GSM module.

The user can judge the content using the display on LED or message sent by the GSM. The proposed work gives the alert message to the user.

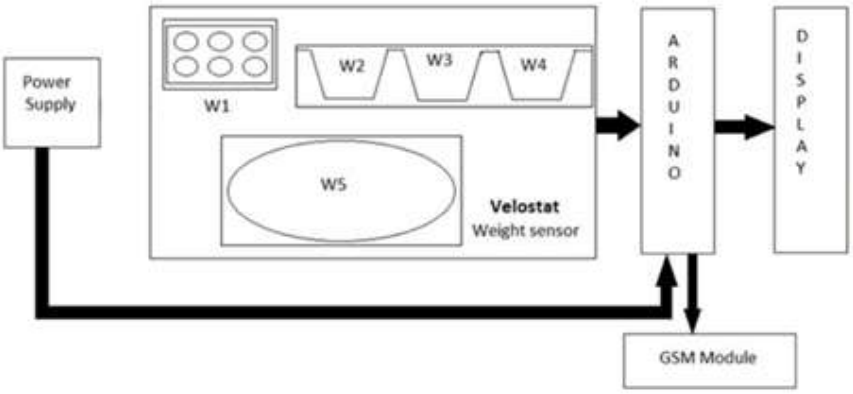

Fig. 3. Block Diagram of Smart Refrigerator

C. Algorithm

The sensor module is also used in cars where the bottle is kept, even this work is used in generalized application for the medical related injection tubes.

Algorithm 1 Algorithm for proposed work

x = containers with contents if x >= 1 then output voltage = sensorvalue

end if
if sensor value > threshold 1 then print Container content is high!!
else if sensor value < threshold 2 then
print container contents is around 50 percent else
print container contents is less than 25 percent end if

if x < 0:25 then
Send an SM S to the user

end if
if x = full then
all three LED^0 s are high
else if x = half then
two LED^0 s are high
else
one LED is high

end if

IV. Hardware and software requirement

A. Arduino

Arduino board has digital input and output pins that can interface with various expansion boards and features com-munication with serial boards including USB(Universal Serial Boards) for loading programs as shown in the figure 4. It supports languages like C and C++. Arduino-UNO has atmega 328P Integrated Circuit. It has 28 pins overall including digital and analog pins, a USB connector,a USB interface chip and external connectors. It contains everything that is required to support the micro-controller. Connecting it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get it started.

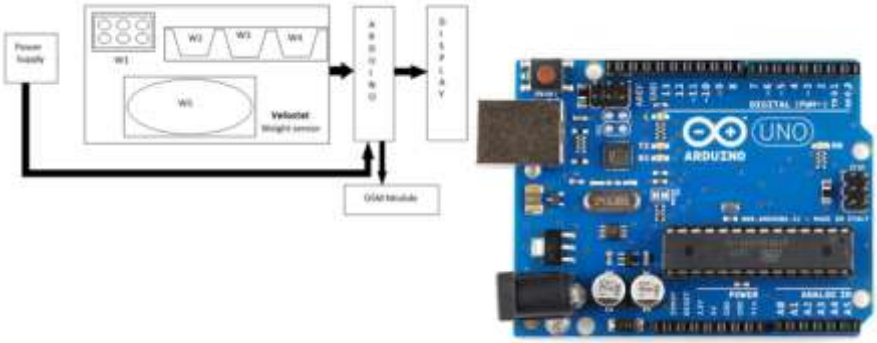

Fig. 4. Arduino UNO board

B. Velostat

Velostat is a packaging material. It is made of a polymeric foil (polyolefines). It is impregnated with carbon black to make it electrically conductive as shown in the figure 5. It is used to protect the items or devices that are susceptible to be damaged from electrostatic discharge.

It changes its resistance with pressure or flexing. Due to these properties, it has become popular within hobbyists for making inexpensive sensors for micro-controller experiments.

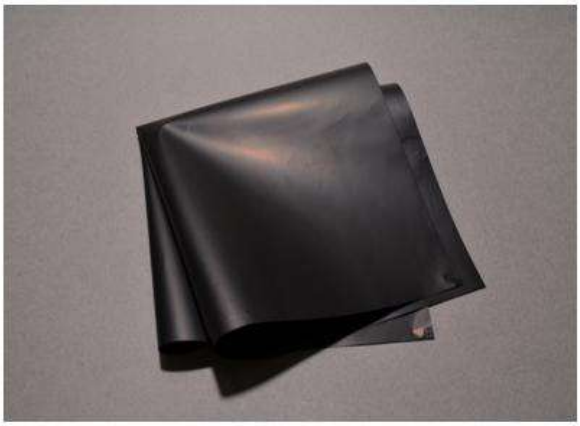

Fig. 5. Velostat

C. GSM Module

GSM (Global System for Mobile Communications, originally Group Special Mobile) is used to describe the protocols for second-generation (2G) digital cellular networks used by mobile phones.The GSM network is described with various structures like base station subsystem, network and switching subsystems, GPRS core network and Operation Support System as shown in the figure 6.

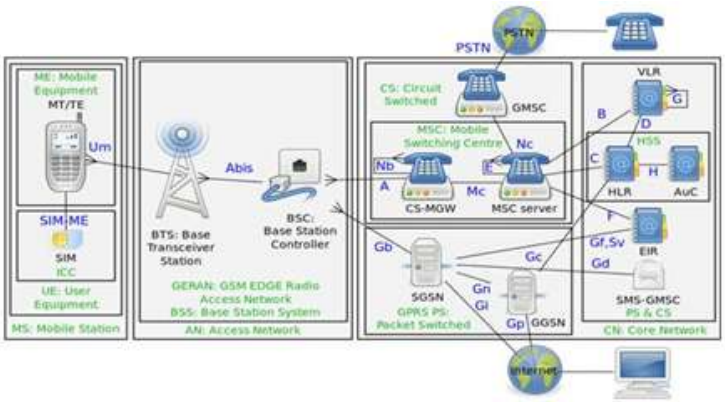

Fig. 6. Structure of GSM network

D. LCD Display

A Liquid-Crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals shown in the figure 7. These liquid crystals do not emit light directly, instead they use a back-light or reflector to produce images in color or monochrome. They are also available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content. The images obtained can be displayed or hidden, such as preset words, digits, and 7-segment displays, as in a digital clock. They use the same basic technology.The only exception is that it uses arbitrary images that are made up of a large number of small pixels, while other displays have larger elements.

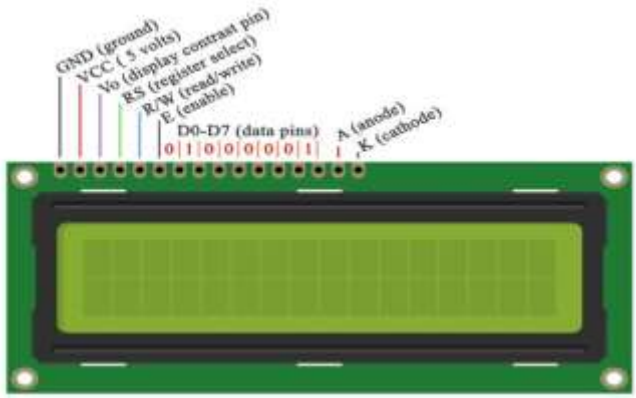

Fig. 7. LCD Display

V. Results And Discussion

The figures 8 and 9 show the model of the proposed work or the prototype developed.The proposed work carried out using arduino micro-controller is seen in the figure 10.

Fig. 8. Model of Proposed Work

Fig. 9. Sensor Tray

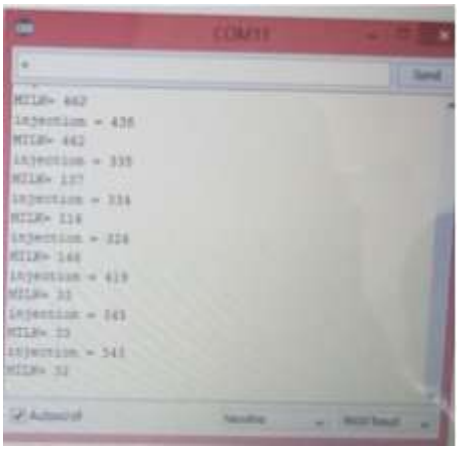

Fig.10. Output from Arduino

The table I shows the sensor value that is obtained and set for the items considered for smart fridge in terms of resistance and voltage. The output can be observed using the LED, LCD display and through GSM.

Table I: Output From Arduino

Items	Levels	Sensor Values
Water Bottle	Empty Spot	greater than 400
	Empty Bottle	greater than 200
	Half Bottle	greater than 120
	Full Bottle	greater than 70
	Threshold Level	greater than 120
Injection	Empty Spot	greater than 400
	Half Slots(5 In-jections)	greater than 180
	Full Slots(10 In-jections)	greater than 110
	Threshold Level	greater than 240
Milk	Empty Spot	greater than 500
	Empty Vessel	greater than 200
	Half Vessel	greater than 90
	Full Vessel	greater than 60
	Threshold Level	greater than 100

VI. Conclusion and future scope

The quantity of the items that are kept in refrigerator are calculated using sensor and micro-controller. The intimation of the message can be analyzed through LED or by SMS. The work gives the warnings with respect to the levels of the content which makes a human being more easier to find its quantity. The work can be further processed for the slots that are kept in multi-utility vehicles for indication of the levels of the content.

Acknowledgement

The acknowledgement transcends the reality of formality when we express deep gratitude to all those people behind the screen who have helped us in the completion of the project work.

We consider it our privilege to express our gratitude and respect to all those who have guided us and inspired us and we would also thank Kushalgouda Patil, Laxmi Nadagi, Panchal Aditya and Sanakousar Sanadi for their assistance in collecting the information about literature survey of the concerned project.

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