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"Coffee Vending Machine"

A Project report submitted in Partial Fulfillment of the requirements for the Post Graduate Diploma

IN
INDUSTRIAL ROBOTICS

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Abstract:-

Vending Machines are automated machines that dispense selling products such as snacks, beverages, lottery tickets, and etc. It is vital to save time and reduce human energy. These vending machines are developed in the way of Non IoT-based and IoT based methods. These Non IoT based machines are not smart and are not operated in real-time data, which are functioned when giving cash or card and inputs (vending things) of the machine. It is controlled by a microcontroller and distributed the given inputs. IoT-based machines are computerized, which have cashless payment facilities, order facility before going to the vending machine to order things, and can be identified the location of machines by the customer. These IoT-based machines are assisted by suppliers to identify the availability of the stocks. Simulation software and prototype are used to validate the machines. In this review, it is found that most of the vending machines developed are capable of operating without IoT technology, and nowadays, vending machine systems are required to implement using IoT with machine learning, and artificial technologies to satisfy customer preferences.

Chapter 1

INTRODUCTION

Introduction:-

Vending Machines are automated machines that dispense selling products such as snacks, beverages, lottery tickets, and etc. It is vital to save time and reduce human energy. These vending machines are developed in the way of Non IoT based and IoT based methods. These Non IoT based machines are not smart and are not operated in real-time data, which are functioned when giving cash or card and inputs (vending things) of the machine. It is controlled by a microcontroller and distributed the given inputs. IoT-based machines are computerized, which have cashless payment facilities, order facility before going to the vending machine to order things, and can be identified the location of machines by the customer. These IoT-based machines are assisted to suppliers to identify the availability of the stocks. Simulation software and prototype are used to validate the machines. In this review, it is found that most of the vending machines developed are capable of operating without IoT technology, and nowadays, vending machine systems are required to implement using IoT with machine learning, and artificial technologies to satisfy the customer preferences. Keywords: Internet of Things; Vending machines; Automatic machine; Automation; Cashless payment; and smart vending

The Automatic machine operates based on electronics engineering, mechanical engineering, and electrical engineering, which is a collectivity termed Mechatronics . People spend more time buying things in supermarkets as the market is crowded. Hence, it disappoints the customers and it leads to losing income to the vendors. Normally people touch the things (mostly vegetables) to identify their quality. At that time, they can be affected by infectious diseases. Low hygiene and quality of most of the things are finally needed more workers to maintain the quality. Therefore, higher salary which needs to be paid to workers, and there is security issue as most of the customers use the cash payment method. As a result, design of the vending machine is the best solution to avoid these problems. The vending machine is one of these automated machines which supply needed things to the customer. The vending machine can be

categorized into product-oriented and service-oriented machines. It distributes snacks, beverages, public transit tickets, jewelry, telephone facility, entertainment things, and etc. . As it has many benefits, such as, man power is no needed, flexibility in time, saving time, reducing labor cost, increasing profitability, and etc. . . Therefore, vending machines are used commonly worldwide . Amid the COVID-19 crisis, vending machine usage is increased internationally . US$134.4 Billion of the global market was estimated by using vending machines in 2020, and it is predicted as it will reach US$146.6 Billion in 2027. According to the report , 1.3 % of CAGR is analyzed in the period of 2020 to 2027. Currently, vending machine owners are facing challenges from hacking and vandalism . Most customers want unmanned retail models and cashless payment methods because customer behavior has changed . Lack of innovation and the way of the operating machine also affect the profitability of the machine . Vending machines are faced with disruption of online delivery, which is increasing income by 23% in Japan . IoT applications are needed to monitor the environment, identify problems, communicate, and resolve problems without human intervention , and they have security issues in data sharing and privacy. Hence, security techniques are important to prevent confidential and important for device protection from some internet security threats . In recent days, machine learning and artificial intelligence technologies are incorporated when developing vending machines. Therefore, it can be able to access real-time data collection, increase sales, make operation more efficient, and supply things to customer desire, which identifies the customer desire by which selected regular things are . Comparison of current systems and identification of drawbacks are important in developing novel vending machine technologies as the usage of vending machine has been increase. Therefore, this article will focus on the comparison of systems developed under laboratory and factory conditions. In this article, a brief discussion on conventional methods used followed by existing IoT based vending technologies are also discussed. Then, statistical algorithms which were used in data analysis will be discussed.

Problem Statement-

Coffee, tea is needs for human's daily stress-full life. But sometimes it is hard to make one or get one when you are out of your house. An if you find one by the street there is low level of hygiene available, And during the time of pandemics like covid-19 a vending machine is a life saver, it not only provides hygiene but also avoids spreading of infection due to no human contact while making and dispersing of drinks.

Chapter 2

REVIEW OF LITERATURE

Literature Review-

Arduino (/ɑːrˈdwiːnoʊ/) is an open-source hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices. Its hardware products are licensed under a CC BY-SA license, while software is licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially from the official website or through authorized distributors.

Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards ('shields') or breadboards (for prototyping) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs. The microcontrollers can be programmed using the C and C++ programming languages, using a standard API which is also known as the Arduino language, inspired by the Processing language and used with a modified version of the Processing IDE. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) and a command line tool developed in Go.

The Arduino project began in 2005 as a tool for students at the Interaction Design Institute Ivrea, Italy, aiming to provide a low-cost and easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats and motion detectors.

The name Arduino comes from a bar in Ivrea, Italy, where some of the founders of the project used to meet. The bar was named after Arduin of Ivrea, who was the margrave of the March of Ivrea and King of Italy from 1002 to 1014.
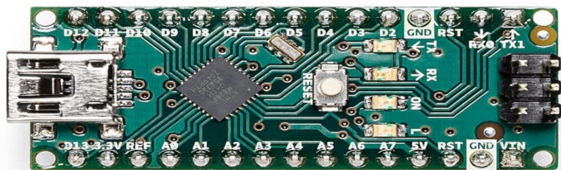

Fig 1

Geared motor-

A geared motor is a component whose mechanism adjusts the speed of the motor, leading them to operate at a certain speed. Geared motor have the ability to deliver high torque at low speeds, as the gearhead functions as a torque multiplier and can allow small motors to generate higher speeds.

Fig 2

Heating element-

A heating element converts electrical energy into heat through the process of Joule heating. Electric current through the element encounters resistance, resulting in heating of the element. Unlike the Peltier effect, this process is independent of the direction of current.

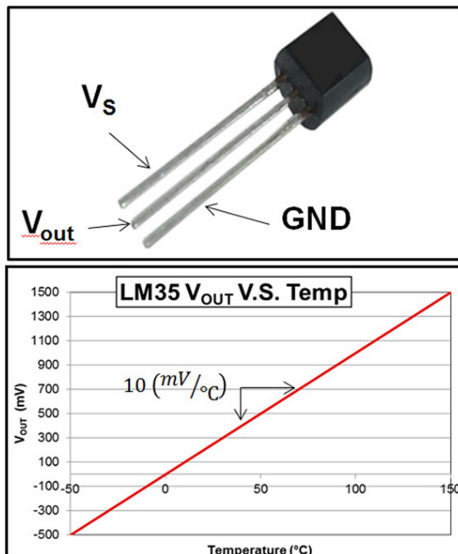

Fig 3

Tactile Switch-

Fig 4

These small sized switches are placed on PCBs and are used to close an electrical circuit when the button is pressed by a person.

When the button is pressed, the switches turn ON and when the button is released, the switches turn OFF.

A tactile switch is a switch whose operation is perceptible by touch.

Temperature sensor-

Fig 5

A temperature sensor is an electronic device that measures the temperature of its environment and converts the input data into electronic data to record, monitor, or signal temperature changes
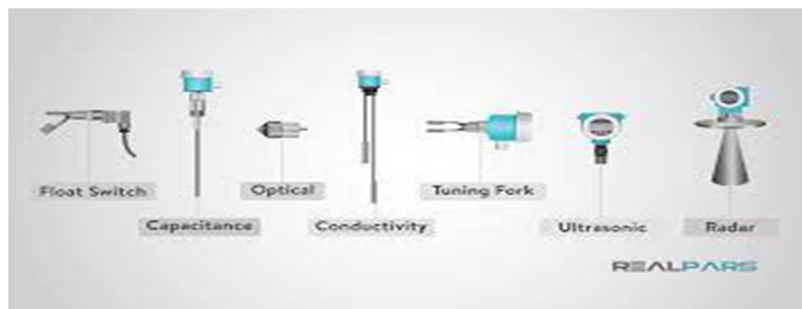
Level sensor-

Fig 6

Level sensors detect the level of liquids and other fluids and fluidized solids, including slurries, granular materials, and powders that exhibit an upper free surface. Substances that flow become essentially horizontal in their containers (or other physical boundaries) because of gravity whereas most bulk solids pile at an angle of repose to a peak. The substance to be measured can be inside a container or can be in its natural form (e.g., a river or a lake). The level measurement can be either continuous or point values. Continuous level sensors measure level within a specified range and determine the exact amount of substance in a certain place, while point-level sensors only indicate whether the substance is above or below the sensing point. Generally the latter detect levels that are excessively high or low.

There are many physical and application variables that affect the selection of the optimal level monitoring method for industrial and commercial processes. The selection criteria include the physical: phase (liquid, solid or slurry), temperature, pressure or vacuum, chemistry, dielectric constant of medium, density (specific gravity) of medium, agitation (action), acoustical or electrical noise, vibration, mechanical shock, tank or bin size and shape. Also important are the application constraints: price, accuracy, appearance, response rate, ease of calibration or programming, physical size and mounting of the instrument, monitoring or control of continuous or discrete (point) levels. In short, level sensors are one of the very important sensors and play very important role in a variety of consumer/ industrial applications. As with other types of sensors, level sensors are available or can be designed

using a variety of sensing principles. Selection of an appropriate type of sensor suiting to the application requirement is very important.

PCB-

Fig-7

PCB or Printed Circuit Board is the traditional name for the bare board of which you supply us with the layout data and which you use to mount your components on once we have delivered it to you.

A printed circuit board, or PCB, is used to mechanically support and electrically connect electronic components using conductive pathways, tracks or signal traces etched from copper sheets laminated onto a non-conductive substrate.

When the board has only copper tracks and features, and no circuit elements such as capacitors, resistors or active devices have been manufactured into the actual substrate of the board, it is more correctly referred to as printed wiring board (PWB) or etched wiring board.

Use of the term PWB or printed wiring board although more accurate and distinct from what would be known as a true printed circuit board, has generally fallen by the wayside for many people as the distinction between circuit and wiring has become blurred.

Today printed wiring (circuit) boards are used in virtually all but the simplest commercially produced electronic devices, and allow fully automated assembly processes that were not possible or practical in earlier era tag type circuit assembly processes.

A PCB populated with electronic components is called a printed circuit assembly (PCA), printed circuit board assembly or PCB Assembly (PCBA). In informal use the term "PCB" is used both for bare and assembled boards, the context clarifying the meaning.

Voltage Regulators-

For many years the 7800 series linear voltage regulators, including the more popular versions of this series like the 7805, 7812, etc, were the most popular voltage regulator chips available and they were used in many electronic circuits, large and small.

The 7800 series voltage regulators were very easy to use, they were cheap to buy, and they provided excellent performance.

Although now they are a little dated, they can still be obtained very cheaply and provide excellent performance - an ideal choice for many electronic devices and circuits, especially for the home constructor, etc.

Not only was there the 7800 series of linear voltage regulators giving a positive output voltage, but there was also the complementary 7900 series regulators used for negative voltage lines.

Fig-8

Chapter 3

WORK DONE

Methodology:-

Non IoT based vending machine technologies In recent past years, there were lots of vending machines developed by several research groups such as PLC based change dispensing machine, PLC based automation of multiple fluid vending machines, AVR ATmega8515 based liquid dispensing vending machine, Arduino based reversed vending machine, Finite State Machine based vending machine with auto-billing features, RFID based ration vending machine, and

International Journal of Sciences: Basic and Applied Research (IJSBAR) (2021) Volume 58, No 2, pp 160-166 162 touchscreen-based medical vending machines . These are commonly known as Non-IoT based vending machines. AVR ATmega8515 , Arduino UNO/MEGA , 8051 , PIC , ARM , AT89s52 , ATmega328 , AT89c51 , MSP430G2553 , and PLC controllers are used to develop the data acquisition system of the vending machines. PLC-based vending machines are developed using Siemens (Version 7) software . The core part of the vending machine is sensors and cameras. Some researchers used position sensors and solenoids to detect the level of fluid and to supply the fluid and IR sensors and Photodiode to detect the presence of coin/currency . Image processing techniques are used to recognize currency and data images of currency collected from a camera or scanner in a change dispensing vending machine Some of the researchers used fingerprint systems and aadhar ID in their vending machine systems to activate the system. These are mainly used railway tickets booking vending machines. These are contained thermal printer and inject printer to print the tickets. The design of a high-tech vending machine is developed using an alarm system for security purposes, which is interfaced with a servo motor and a buzzer All of the designed systems and available systems in the market use a touchscreen and a keypad to input the data to the machine Smart cards or RFID cards are used to access vending machines. Non IoT based vending machines commonly accept coin / currency / credit/ debit card for the payment methods. 16 x2 Liquid Crystal Display has been used for display purposes. Some of the studies have been

used digital weight measuring systems and load cell to measure the weight. The finite-state machine-based vending machine is using FBGA Spartan 2 development boards as a controller and is coded by VHDL language 2.2 Existing IoT based vending machine technologies Coffee vending machines, vending machines with cashless payments for snacks, smart computerized vending machines, and smart automatic juice vending machines are well-known vending machines, which are developed using IoT-based technology . Some of the developed machines were used the PIC microcontroller as the brain of the system and read data from an RFID reader . In some cases, thingspeak and database management systems were used to collect data from sensors and save the data. Some of them used the ESP8266 Wi-Fi module to transfer data to the cloud platform and android based application to access the vending machines . An authentication code is generated by the Blynk platform's mobile application to access the data on application. Some researchers developed websites for payment gateway and accessing vending machines. Especially in India, Razorpay API was mostly used for payment gateways. HTML, CSS, and Java are used to create an advertising platform (website) . The voice-enabled vending machine is used UUGear devices to integrate multiple microcontrollers (Arduino, Nano 33 BLE, NodeMCU, and Raspberry pi). A 12w solar panel, 1820mAh lithium-lon battery, and power management board (UPS) are used for the power source of a voice-enabled vending machine .Nowadays, vending machines are developed using new technologies. They are debit/credit card payment, cashless payment, energy-saving vending , smartphone interactions with Artificial intelligence , wireless communication , Global positioning system , facial recognition, voice recognition system Internet of things and self-inventory.Initially, the vending machine faced a problem was that inserting a coin or cash could be a fraud/ difficult

to count one. The technology of credit/debit card payment method is difficult to cheat the machine]. Today, more vending machines are equipped with cashless payment options. A QR/barcode scanner is used for payment from a virtual wallet using

QR/Barcode. In the distant future, checkbooks, credit cards, and cash may completely disappear. This technology reduces mass adoption in a short time. Near-field communication (NFC) is paired with Google Wallet and Apple pays. Recent innovations detect vendors and repair machines remotely. Coco-Cola Company introduced an ultra-saving vending machine that was used to cool beverages in the daytime using airtight doors and vacuum-insulated materials. So, it reduces the consumption of energy, and this type of machine has more profitability and productivity Nowadays, vending machines can interact with smartphones in real-time and include artificial intelligence for the customer preferences. Wireless communication method is used to receive messages about overview of sales trends, stock data to vendors. A GPS connected to the machine is used to track the machine for customers. Face recognition technology helps to recognize consumers. Then the machine gives preference to the customer and prevents restricted products. Self-inventory machines collect data from various sensors, monitor stock, and make decisions for themselves. 2.3 Validation of the vending machines Simulation of the software model and development of prototype has been done by several research groups to validate the accuracy of machine. Proteus software was used to simulate the operation of the machine in Arduino based reversed machine and real-time embedded-based drinking water vending machine. Rarely, Xilinx ISE Simulator has been used for a finite-state machine-based vending machine with auto-billing and this simulation software has been shown waveforms to represent which items/products are selected infinite state machine based vending machine with auto-billing. Vending machines using 8051 microcontrollers have been validated with coin acceptor when input different sizes of the 5-rupee coin. Coin accepting efficiency is nearly 50% because it works while including a shape of 5 rupees . Validation of mobile app is checked transaction process completed or not in the real-time process. 3. Data Analysis Moore machine and Mealy machine models were used for Finite State Machine-based vending machine. μVision Keil IDE software was mostly used to accelerate embedded software development and also μVision debugger was selected to test, verify and optimize application code. In the cases of IoT based vending machines, thing speak has been used as a cloud

platform to transfer data between a software application and embedded system, and MATLAB was used to analyze and visualize processed data, specially, in IoT based coffee vending machine . Stored data are visualized in graphs and statistical distribution using MATLAB and help to send alert messages to the system in IoT-based coffee vending machines. Manipulation of the functions and implementation of the software was done by MATLAB and processed data is stored using MySQL database in IoT-based vending machine without cashless payment . MATLAB was used to visualize graph format for verifying currency values using image processing techniques in a PLC-based change dispensing vending machine. A unique identification code

International Journal of Sciences: Basic and Applied Research (IJSBAR) (2021) Volume 58, No 2, pp 160-166 164 was used in the verification process of the vending machine. Big data analytics tools and NoSQL database aiming to support smart and efficient data collection and integration. Machine learning and statistics were used to analyze heterogeneous data from various sources, mapping and forecasting customer's needs with production planning, providing the right information at the right time, to the right place . MapReduce, Spark, Splunk, and Skytree analytical tools were used to analyze the stored big data analysis. Classification, clustering, prediction, and association rule analytical methods were applied in the IoT data analysis. SVM and KNN algorithms were used to analyze data in the IoT data analysis, which is used for efficient performance. DataV's data analysis is used to determine customer interactions, unique characteristics of the items, and stored patterns, which is predicted to identify how will affect the overall sales and performance of vending machines.
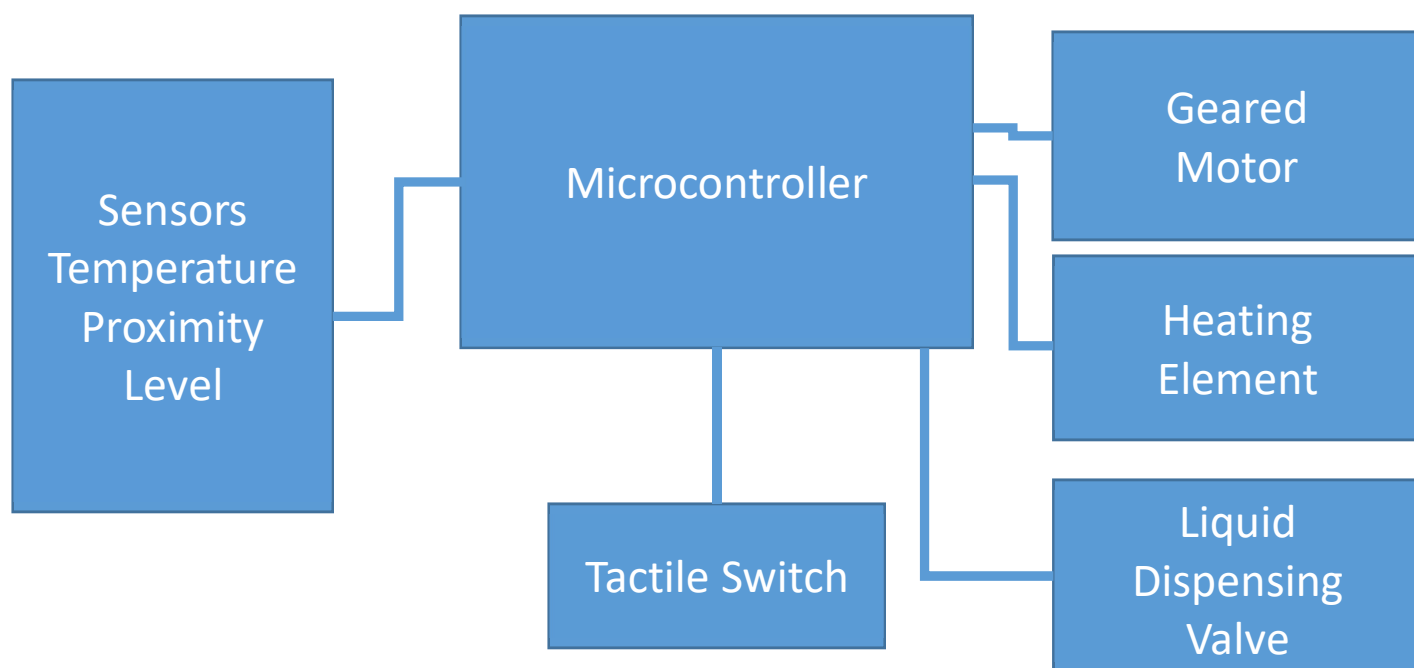
Block diagram:-

Fig 9

Working:-

B. ARDUINO UNO CONTROLLER It is 8bit microcontroller based on the AVR enhanced RISC architecture. It has 32kbytes flash program memory and 1Keprom. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board. There is no need of separate piece of hardware (called a programmer) in order to load new code onto the board Arduino can interact with buttons, LEDs, motors, speakers, GPS units, cameras, the internet, and even your smart-phone or your TV! The hardware boards are pretty cheap. C. Serial Interface Every RFID reder comes with serial output pins. We can collect the read data through these output pins using arduino. There are two possible outputs from an RFID reader. One is RS232 compatible output and other one is TTL compatible output. A TTL compatible output pin can be connected directly to arduino. D. IR sensor A proximity sensor is used to detect any object without any contact. It mainly consists of two parts. One of these is transmitter i.e. LED, and another is receiver i.e. detector. The IR sensor is interfaced with the Arduino board. It is used to detect the presence of the cup for the coffee. The required supply for the IR sensor is the 5 Volt. E. AC motor The AC motor is used to control the feed material like coffee powder. By connecting the shaft of motor to the hopper mechanism the flow of solid material can be controlled. The controller is programmed in such a way that the motor will be on for particular time which is fixed as per the requirement. The power supply required for the motor is 230 Volts, 50Hz. It is controlled through the relay board. Smart Coffee Vending Machine Using RFID 797 Solenoid valve: It is used to control the flow of the liquid such as hot water. 5Volt power supply is used to operate the solenoid valve. F. LCD Display A liquid Crystal Display is a flat panel display, electronic visual display that uses the light modulating properties of liquid crystals. LCDs are available to display arbitrary images (as in general purpose computer display) or fixed images which can be displayed or hidden such as preset words, digits and seven segment displays as in digital clocks. The lcd display is used to display the

information regarding the consumer (such as Name, Unique ID,etc). G. EPROM An EPROM or erasable programmable read only memory is type of memory chip that retains its data when its power supply is switched off. Each storage location of EPROM consists of single field effect transistor. Each field effect transistor consists of channel in the semiconductor body of device. To retrieve data from the EPROM, the address represented by the values at the address pins of the EPROM is decoded and used to connect one word (usually an 8 bit byte) of the storage to the output buffer amplifier. The EPROM is used to store the data regarding the consumption of coffee by each employ. H. Power Supply Since Arduino (ATMega 328P), LCD, IR operate on 5Volt DC Supply, we have used 7805 regulator IC and 0.05 micro farad capacitor that generate conatant output voltage 5Volt, output current capability of 100 mA. To drive the AC motor and heater we require 230 Volt, 50 Hz supply.
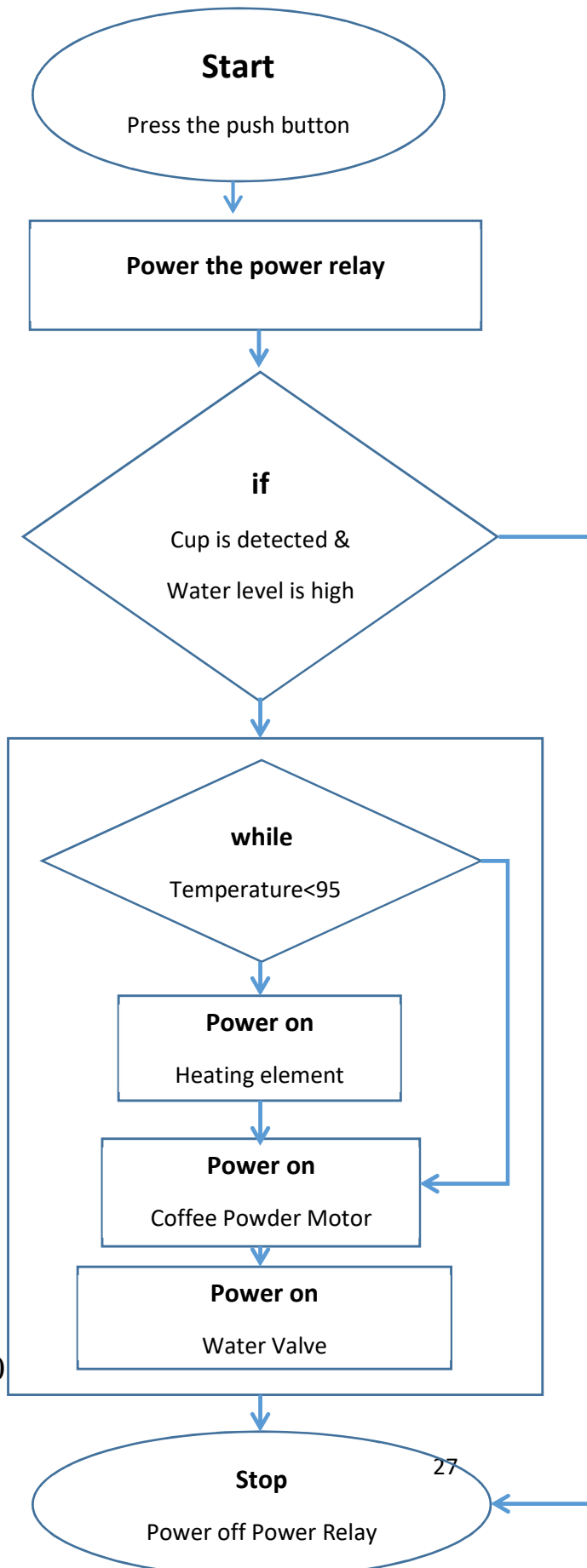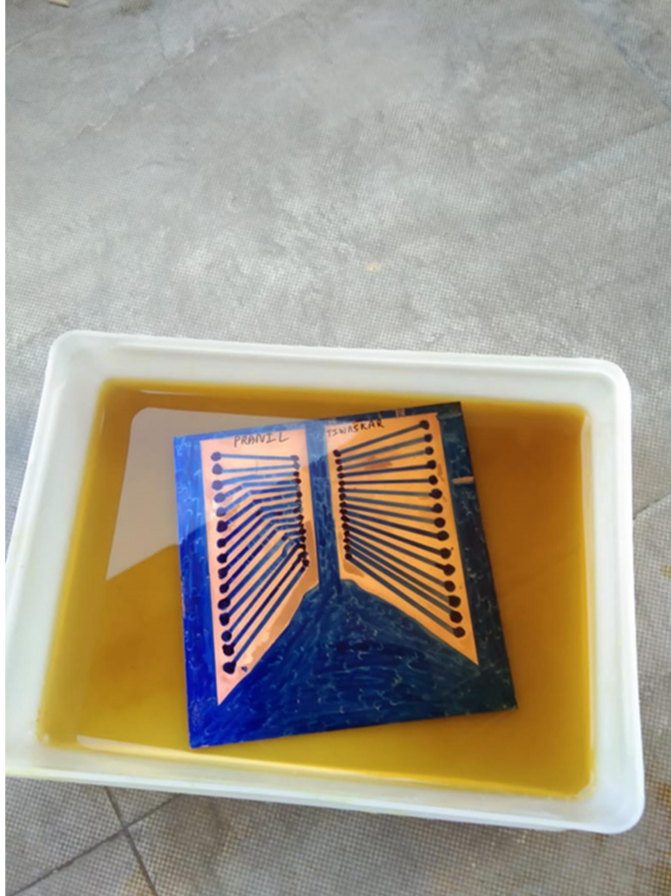
Flow Chart-
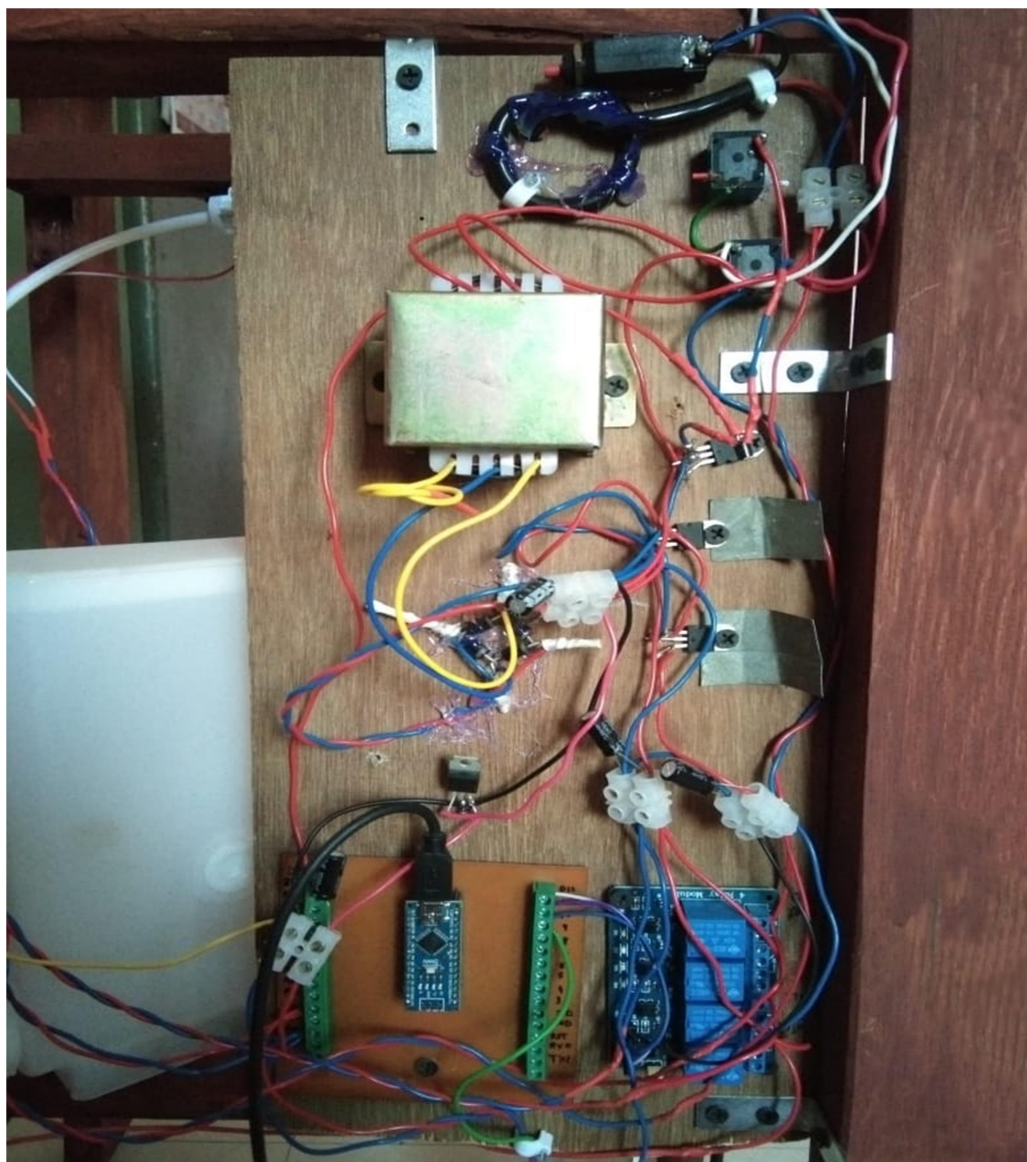

Fig-10

Work Images –

Fig-11   **PCB Etching**

Fig12   **Frame**

Fig 13   **Circuit**

Fig 14 **Frame with Components**

Fig-15 **Frame with mounted components and Circuit.**

Calculation-

Volume of frame –

Length- 38 cm

Breadth - 38 cm

Height- 83.83 cm.

Volume available to house the components = L*B*H.

121050.52 Cm^3

LM35 Analog value to temperature.

temp= analogRead(A0);

temp= temp*(5/1024);   gives reading in millivolts

temp= temp/1000   gives values in volts

temp= temp/10   gives values in degree Celsius

(because value of LM35 changes

1 degree/ 10mv).

Chapter 4
CONCLUSION

Costing-

Component	Quantity	Total
Arduino Nano	1	450
Transformer 3AMP 12V	1	300
Circuit Breaker	1	160
Coffee box	1	450
Dc motor	1	100
Relay module	1	380
Wire connectors	10	30
3 pin Wire connectors (PCB)	10	150
Capicator 1000uf	3	30
PCB Board	1	60
Wire(copper)	20 feet	80
PVC pipes	2 feet	50
IR sensor	1	70
LM35	1	50
2N2222	1	30
Relay	2	160
Wood poles		450
Heating Element	1	300
Push Button	1	60
L clamp	15	75
Screw	40	32
PVC connector	1	15
7805, 7812, 7809	4	240
0.6 mm filter pipe	3 feet	30
Pipe connector	1	5
3Pin Socket & Wire	1	100
PVC brass connector	1	60
Total	*All Expenses Not Includes	3575 Rs

Application:-

A coffee vending machine is a type of vending machine that dispenses hot coffee. Some of the machines, particularly older models, utilize powdered instant coffee mixed with hot water, and some of these offer condiments such as cream and sugar. Some newer models fresh-brew the coffee using hot water and ground coffee beans, and some also grind the coffee to order using coffee grinders installed in the machines, as well as providing various condiments. Some modern machines also provide other hot drinks such as tea, espresso, lattes, cappuccinos, mochas and hot chocolate. Some of the machines dispense canned coffee, and some dispense both hot coffee and iced coffee.

Public coffee vending machines typically require payment, functioning as coin-operated machines, and some also accept bills and credit cards. Some do not require payment; these are typically found at places of employment, whereby the company furnishes the beverage to employees free of charge.

Machines that purvey hot and iced coffee are common in Japan, and many of them are placed in street locations. In Italy, some of the machines purvey up to 18 coffee varieties.

Conclusion-

The design and development of coffee vending machine has been successfully conducted. For Future work by adding extra canister the coffee vending machine will be converted to multi-drinks vending machine. Few parts needed to be replaced with high quality food grade material.

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