Design and Fabrication of Liquid Dispensing Machine using Automatic Control for Engg. Industry

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Abstract— Liquid dispenser machine is commonly found in our daily life in different places like offices, bus stands, railway stations, petrol pumps. In this thesis we are going to present a touch screen operated liquid dispenser machine. Using a touch screen interface, we can effectively increase operator accuracy, reduce training time and improve overall efficiencies, thus keeping cost down a properly designed touch screen interface can improve overall accuracy. Present liquid dispenser machine available in industries are costly, complex and hard in design and fabrication. Main requirement from this machine is its metering or measuring quality. Accuracy of measuring is very less in various machine. Hence, the basic theme behind this research is to improve these disadvantages of liquid dispenser machine. The liquid dispenser machine presently available is based on practice and past experience of the employer in his working field and also, its efficiency declines at a greater rate after a period of time. By surveying the present machines and comparing their present limitations, new model will be fabricated so that designs data can be obtained to formulate experimental data based model for this process. The design of model will be so simple that it can be adopted easily by small industries. Easy technology will help to reduce metering problem. The present work reports the design and fabrication of liquid dispenser machine which is used in color industry.

Keywords-: liquid dispenser machine, MAX232IC, microcontroller, relays, solenoid valve,aquarium pump,hydraulic pump & pcb.

I. INTRODUCTION

Liquid dispensing machine is widely used in all industries like liquid filling machine, bottle capping machines, bottle filling equipment, dry syrup powder filling machine, paint industry, automatic liquid milling Machine, etc In this we are going present fluid dispensing machine specially use where our main aim is to mix number of fluids in proper proportion i.e. we are going to design mix, meter and dispense type of machine. In this machine metering is done by operating solenoid valve with the help of touch screen interfacing. This touch screen is help to handle control unit consist of MAX232IC, microcontroller and relays .This control unit control mechanical components like gear motor, hydraulic pump, solenoid valve & aquarium pump etc. In this machine three solenoid valve are use connected with three aquarium pump resp. Data related to color is collected from catalog of Asian paint. Programming is done with the help of VB.net .User can select desired color from well define data and amount of color required. With the help of VB.net
software we can calculate how much basic color is required to make desired color. With the help of solenoid valve metering of basic color is done in precise manner and we get desired color.

Classification of liquid dispensing machine:

Liquid dispensing machine can be classified on the basis of application as follows:

1. Dispense-only,
2. Mix and dispense type,
3. Meter, mix and dispense type,
4. Hot melt dispense applications.

A dispense only unit is designed to dispense only. It does not mix, nor does it have any metering capabilities. This includes manual and power driven dispensers. Mix and dispense units mix two or more items at a determined ratio and then dispense. Meter, mix and dispense units meter, mix and dispense items with a determined mix ratio and shot size. Hot melt dispense units melt a media from a solid form and dispense as a liquid. One example is a hot glue gun.

It can be classified on the basis of its mounting as follows:

1. Container mounted,
2. Hand held,
3. Machine-mounted,
4. Robotic,
5. Rotary.

Container mounted dispensers are mounted on the container from which the fluid is dispensed. Hand held dispensers are hand held to manually control dispense rate and application location. Machine mounted dispensers are mounted on the machine from which the fluid is dispensed. This includes items such as wall-hung soap dispensers. Robotic dispensers are mounted on a robotic mechanism to control dispense rate and application location. Rotary units have rotating platforms from which the media can be accurately dispensed. Model features may be manual or fully adjustable in rotation-speed, circle diameter and dispensing time.

Liquid dispensing machine can be classified on the basis of its operation as follows:

1. Continuous dispensing,
2. Foot control,
3. Manual driven,
4. Power driven,
5. Programmable microprocessor,

The dispenser can be capable of continuously supplying a media. This is not limited by a shot size. A foot pedal can be included to control the rate and length of material flow. In a manual driven unit an operator manually powers the dispenser. Fluid dispensing equipment that is capable of multiple dispensing has features to allow it to dispense multiple fluids or same fluid from multiple nozzles.

Power driven fluid dispensers are powered by an auxiliary

source; typically air or electricity. A programmable microprocessor is an electrical control device that controls the operation of the dispenser. This device may control any of a number of parameters that are associated with the operation of the dispenser. This device is widely use over all other type of device in industry. With the help of microcontroller machine dispense liquid in exact desired amount.

In this we are going to present meter, mix & dispense type of machine which is mounted on container & control by microprocessor

A. Limitation of present available liquid dispensing machine.

1. Present liquid dispensing machine is having very low metering quality.
2. Designed for heavy electric power consumption so that they can be used in big industrial set up. Hence, not much useful for small town/villages where electric power is itself a big problem .
3. In some industry, multihead dispensing machine is also use like in bottle filling plant, PCB making laboratory in which idle time is high of each head which in result reduce production rate.
4. Precision & working efficiency of conventional liquid dispensing machine is less.

While constructing of the machine, the main aspects which are broadly taken care are that this machine model should be simple in design and it could be re-fabricated in small industries.

B. Aims and objective of the project.

Main aim is to present modern era Liquid dispenser machine which is meant to be operated with touch screen interfacing. Operators of the dispenser machine should be trained perfectly so that they hold the controls until required amount of liquid is dispensed instead of this hard core mechanism. We are designing touch screen based dispenser machine which is going to dispense the particular liquid to the required amount and is turn off immediately, the major advantage here is there is no need for any mandatory person to take care about the system. Touch screen provide fast access to any and all type of digital media with no text bound interface getting in the way. Owners familiar with the icon system appreciate touch screens that make system user friendly.

II. CONSTRUCTION AND WORKING OF THE SYSTEM

Model design will be simple which can be adopted to use by a small industries in a simple way. This machine will be helpful for paint industry.

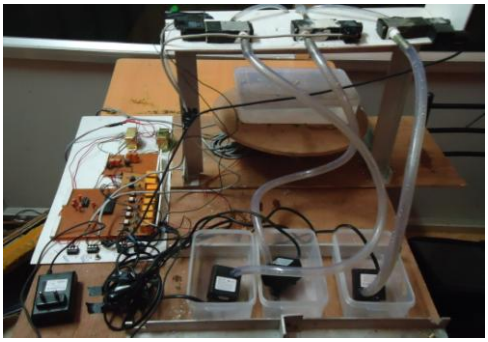


Figure 1. liquid dispensing machine

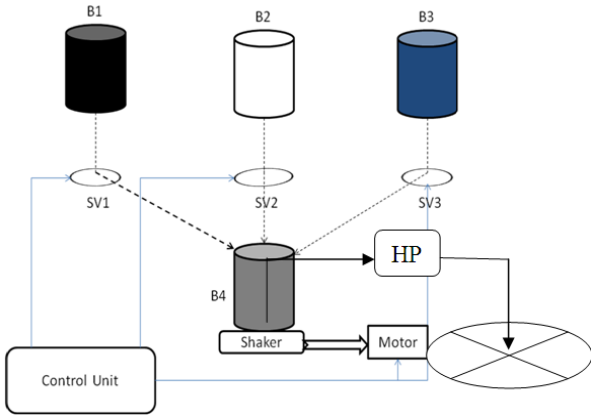


Figure2. Block diagram of liquid dispensing machine

SV - Solenoid valve, B - Beaker
HP - Hydraulic pump. AP - Aquarium pump.

A. Mechanical components

Liquid dispensing machine consist of following mechanical components:

1. Solenoid valve.
2. Gear motor.
3. Hydraulic pump.
4. Aquarium pump.

Figure3.solenoid valve

A solenoid valve

is an electromechanically operated valve. This valve is controlled by an electric current through a solenoid. Solenoid valves are the most frequently used control elements in fluids. Their tasks are to shut off, release, dose, distribute or mix fluids. They are found in many application areas. Solenoids offer fast and safe switching, high reliability, long service life, good medium compatibility of the materials used, low control power and compact design. In this machine metering is done by operating three solenoid valve with the help of touch screen interfacing.

Figure4.Gear motor

A gear motor is a type of electrical motor. Like all electrical motors, it uses the magnetism induced by an electrical current to rotate a rotor that is connected to a shaft. The energy transferred from the rotor to the shaft is then used to power a connected device. In a gear motor, the energy output is used to turn a series of gears in an integrated gear train.In liquid dispensing machine we have use one gear motor to rotate a disc of 220gm. Which help to mix different fluids properly

Figure5.Hydraulic pump

This product can be used in many fields, such as computer cooling system, Garden fountain, Aquarium, car cooling system, humidifier, air conditioner, and many other cooling and circulation systems. In this liquid dispensing machine we have used one hydraulic pump to transfer fluid from beaker 4 to desired location. In this liquid dispensing machine we have used one hydraulic pump to transfer fluid from beaker 4 to desired location.

Figure6.Aquarium pump

Aquarium Pump is truly universal in application, built for silent, energy efficient continuous circulation of fluid. It can be installed safely submerged in fresh or saltwater. With compact design and a solid weight of 1.58kg, it provides more effective and durable operation than those cheaply-made ones do. Its have magnetic drive technology. It is totally submersible and oil-free motor. In this liquid dispensing machine we have used three aquarium pump.

B. Electronic components.

Liquid dispensing machine consist of following electronic components:

1. MAX 232 IC.
2. Microcontroller AT89C52.
3. Relays.
4. Printed circuit board (PCB).

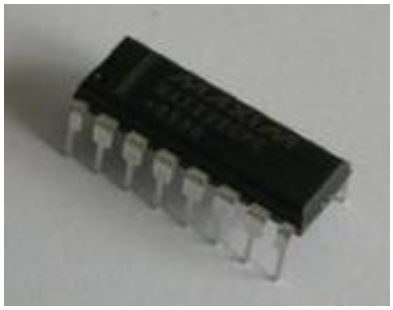


Figure6.MAX 232 IC

The maximum RS-232 signal levels are far too high for computer logic electronics, and the negative RS-232 voltage for high can't be handle at all by computer logic. Therefore, to receive serial data from an RS-232 interface the voltage has to be reduced, and the low and high voltage level inverted. In the other direction (sending data from some logic over RS-232) the low logic voltage has to be "bumped up", and a negative voltage has to be generated, too.

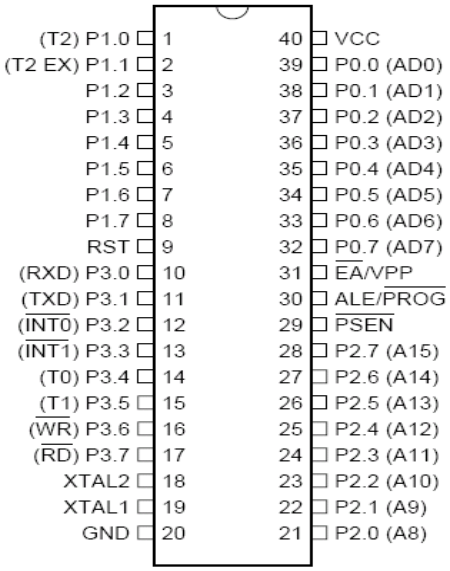


Figure7. Microcontroller AT89C52

The AT89C52 is a low-power, high-performance CMOS 8-bit microcomputer with 8K bytes of Flash programmable and erasable read only memory (PEROM). The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard 80C51 and 80C52 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer.

By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C52 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications.

Figure8. Relays.

Transistors cannot switch AC or high voltages (such as mains electricity) and they are not usually a good choice for switching large currents (> 5A). In these cases a relay will be needed, but note that a low power transistor may still be needed to switch the current for the relay's coil!

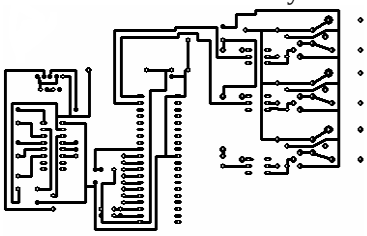


Figure9. Printed circuit board (PCB).

PCB are compact, professional looking, easy to troubleshoot and repair am, easy to duplicate. Artwork can easily make multiple copies of each board PCB's are neat and durable

C. Working of the system and measurement of process variables:

1) Velocity of fluid flow:

The velocity of fluid flow in a pipe is as follows:

$V = L / T$

L (distance) - the distance of the fluid flow is expressed by meter or cm

T (time) -the time is expressed by hour or second

In liquid dispensing machine, liquid cover 30 cm distance in 4.49 sec then with the help of above relation velocity of fluid flow is 0.06 m/sec.

2) Discharge or Flow rate of fluid:

The fluid flow rate in a pipe is as follows:

$Q = A \times V$

Q - fluid flow rate (m3/h or cm3/sec).

A - Cross section area of a pipe (m2 or cm2).

V - Water flow velocity (m/h or cm/sec).

In liquid dispensing machine, 1 liter bottle is fill in 1.49 minute then with the help of above relation flow rate of fluid is 0.00001185 m3/sec.

3) Pressure Head:

Water pressure can also be defined in meters rather than atmosphere or psi as follows:

$H = P / \gamma$

H = pressure head (meters)

P = Pressure of atmosphere

γ = specific weight (kg/cm)

In the case of liquid dispensing machine, in room atmosphere is 1 and for water γ is 0.001 kg/cm3, then with the help of above relation pressure head is 10 m.

Energy in pipe flow is expressed as head and is defined by the Bernoulli equation. Hydraulic head or piezometric head is a specific measurement of liquid pressure above a geodetic datumIt is usually measured as a liquid surface elevation, expressed in units of length, at the entrance (or bottom) of a piezometer. In an aquifer, it can be calculated from the depth to water in a piezometric well (a specialized water well), and given information of the piezometer's elevation and screen depth. Hydraulic head can similarly be measured in a column of water using a standpipe piezometer by measuring the height of the water surface in the tube relative to a common datum. The hydraulic head can be used to determine a hydraulic gradient between two or more points.

Head loss:

In any real moving fluid, energy is dissipated due to friction; turbulence dissipates even more energy for high Reynolds number flows. Head loss is divided into two main categories:

- major losses
- minor losses

"major losses" associated with energy loss per length of pipe, and "minor losses" associated with bends, fittings, valves, etc. Older, more empirical approaches are the Hazen-Williams equation and the Prony equation. or relatively short pipe systems, with a relatively large number of bends and fittings, minor losses can easily exceed major losses. In design, minor losses are usually estimated from tables using coefficients or a simpler and less accurate reduction of minor losses to equivalent length of pipe.

4. Viscosity:

Tangential or shearing forces always develop where there is motion relative to solid body Thus, fluid friction is created Shear forces oppose motion of one particle past another Friction forces gives rise to a fluid property called viscosity. a fluid with no friction is known as Ideal fluid.

Viscosity of fluid decreases as temperature increases.

viscocity is also known as dynamic viscocity.

Ratio of absolute viscosity to density is known as kinematic viscosity.

poise (P):-Metric unit of viscosity.

stoke (St)-Metric unit of kinematics viscosity.

μ - coefficient of viscosity.

5. Density:

The mass density or density of a material is defined as its mass per unit volume. Less dense fluids float on more dense fluids if they do not mix. This concept can be extended, with some care, to less dense solids floating on more dense fluids. If the average density (including any air below the waterline) of

an object is less than water it will float in water and if it is more than water's it will sink in water.

6. Compressible and incompressible flow:

All fluids are compressible to some extent, that is, changes in pressure or temperature will result in changes in density. However, in many situations the changes in pressure and temperature are sufficiently small that the changes in density are negligible. In this case the flow can be modeled as an incompressible flow.

7. Pipe flow:

A branch of Hydraulics and Fluid Mechanics, is a type of liquid flow within a closed conduit (conduit in the sense of a means of containment). The other type of flow within a conduit is open channel flow. These two types of flow are similar in many ways, but differ in one important respect. Pipe flow does not have a free surface which is found in open-channel flow. Pipe flow, being confined within closed conduit, does not exert direct atmospheric pressure, but does exert hydraulic pressure on the conduit.

States of Flow:

The behavior of pipe flow is governed mainly by the effects of viscosity and gravity relative to the inertial forces of the flow. Depending on the effect of viscosity relative to inertia, as represented by the Reynolds number, the flow can be either laminar or turbulent. At a Reynolds number below the critical value of approximately 2040 pipe flow will ultimately be laminar, whereas above the critical value turbulent flow can persist. In addition, the transition between laminar flow and turbulence can be sensitive to disturbance levels and imperfections.

Laminar flow:

It also known as streamline flow, occurs when a fluid flows in parallel layers, with no disruption between the layers At low velocities the fluid tends to flow without lateral mixing, and adjacent layers slide past one another .

Turbulent flow:

It is the opposite of Laminar flow which occurs at higher velocities where eddies or small packets of fluid particles form leading to lateral mixing.] In nonscientific terms laminar flow is "smooth", while turbulent flow is "rough." In practice turbulent flow occur more as compare to laminar flow in all machines.

8. Hydraulic circuit:

It is a system comprising an interconnected set of discrete components that transport liquid. The purpose of this system may be to control where fluid flows or to control fluid pressure. hydraulic circuit theory works best when the elements (passive component such as pipes or transmission lines or active components such as power packs or pumps) are discrete and linear. This usually means that hydraulic circuit analysis works best for long, thin tubes with discrete pumps,

A flow-control valve meters flow in one direction only, the inlet and outlet ports must be correctly connected in a circuit in relation to the flow direction to be metered. A valve's drain connection must be piped to a tank so that a connection will not be subjected to possible pressure surges. The location of a flow-control valve with respect to workload has an affect on a circuit's operating characteristics. The three basic types of flow-control-valve installations are the meter-in & meter-out.

Meter-In Circuit:

A flow-control valve is installed in a pressure line that leads to a work cylinder. All flow entering a work cylinder is metered through a flow-control valve. Since this metering action involves reducing flow from a pump to a work cylinder, a pump must deliver more fluid than is required to actuate a cylinder at the desired speed. Excess fluid returns to a tank through a relief valve. To conserve power and avoid undue stress on a pump, a relief valve's setting should be only slightly higher than a working pressure's.

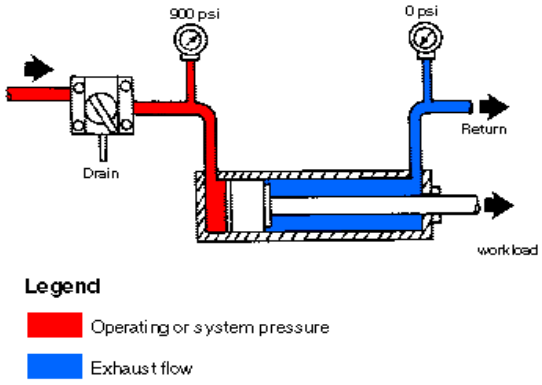


Fig 10.Meter in circuit

A meter-in circuit is ideal in applications where a load always offers a positive resistance to flow during a controlled stroke. Examples would be feeding grinder tables, welding machines, milling machines, and rotary hydraulic motor drives. A flow-control-and-check valve used in this type of circuit would allow reverse free flow for the return stroke of a cylinder, but it would not provide control of return stroke speed.

Meter-Out Circuit:

A flow-control valve is installed on the return side of a cylinder so that it controls a cylinder's actuation by metering its discharge flow. A relief valve is set slightly above the operating pressure that is required by the type of work.

This type of circuit is ideal for overhauling load applications in which a workload tends to pull an operating piston faster than a pump's delivery would warrant. Examples would be for drilling, reaming, boring, turning, threading, tapping, cutting off, and cold sawing machines. A flow-control-and-check valve used in this circuit would allow reverse free flow, but it would not provide a control of return stroke speed.

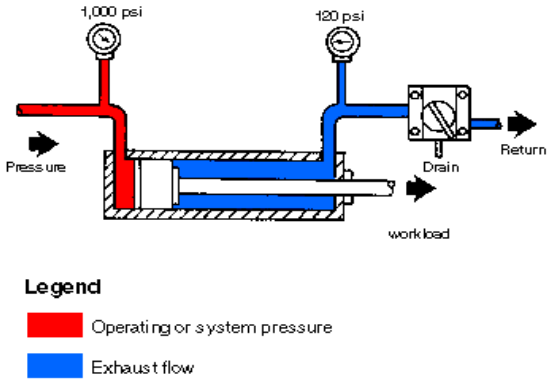


Fig 11. Meter-out circuit

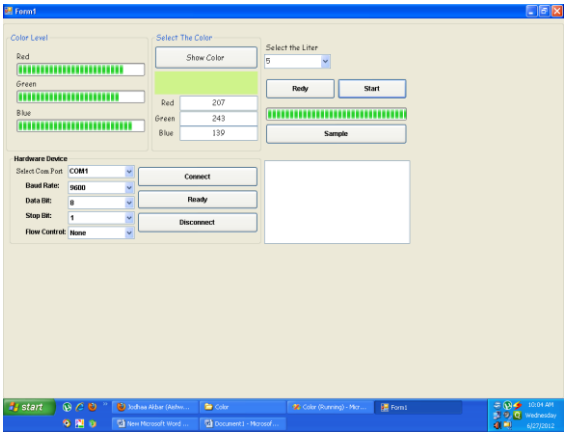
9. Valve:

A valve is a device that regulates, directs or controls the flow of a fluid (gases, liquids, fluidized solids, or slurries) by opening, closing, or partially obstructing various passageways. Valves are technically pipe fittings, but are usually discussed as a separate category. In an open valve, fluid flows in a direction from higher pressure to lower pressure.The main parts of the most usual type of valve are the body and the bonnet. These two parts form the casing that holds the fluid going through the valve.

Valve positions are operating conditions determined by the position of the disc or rotor in the valve. Some valves are made to be operated in a gradual change between two or more positions. Return valves and non-return valves allow fluid to move in 2 or 1 directions respectively.

10. Software:

Visual Basic .NET software is use to make command window and which help to operate liquid dispensing machine. It is an object-oriented computer language that can be viewed as an evolution of Microsoft's Visual Basic (VB) implemented on the Microsoft .NET framework Visual Basic .NET comes with features such as a powerful new forms designer, an in-place menu editor, and automatic control anchoring and docking. Visual Basic .NET delivers new productivity features for building more robust applications easily and quickly. With an improved integrated development environment (IDE) and a significantly reduced startup time, Visual Basic .NET offers fast, automatic formatting of code as you type, improved IntelliSense, an enhanced object browser and XML designer, and much more. Following command windows are made with the help of VB.net software.



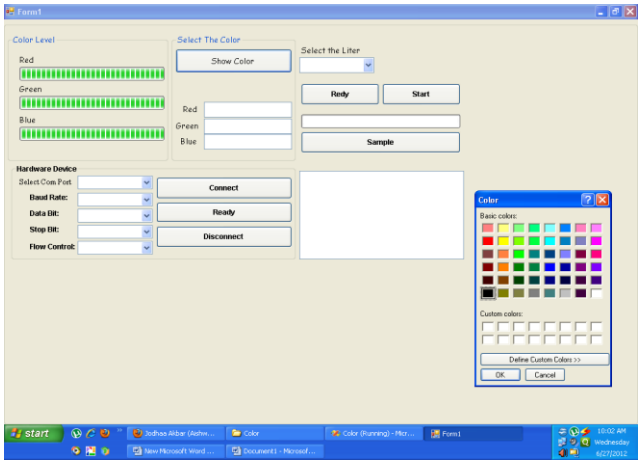


Figure 12. Command window

Visual Basic .NET (VB.NET) program for above command window is as follows:-

```
Public Class Form1
    Dim WithEvents HDCom As New IO.Ports.SerialPort
    Dim R_Out As String = "A"
    Dim G_Out As String = "B"
    Dim B_Out As String = "C"
    Dim Mix_Out As String = "D"
    Dim Sample As String = "E"
 Private Sub Button1_Click(ByVal sender As System.Object,
ByVal e As System.EventArgs) Handles Button1.Click
        CD.ShowDialog()
        Try
            SC.BackColor = CD.Color
            txt_R.Text = CD.Color.R
            txt_B.Text = CD.Color.B
            txt_G.Text = CD.Color.G
Catch ex As Exception
            MsgBox(ex.Message.ToString,
MsgBoxStyle.Critical, "Error")
        End Try
End Sub
Private Sub Form1_Load(ByVal sender As System.Object,
ByVal e As System.EventArgs) Handles MyBase.Load
        For i As Integer = 0 To
My.Computer.Ports.SerialPortNames.Count - 1

HCom.Items.Add(My.Computer.Ports.SerialPortNames(i).T
oString)
        Next
    End Sub
Private Sub Button14_Click(ByVal sender As
System.Object, ByVal e As System.EventArgs) Handles
Button14.Click
        Try
            With HDCom
                .BaudRate = 9600
                .DataBits = 8
                .PortName = HCom.Text
                .StopBits = IO.Ports.StopBits.One
            End With
            HDCom.Open()
Catch ex As Exception
```

```
MsgBox(ex.Message.ToString, MsgBoxStyle.Critical, "Err")
        End Try
    End Sub

Private Sub Button3_Click(ByVal sender As System.Object,
ByVal e As System.EventArgs) Handles Button3.Click
        L()
    End Sub

Public Sub L()
        My.Application.DoEvents()
        For i As Integer = 0 To (Val(txt_R.Text) * 10)
            HDCom.Write(R_Out)
        Next
        HDCom.Write(LCase(R_Out))
        R_.Value = R_.Value - CInt(Val(txt_R.Text) / 10)
        Progrss.Value = 25
        My.Application.DoEvents()
        For i As Integer = 0 To (Val(txt_G.Text) * 10)
            HDCom.Write(G_Out)
        Next

        For i As Integer = 0 To (Val(txt_B.Text) * 10)
            HDCom.Write(B_Out)
        Next
        HDCom.Write(LCase(B_Out))
        B_.Value = B_.Value - CInt(Val(txt_B.Text) / 10)
       Progrss.Value = 75
        My.Application.DoEvents()
        Threading.Thread.Sleep(1000)
        HDCom.Write(Mix_Out)
        Threading.Thread.Sleep(2000)
        HDCom.Write(0)
        Progrss.Value = 100
  End Sub
Private Sub Button4_Click(ByVal sender As System.Object,
ByVal e As System.EventArgs) Handles Button4.Click
        HDCom.Write(Sample)
        Threading.Thread.Sleep(2000)
        HDCom.Write(0)
    End Sub
End Class
```

III. CONCLUSIONS

Liquid dispensing machine is common device in our day to day life. It is also use in large number of industries for various purposes. As it is use widely In each & every field so it is need of time to design machine having high precision. Following are some important points observe during the design & fabrication of machine.

- Metering is main parameter of any dispensing machine. For this purpose it is good to use device of high quality like solenoid valve, programmable syringe etc. In some industries like paint industries, bottle filling plant etc it is important to dispense liquid in some predefine quantity. This is main requirement of any dispenser & hence precise metering device is required in dispensing machine.
- In some industry, multihead dispensing machine is also use like in bottle filling plant, PCB making laboratory over conventional dispensing machine .In this case it is important to design machine according to requirement so that idle time of each head must be low.
- Automatic dispensing machine is widely use over manual operating dispensing machine. This automatic machine is operated with the help of well defined programmed microcontroller. Microcontroller AT89C52 is use for this purpose on large scale. Programming of this microcontroller is done with the help VB.net or with the help of metlab language .With the help of microcontroller precision & working efficiency of machine increases.
- Screen operated dispensing machine is also use in large scale. This machine reduces human error thus increase operator accuracy. Operator familiar with the icon system appreciate touch screens that make automation system user friendly. Touch screen provide fast access to machine as compare to conventional machine hence production time is also reduce.

There is large scope for the improvement of liquid dispensing machine in future. By considering properties of fluid like viscosity, kinematics viscosity ,density, fluid flow in pipe, fluid head, major losses and minor losses in pipe leakage of liquid can be reduce which will help to make machine more efficient. The future work on these issues can improve the application performance of system in critical working environments and complex backgrounds. This will perform a vital role in minimizing human efforts in handling system.

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