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An Automatic Internet-Oriented Measurement System By Qt

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Abstract-For all new applications automation proves to play a very vital role. On that note, this project is put forth to implement measurement automation, which can be achieved by monitoring various parameters and a controlled environment fora specific application. Here the system provides not only controls but also self-analyzed data, performance monitoring and machine observation by the use of Qt which makes it unique than other systems, resulting in the increase of productivity and efficiency of the system. Apart from the normal lists of parameters we can also obtain some of additional data like temperature, light intensity, vibration of system.

Keywords-Automation, Qt, IoT.

1 INTRODUCTION

The fast-paced world today has paved way to the concept of automation which relieves humans from monotonic work pattern which can be mechanised. The advent of automation has a huge impact in the community when it comes to the fast commencement of work and reduction of errors when compared to the manually maintained systems.

Automation covers applications ranging from a household thermostat controlling a boiler, to a large industrial control system with tens of thousands of input measurements and output control signals. In control complexity, it can range from simple on-off control to multi-variable high-level algorithms. Automation has been achieved by various means including mechanical, hydraulic, pneumatic, electrical, electronic devices, and computers, usually in combination. Complicated systems, such as modern factories, airplanes, and ships typically use all these combined techniques. The benefit of automation includes labour savings, reducing waste, savings in electricity costs, savings in material costs, and improvements to quality, accuracy, and precision.

Industrial automation is the use of control systems, such as computers or robots, and information technologies for handling different processes and machineries in an industry to

replace a human being. It is the second step beyond mechanization in the scope of industrialization. Industrial automation has recently found more and more acceptance from various industries because of its huge benefits, such as, increased productivity, quality and safety at low costs.

Thus, achieving proper control over several operations in an industrial environment requires large number of sensors, transducers and controllers. The proposed model introduces a system where the data from multiplesensors can be viewed and controlled from a common dashboard put together using Qt software. This model simplifies the view of complex setups and provides easyto understand visualization for the user to control.

The values in the system can be kept in track from a remote location and controlled. The values can be viewed in a graphical format so the performance of the various sub units can be kept in check.

2 SYSTEM ARCHITECTURE

The model of system proposed uses a software which visualises the readings such as the readings of voltmeter, ammeter, temperature, etc in the place ofwork, the data received can be used to control and maintain the industrial environment. If any abnormal case is sensed it also raises a command so we can diagnose the issue from where it raised and solve it effectively in short duration.

AC voltage is given to lighting system and SMPS which converts the AC voltage to DC voltage to supply power to rest of the systems. Voltage and current sensors are connected parallel and series to the source respectively and transmits data to the microcontroller

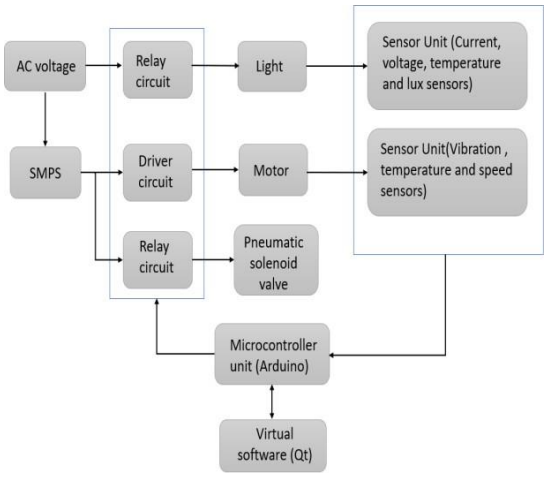

Fig 1. System architecture

Lux, temperature, speed and vibration sensors are connected in the load side to monitor and transmits the respective data to the microcontroller. The data accumulated by the microcontroller is sent to the Qt software which acts as a GUI and provides visualization. The changes made in the GUI is fed back to the microcontroller which in turn sends the signal back to the respective control units.

3 SENSOR ACQUISITION SYSTEM

A microcontroller (MCU for microcontroller unit) is a small computer on a single metal-oxide-semiconductor (MOS) integrated circuit chip. In modern terminology, it is similar to, but less sophisticated than, a system on a chip (SoC); a SoC may include a microcontroller as one of its components. A microcontroller contains one or more CPUs (processor cores) along with memory and programmable input/output peripherals. Program memory in the form of ferroelectric RAM, NOR flash or OTP ROM is also often included on chip, as well as a small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general-purpose applications consisting of various discrete chips. Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non- digital electronic systems. In the modern-day concept of automation, the microcontroller based embedded systems are used to collect and provide information for the implementation of controlled environment.

Arduino UNO (ATmega 328P)

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output) six analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts.

It is also similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

The word "Uno" means "one" in Italian and was chosen to mark the initial release of Arduino Software. The Uno board is the first in a series of USB-based Arduino boards; it and version 1.0 of the Arduino IDE were the reference versions of Arduino, which have now evolved to newer releases.

The ATmega328 on the board comes preprogramed with a bootloader that allows uploading new code to it without the use of an external hardware programmer.

Current sensor (ACS712)

ACS712 Current Sensor uses Indirect Sensing method to calculate the current. To sense current a liner, low- offset Hall sensor circuit is used in this IC. This sensor is located at the surface of the IC on a copper conduction path. When current flows through this copper conduction path it generates a magnetic field, which is sensed by the Hall effect sensor. A voltage proportional to the sensed magnetic field is generated by the Hall sensor, which is used to measure current.

The proximity of the magnetic signal to the Hall sensor decides the accuracy of the device. Nearer the magnetic signal higher the accuracy. ACS712 Current Sensor is available as a small, surface mount SOIC8 package. In this IC current flows from Pin-1 and Pin-2 to Pin-3 and Pin-4. This forms the conduction path where the current is sensed. Implementation of this IC is very easy. ACS712 can be used in applications requiring electrical isolation as the terminals of the conduction path are electrically isolated from the IC leads. Thus, this IC doesn't require any other isolation techniques.

This IC requires a supply voltage of 5V. Its output voltage is proportional to AC or DC current. ACS712 has a nearly zero magnetic hysteresis. Where Pin-1 to Pin-4 forms the conduction path, Pin-5 is the signal ground pin. Pin-6 is the FILTER pin that is used by an external capacitor to set the bandwidth. Pin-7 is theanalog output pin. Pin-8 is the power supply pin.

Temperature sensor (DHT11)

The DHT11 is a commonly used Temperature and humidity sensor. The sensor comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. The sensor is also factory calibrated and hence easy to interface with other microcontrollers.

The sensor can measure temperature from 0°C to 50°C and humidity from 20% to 90% with an accuracy of ±1°C and ±1%. The DHT11 detects water vapor by measuring the electrical resistance between two electrodes. The humidity sensing component is a moisture holding substrate with electrodes applied to the surface. When water vapor is absorbed by the substrate, ions are released by the substrate which increases the conductivity between the electrodes.

The change in resistance between the two electrodes is proportional to the relative humidity. Higher relative humidity decreases the resistance between the electrodes, while lower relative humidity increases the resistance between the electrodes. The DHT11 measures temperature with a surface mounted NTC temperature sensor (thermistor) built into the unit.

Vibration sensor (SW420)

The vibration sensor module based on the vibration sensor SW-420 and Comparator LM393 is used to detect vibrations. The threshold can adjust using an on-board potentiometer. During no vibration, the sensor provides Logic Low and when the vibration is detected, the sensor provides Logic High.

This Vibration Sensor Module consists of an SW-
420 Vibration Sensor, resistors, capacitor, potentiometer, comparator LM393 IC, Power, and status LED in an integrated circuit. It is useful for a variety of shocks triggering, theft alarm, smart car, an earthquake alarm, motorcycle alarm, etc.

LM393 Comparator IC is used as a voltage comparator in this vibration sensor module. Pin 2 of LM393 is connected to Preset (10KΩ Pot) while pin 3 is connected to vibration sensor. The comparator IC will compare the threshold voltage set using the preset (pin2) and the Vibration Sensor pin (pin3). Using the onboard preset, the threshold (sensitivity) of the digital output can be adjusted. Vibration switch recognizes the amplitude of the vibration to which it is exposed. The switch response can be electrical contact closure or contact opening. The electrical contact may be either an electromechanicalrelay or a solid-state device.

Magnetic hall effect sensor (KY-024)

The sensor has 3 main components on its circuit board. First, the sensor unit at the front of the module which measures the area physically and sends an analog signal to the second unit, the amplifier. The amplifier amplifies the signal, according to the resistant value of the potentiometer, and sends the signal to the analog output of the module. The third component is a comparator which switches the digital out and the LED if the signal falls under a specific value.

This sensor doesn't show absolute values (like exact temperature in °C or magnetic field strength in mT). It isa relative measurement: you define an extreme value to a given normal environment situation and a signal will be send if the measurement exceeds the extreme value.

LDR sensor

The Light Dependent Resistor (LDR) is made from a piece of exposed semiconductor material such as cadmium sulphide that changes its electrical resistance from several thousand Ohms in the dark to only a few hundred Ohms when light falls upon it by creating hole- electron pairs in the material.The net effect is an improvement in its conductivity with a decrease in resistance for an increase in illumination. Also, photoresistive cells have a long response time requiring many seconds to respond to a change in the light intensity.

Materials used as the semiconductor substrate include, lead sulphide (PbS), lead selenide (PbSe), indium antimonide (InSb) which detect light in the infra-red range with the most commonly used of all photoresistive light sensors being Cadmium Sulphide (CdS).

A photoresistor or LDR (Light Dependent Resistor), as the name suggests will change it resistance based on the light around it. That is when the resistor is placed in a dark room it will have a resistance of few Mega ohms and as we gradually impose light over the sensor its resistancewill start to decrease from Mega Ohms to few Ohms.

The most commonly used photo resistive light sensor is the ORP12 Cadmium Sulphide photoconductive cell. This light dependent resistor has a spectral response of about 610nm in the yellow to orange region of light. The resistance of the cell when unilluminated (dark resistance) is very high at about 10MΩ's which falls to about 100Ω's when fully illuminated (lit resistance).

To increase the dark resistance and therefore reduce the dark current, the resistive path forms a zigzag pattern across the ceramic substrate. The CdS photocell is a very low-cost device often used in auto dimming, darkness or twilight detection for turning the street lights "ON" and "OFF", and for photographic exposure meter type applications.

4 HARDWARE DEVICES

Electric DC motor (MY1016)

A brushed DC electric motor is an internally commutated electric motor designed to be run from a direct current power source. Brushed DC motors can be varied in speed by changing the operating voltage or the strength of the magnetic field.

PMDC motor is just similar to the general working principle of DC motor. That is when a carrying conductor comes inside a magnetic field, a mechanical force will be experienced by the conductor and the direction of this force is governed by Fleming's left hand rule.

As in a permanent magnet DC motor, the armature is placed inside the magnetic field of a permanent magnet; the armature rotates in the direction of the generated force. Here each conductor of the armature experiences the mechanical force F = B.I.L Newton where, B is the magnetic field strength in Tesla (weber / m2), I is the current in Ampere flowing through that conductor and L is the length ofthe conductor in meter comes under the magnetic field.

Each conductor of the armature experiences a force and the compilation of those forces produces a torque, which tends to rotate the armature.

Motor driver (BTS7960)

The BTS7960 provides a cost optimized solution for protected high current PWM motor drives with very low board space consumption.The BTS7960 is a fully integrated high current H bridge module for motor drive applications. Interfacing to a microcontroller is made easy by the integrated driverIC which features logic level inputs, diagnosis with current sense, slew rate adjustment, dead time generation and protection against overtemperature, overvoltage, undervoltage, overcurrent and short circuit.

Solenoid valve (PU520)

A solenoid valve is an electrically controlled valve. The valve features a solenoid, which is an electric coil with a movable ferromagnetic core (plunger) in its centre. In the rest position, the plunger closes off a small orifice. An electric current through the coil creates a magnetic field. The magnetic field exerts an upwards force on the plunger opening the orifice. This is the basic principle that is used to open and close solenoid valves. Solenoid valves are used in a wide range of applications, with high or low pressures and small or large flow rates. These solenoid valves use different operating principles that are optimal for the application. The three most important ones are explained in this article: direct acting, indirect acting, and semi-direct acting operation.

SMPS-24V

A switched-mode power supply (switching-mode power supply, switch-mode power supply, switched power supply, SMPS, or switcher) is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently. Like other power supplies, an SMPS transfers power from a DC or AC source (often mains power, see AC adapter) to DC loads, such as a personal computer, while converting voltage and current characteristics. Unlike a linear power supply, the pass transistor of a switching-mode supply continually switches between low-dissipation, full-on and full-off states, and spends very little time in the high dissipation transitions, which minimizes wasted energy. A hypothetical ideal switched-mode power supply dissipates no power. Voltage regulation is achieved by varying the ratio of on-to-off time (also known as duty cycles). In contrast, a linear power supply regulates the output voltage by continually dissipating power in the pass transistor. This higher power conversion efficiency is an important advantage of a switched-mode power supply. Switched-mode power supplies may also be substantially smaller and lighter than a linear supply due to the smaller transformer size and weight.

Switching regulators are used as replacements for linear regulators when higher efficiency, smaller size or lighter weight are required.

Buck converter

A buck converter (step-down converter) is a DC-to-DC power converter which steps down voltage (while drawing less average current) from its input (supply) to its output (load). It is a class of switched-mode power supply (SMPS) typically containing at least two semiconductors (a diode and a transistor, although modern buck converters frequently replace the diode with a second transistor used for synchronous rectification) and at least one energy storage element, a capacitor, inductor, or the two in combination. To reduce voltage ripple, filters made of capacitors (sometimes in combination with inductors) are normally added to such a converter's output (load-side filter) and input (supply-side filter).

Switching converters (such as buck converters) provide much greater power efficiency as DC-to-DC converters than linear regulators, which are simpler circuits that lower voltages by dissipating power as heat, but do not step up output current.

Buck converters can be highly efficient (often higher than 90%), making them useful for tasks such as converting a computer's main (bulk) supply voltage (often 12 V) down to lower voltages needed by USB, DRAM and the CPU (1.8 V or less).

Solid state relay

A solid state relay (SSR) is an electronic switching device that switches on or off when an external voltage (AC or DC) is applied across its control terminals. It serves the same function as an electromechanical relay, but has no moving parts and therefore results in a longer operational lifetime. SSRs consist of a sensor which responds to an appropriate input (control signal), a solid-state electronic switching device which switches power to the load circuitry, and a coupling mechanism to enable the control signal to activate this switch without mechanical parts. The relay may be designed to switch either AC or DC loads.

Packaged solid-state relays use power semiconductor devices such as thyristors and transistors, to switch currents up to around a hundred amperes. Solid-state relays have fast switching speeds compared with electromechanical relays, and have no physical contacts to wear out. Users of solid-state relays must take into consideration an SSR's inability to withstand a large momentary overload the way an electromechanical relay can, as well as their higher "on" resistance.

An SSR based on a single MOSFET, or multiple MOSFETs in a paralleled array, can work well for DC loads. MOSFETs have an inherent substrate diode that conducts in the reverse direction, so a single MOSFET cannot block current in both directions. For AC (bi- directional) operation two MOSFETs are arranged back-to-back with their source pins tied together. Their drain pins are connected to either side of the output. The substrate diodes are alternately reverse biased to block current when the relay is off.

When the relay is on, the common source is always riding on the instantaneous signal level and bothgates are biased positive relative to the source by thephoto-diode.

4 – Channel relay

The four-channel relay module contains four 5V relays and the associated switching and isolating components, which makes interfacing with a microcontroller or sensor easy with minimum components and connections. The contacts on each relay are specified for 250VAC and 30VDC and 10A in each case, as marked on the body of the relays.

The four-channel relay module contains four 5V relays and the associated switching and isolating components, which makes interfacing with a microcontroller or sensor easy with minimum components and connections. There are two terminalblocks with six terminals each, and each block is shared by two relays. The terminals are screw type, which makes connections to mains wiring easy and changeable.

The four relays on the module are rated for 5V, which means the relay is activated when there is approximately 5V across the coil. The contacts on each relay are specified for 250VAC and 30VDC and 10A in each case, as marked on the body of the relays.The switching transistors act as a buffer between the relay coils that require high currents, and the inputs which don't draw much current. They amplify the input signal so that they can drive the coils to activate the relays.

5SOFTWARE

Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributionshave added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike. Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming.

As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs. The software, too, is open- source, and it is growing through the contributions of users worldwide.

Arduino IDE

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs
to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards.

It is a text editor like a notepad with different features. Itis used for writing code, compiling the code to check if any errors are there and uploading the code to the Arduino. It is a cross-platform software which is available for every Operating System like Windows, Linux, macOS.

It is open-source software, where the user can use the software as they want it to. They can also make their own modules/functions and add them to the software

It supports every available Arduino board including Arduino mega, Arduino Leonardo, Arduino Ethernet and more. Word file is called a Document similarly, Arduino file is called a Sketch where the user writes code. The format of Arduino is saved as .ino.

When a user writes code and compiles, the IDE will generate a Hex file for the code. (Hex file are Hexa Decimal files which are understood by Arduino) and then sent to the board using a USB cable. Every Arduino board is integrated with a microcontroller, the microcontroller will receive the hex file and runs as per the code written.

Qt software

Qt is a graphical user interface, a cloud-based storage system that can run on Windows, macOS, Linux, Android, etc. It's based-on C++ programming language.It can be used for developing a realistic visualization ofall components and their readings.Implementation of hardware can be done with any type of controller, Qt software and a range of sensors and transducers. Qt software reads current, voltage, temperature, rpm and various other parameters without need for human intervention using a wireless network and stores it in cloud. This design can be used in leather factory for creating suitable environment, a large production unit with n number of control panel for easier data sharing and many more applications.

Qt Creator is a cross-platform integrated development environment (IDE) built for the maximum developer experience. Qt Creator runs on Windows, Linux, and macOS desktop operating systems, and allows developers to create applications across desktop, mobile, and embedded platforms**.** Qt Creator includes a code editor and integrates Qt Designer for designing and building graphical user interfaces (GUIs) from Qt widgets.

The code editor in Qt Creator supports syntax highlighting for various languages. In addition to that, the code editor can parse code in C++ and QML languages and as a result code completion, context-sensitive help, semantic navigation are provided.

Qt Designer is a tool for designing and building graphical user interfaces (GUIs) from Qt widgets. It is possible to compose and customize the widgets or dialogs and test them using different styles and resolutions directly in the editor. Widgets and forms created with Qt Designer are integrated with programmed code, using the Qt signals and slots mechanism.

Qt Quick Designer is a tool for developing animations by using a declarative programming language QML. Qt Creator provides support for building and running Qt applications for desktop environments (Windows, Linux, FreeBSD and Mac OS), mobile devices (Android, BlackBerry, iOS, Maemo,and MeeGo) and embedded Linux devices. Build settings allow the user to switch between build targets, different Qt versions and build configurations. For mobile device targets, Qt Creator can generate an installation package, install it to a mobile device that isattached to the development computer and run it there.

6 HARDWARE RESULTS

Hardware kit

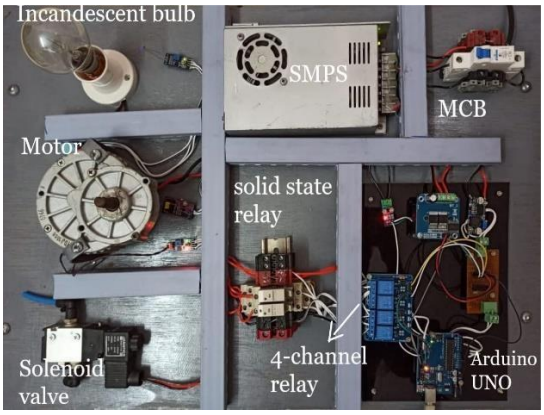

Fig 2. Hardware kit

The results from the sensors connected in various units are sent to the Qt software via the microcontroller (Arduino). This provides a setup where the user can view the values from the software end. The units in the system can be controlled directly from the Qt dashboard.

Qt software results

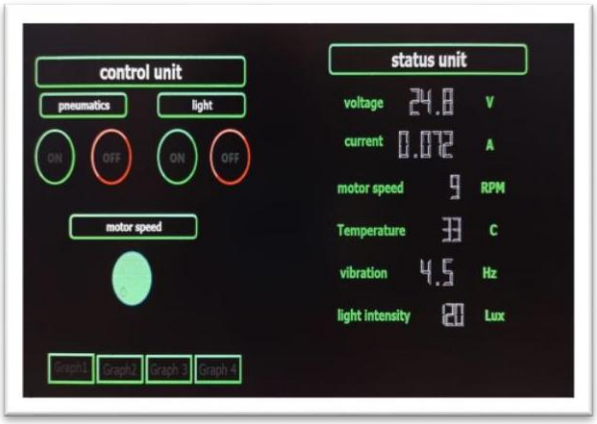

Fig 3. Qt software results

The values of the sensed parameters like voltage, current, motor speed, temperature, vibration and light intensity are displayed in the status unit of the software screen. The control unit provides the user the options to control various parameters involved like motor speed, ON/OFF of light and pneumatic valve.

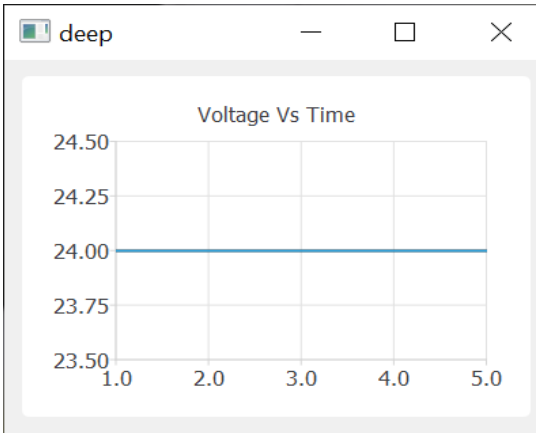

Fig 4.Voltage vs Time Graph

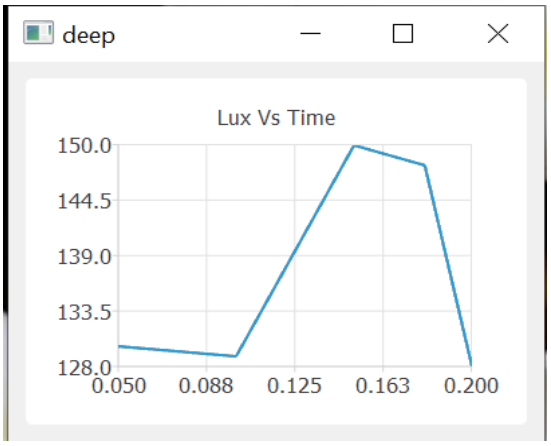

Fig 5.Lux vs Time Graph

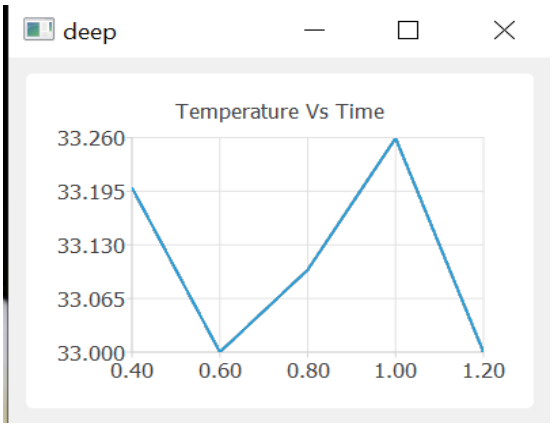

Fig 6. Temperature vs Time Graph

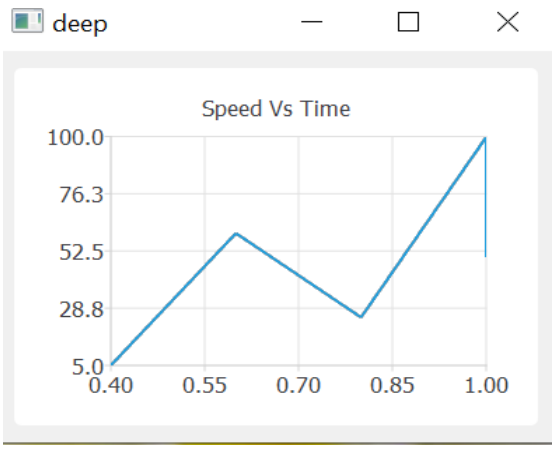

Fig 7. Speed vs Time Graph

The provision to view the graphs between parameters and time based on the values recorded is also covered in this unit.

7 CONCLUSIONS

Thus, the proposed model keeps track of various parameters in a system and performance of various sub units involved, which makes the monitoring and maintenance of that system easy. This provides additional convenience when adapted in an industrial setup where there are numerous parameters which require constant monitoring. This model has an edge as it helps provide a controlled environment by allowing the user to remotely control the components involved and to turn ON/OFF the desired units from a remote location. The system also provides warning when the values cross a particular critical point which adds to the safety of the system. Since, automation plays a vital role for the future, the proposed system will aid in maintaining controlled environment in a industrial scenario.

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