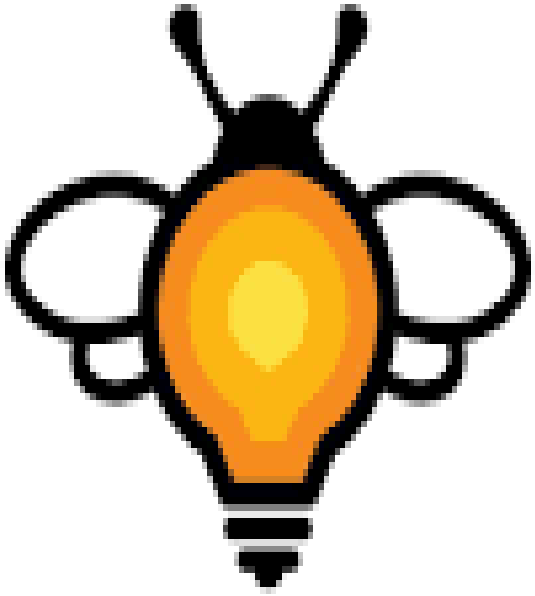

BEES Magazine

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K S R Institute for Engineering and Technology

Department of Electrical and Electronics Engineering

BEES Magazine

Together We Make Difference

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Contents

Editorial Board

Internet of Things (IoT) in Smart Grid Technology

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Introduction

Smart grids coordinate the needs and capabilities of all generators, grid operators, end-users, and electricity market stakeholders to cooperate with all parts of the system as efficiently as possible. This also helps in minimizing costs and environmental impacts while maximizing system reliability, resilience, and stability. A network of physical objects contains embedded technology to communicate and sense or interact with their internal states or the external environment.

In general, "smart city" applications are vast and include everything from smart city lighting, energy management, and intelligent traffic management to water treatment and waste management. Smart meters enable demand response that allows home and business owners to monitor real-time pricing information to adjust their energy usage accordingly. Smart grids can detect energy spikes and equipment failure while preventing power outages and routing power to those in need instantaneously.

Smart GridArchitecture

A smart grid is an electricity network that uses digital and other advanced technologies to monitor and manage the transportation of electricity from generation sources to meet the varying electricity demands of end-users. From a technical perspective, the smart grid can be divided into three major systems - smart infrastructure, smart management, and smart protection systems. The main prerequisites for improving the energy supply management are the separation of local markets, the emergence of active consumers, increasing competition from local energy trading platforms, a global strategy to reduce energy consumption, and improving the quality of energy consumers in cities. A sample illustration of the smart grid architecture is shown in Figure 1.

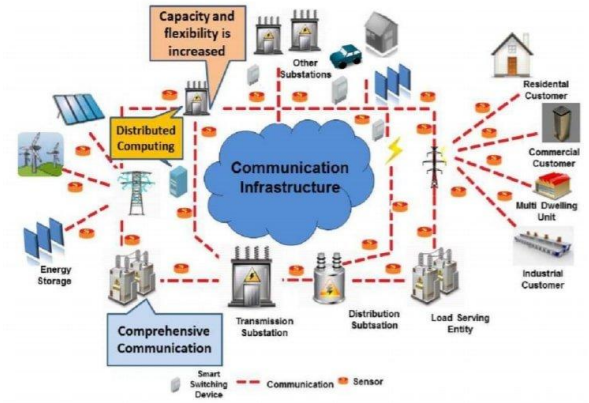

Figure 1. Smart grid architecture

The smart electric grid is a complex end-to-end system composed of multiple sub-power systems interconnected through multiple protocols that contain multiple layers of technologies. The priority for the growth of smart grids in which most progress can be anticipated can be ordered as modernization of main and distributive networks along with the introduction of technological components of smart grid. This is followed by integrating dispersed generation and renewable

energy sources in the power system. The third direction is the introduction of communication infrastructure for consumers.

Combining the IoT and the Smart Grid

The need for integrating IoT with the smart grid is justified based on the advantages it has to offer. However, the implementation of the same is not straightforward. There are several challenges at multiple levels, including but not limited to technological, social, and economic constraints. Some of these challenges need to be addressed in future research endeavors. We need to factor in the scenarios where IoT devices work under extreme conditions and diverse environments. These could be extreme temperatures, exposure to electromagnetic waves, or high voltages. Irrespective of the external conditions, reliability, compatibility, and performance cannot be compromised.

Energy harvesting techniques need to be considered as several IoT devices and sensors operate on batteries. Also, due to resource constraints and limited capabilities, it is essential to compress and aggregate the critical data. It is equally important to support necessary communication protocols so that transferring data from smart meters to the central system is guaranteed. The performance of the entire smart grid is governed by key system parameters like delay and packet loss caused by congestion. It is necessary to minimize delay, optimize network design and minimize the number of connections to each gateway.

IoT based Smart Grid Architectures

Application of IoT in smart grids allows sharing of information between all components in the grid. Inimplementing smart cities with smart grids, IoT has a crucial role to play. IoT also enables smart energymanagement. Strong sensing capabilities and higher connectivity features of smart meters are exploited by IoT.The consumption patterns can be understood in large scale environments and can be used for optimization ofenergy and billing.

There are several challenges in implementing these systems. The major challenge is safety and privacy. It is essential to enforce safety in data collection, control messages, monitoring of equipment and notification transmission. Other factors to be considered include confidentiality, integrity, availability, authentication, nonrepudiation and access control. Several passive attacks like release of message contents and traffic analysis and active attacks like denial of service, jamming, False Data Injection (FDI) and masquerade are to be addressed. For this purpose, firewalls and encryption techniques are considered. Flocking-based model, warning systems,Jamming Attack Detection Based on Estimation (JADE), Cryptographic Keys, Real-Time Detection of False DataInjection, Minimizing Message Delay under Jamming Conditions, Aggregated Key Encryption, IntrusionDetection and such solutions are explored by several researchers.

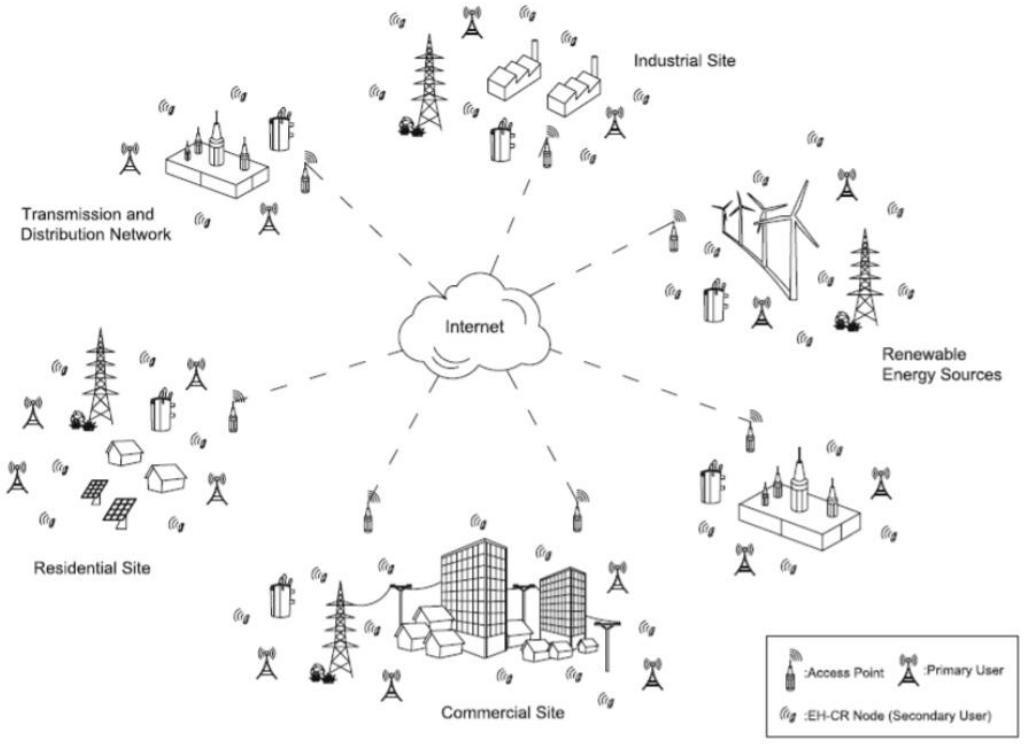

Figure 2. IoT based Smart grid architecture

Communication and Data Security within the Smart Grid

A smart grid typically comprises a host of gateways and IoT devices that possess different specifications and resources. Interoperability between these devices is critical to exchange useful information. This can be achieved using IP-based networks and supporting different communication protocols and architectures. Communication should be secure to protect internet-related vulnerabilities and possible security breaches. It is also important to secure consumer-specific private data and prevent any chances of misuse by using trust management techniques, including authentication, authorization, data integrity, maintaining confidentiality, and detecting identity.

Challenges in Implementation of IoT based Smart Grids

i) Connection Stability and Communication

The system response in smart grids reallocates the surplus power to the area where there is shortage in powerlocally. This improves the efficiency of the system. Similarly, it can work efficiently in several scenarios. It isessential to establish communication between systems. For proper communication, IoT needs fast internetconnectivity. Low connectivity leads to reduction in optimality of redistribution of power. Small latency and quickresponse is a major requirement for smooth communication among the components in smart grid. Collection ofscalable

data is a major challenge due to the lack of tools for live analysis.

Also, during severe disasters, it is difficult to collect data and enable event logging hardware. It is alsoessential to implement cloud storage as the data will be streamed in large quantities while implementing the systemin smart cities.

ii) Cost

It is simpler to establish a wireless network whereas, implementation of wired network involves properplanning and installation. While implementing smart grids, power failure are intolerable. This factor may lead toincreased cost of implementation. Despite the huge implementation costs, smart grids and IoT save largeamounts of energy by rerouting power instantly on detection of power failure.

In certain application of IoT in smart grid, power distribution, transmission and distribution causes severeelectromagnetic interference. To avoid this, the chips and equipment are to be made to withstand low and hightemperature variations, with anti-vibration and anti-electromagnetic capabilities, enabled with water and dustproof systems and new technologies so as to improve the lifetime of the module.

iii) Information Security

Smart grids and IoT are vulnerable to several security issues. Internet based security issues, cyber threats,resource constraints, data privacy, trust management, authorization and authentication, data integrity, cyberattacks, scalability, confidentiality and identity spoofing are some of the commonly faced issues. Security toolssuch as deep packet inspection and information management tools can provide security to a certain extent in IoTbased smart grids. These techniques can address specific vulnerabilities and secure data threads. Wired networksare prone to physical damage and interruption. In case of wireless networks, despite strong encryption techniques,the data packets tend to be seized and decrypted in certain cases.

Cameras and sensors in smart environment can capture every movement and attract cybercriminals.Hence it is essential to create a secure environment and avoid leakage and misuse of data. Block chain and similarplatforms can be used to ensure this security. Poor design in the system may lead to vulnerabilities and bugs. It is difficult to integrate reliable and complex security methods due to the power constraints in IoT and smart meters. The most frequent threats to information security includes remote controlling of smart meters, violation of confidentiality of consumers, alteration of energy transaction and grid destabilization, data monitoring forfalsified reasons.

Conclusion

The design of a smart grid should be efficient enough to store and process a huge amount of collected data as devices create big data that consumes a lot of energy and other resources. This could end up being a serious bottleneck. There is no unified standard for IoT devices in a smart grid which may lead to security, reliability, and interoperability issues, thus demanding unified standardization efforts.

TinyML

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Introduction

TinyML is a field of study in Machine Learning and Embedded Systems that explores the types of models you can run on small, low-powered devices like microcontrollers. It enables low-latency, low power and low bandwidth model inference at edge devices. While a standard consumer CPUs consume between 65 watts and 85 watts and standard consumer GPU consumes anywhere between 200 watts to 500 watts, a typical microcontroller consumes power in the order of milliwatts or microwatts. That is around a thousand times less power consumption. This low power consumption enables the TinyML devices to run unplugged on batteries for weeks, months, and in some cases, even years, while running ML applications on edge.

Hardware for TinyML

Now we have basic understanding of TinyML, let's discuss about the hardware that we can use to run TinyML models. To test your programs, you'll also need an embedded development board with some sensors such as microphone, accelerometers, or a camera attached to perform something interesting, and you'll need something tiny enough to build into a practical prototype project, as well as a battery. So, for this series we are going to use Arduino Nano 33 BLE Sense embedded board.

Arduino Nano 33 BLE Sense Board

It is very small AI enabled board in 45*18mm size. It is powerful version of the regular Arduino Nano, with the nRF52840 from Nordic Semiconductors, a 32-bit ARM CortexTM-M4 CPU running at 64 MHz. It will allow you to write larger programs (it has 1MB of programme memory, which is 32 times greater than the Uno) and with a lot more variables than with the Arduino Uno (the RAM is 128 times bigger). Other remarkable features of the main processor include Bluetooth pairing. It has inbuilt embedded sensors:

- 9 axis inertial sensor: what makes this board ideal for wearable devices
- humidity, and temperature sensor: to get highly accurate measurements of the environmental conditions
- barometric sensor: you could make a simple weather station
- microphone: to capture and analyze sound in real time
- gesture, proximity, light color and light intensity sensor: estimate the room's luminosity, but also whether someone is moving close to the board

Apart from the outstanding selection of sensors, the key feature of this board is the ability to run Edge Computing applications (AI) on it using TinyML. TensorFlow Lite may be used to develop machine learning models, which can then be uploaded to your board using the Arduino IDE.

Software for TinyML

The TensorFlow Lite for Microcontrollers framework will be used in all of the projects in the TinyML tutorial series. This is a modified version of the TensorFlow Lite framework that is meant to run on embedded devices with only a few tens of kilobytes of memory.

TensorFlowLite is TensorFlow's mobile and embedded device lightweight solution. It allows you to execute machine-learned models on mobile devices with minimal latency, allowing you to use them for classification, regression, and other tasks without having to make a round trip to a server. TensorFlow Lite and TensorFlow Mobile differ in the following ways: It is the latest TensorFlow mobile version. TensorFlow Lite applications will typically have better performance and smaller binary file sizes than TensorFlow mobile apps.

Advantage of Tiny ML

Low power consumption is one of the main advantages of TinyML. We will use microcontrollers here which consumes very less power (less than 1mW). This allows to run devices for an extended period of time without needing to be recharged.

It requires very less bandwidth for TinyML project because data does not need to be transferred to the server on a regular basis, less internet bandwidth is consumed.

Using TinyML we can develop number of smart sensors and smart devices. TinyML will be widely used in a variety of industries. Retail, healthcare, transportation, wellness, agriculture, fitness, and manufacturing are just a few of the industries that will be affected. By adding the data acquisition and selecting the sensors, such as the accelerometer sensor to sample the phone's movements, our phones can become the edge device that gathers data. This enables it to execute advanced learning models based on artificial neural networks (ANN), which can access and sample tiny sensors and low-power microcontrollers.

Applications of TinyML

By summarizing and analyzing data at the edge on low power devices, TinyML offers many unique solutions. Even though TinyML is an emerging field, it has been used in production for years. The “OK Google”, “Alexa”, “Hey Siri” wake words are an example of TinyML. Here, the devices are always on and are analyzing your voice to detect the wake word. I’ll add some more applications of TinyML here.

Industrial Predictive Maintenance: Machines are prone to fault. Using TinyML on low powered devices, it is possible to monitor the machine and

predict faults ahead of time constantly. This predictive maintenance can lead to significant cost savings. Ping Services, an Australian startup, has introduced an IoT device that autonomously monitors wind turbines by magnetically attaching to the outside of the turbine and analyzing detailed data at the edge. This device can alert the authorities regarding potential issues even before it occurs.

Healthcare: The Solar Scare Mosquito project uses TinyML to curb the spread of mosquito-borne diseases like Dengue, Malaria, Zika Virus, Chikungunya, etc. It works by detecting the mosquito breeding conditions and agitates the water to prevent mosquito breeding. It runs on solar power and can thus run indefinitely.

Agriculture: The Nuru app helps farmers detect diseases in plants just by taking a picture of it by running Machine Learning models on the device using TensorFlow Lite. Since it works on the device, there is no need for an internet connection. This is a crucial requirement for remote farmers since they might not have proper internet connection in their place.

Ocean Life Conservation: Smart ML-powered devices are used to monitor whales in real-time in waterways around Seattle and Vancouver to avoid whale strikes in busy shipping lanes.

How can I get started?

Hardware: The Arduino Nano 33 BLE Sense is the suggested hardware for deploying Machine Learning models on edge. It contains a 32-bit ARM Cortex-M4F microcontroller running at 64MHz with 1MB of program memory and 256KB RAM. This microcontroller provides enough horsepower to run TinyML models. The Arduino Nano 33 BLE Sense also contains colour, brightness, proximity, gesture, motion, vibration, orientation, temperature, humidity, and pressure sensors. It also contains a digital microphone and a Bluetooth low energy(BLE) module. This sensor suite will be more than enough for most applications.

Machine Learning Framework: There are only a handful of frameworks that cater to TinyML needs. Of that, TensorFlow Lite is the most popular and has the most community support. Using TensorFlow Lite Micro, we can deploy models on microcontrollers.

Conclusion

Microcontrollers are everywhere, and with the help of sensors attached to them, they collect a vast amount of data. Adding TinyML with these microcontrollers will open up a series of possibilities for applications in IoT devices, such as TVs, cars, coffee machines, watches, and other devices so that they have intelligence that are only restricted to computers and smartphones.TinyML, can leverage this data to build better products. There are over 250 Billion microcontroller units today, and this number is only going to rise in the future. This will lead to a decrease in price. Enabling Machine Learning in microcontrollers will open up new opportunities.

Hybrid Electric Vehicles

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Introduction:

Hybrid electric vehicles are powered by an internal combustion engine and an electric motor, which uses energy stored in batteries. A hybrid electric vehicle cannot be plugged in to charge the battery. Instead, the battery is charged through regenerative braking and by the internal combustion engine. The extra power provided by the electric motor can potentially allow for a smaller engine. The battery can also power auxiliary loads and reduce engine idling when stopped. Together, these features result in better fuel economy without sacrificing performance. Learn more about hybrid electric vehicles.

Components of a Hybrid Electric Car

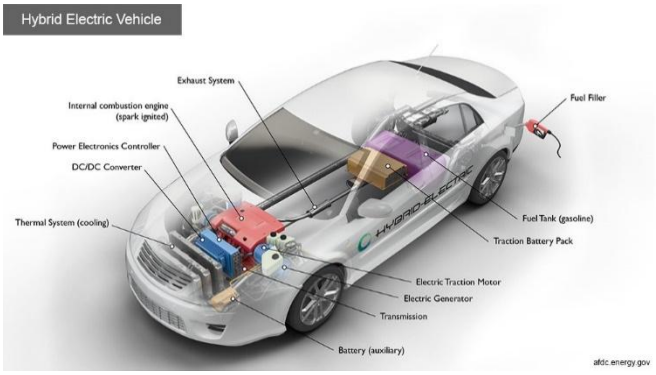
Battery (auxiliary): In an electric drive vehicle, the low-voltage auxiliary battery provides electricity to start the car before the traction battery is engaged; it also powers vehicle accessories.

DC/DC converter: This device converts higher-voltage DC power from the traction battery pack to the lower-voltage DC power needed to run vehicle accessories and recharge the auxiliary battery.

Electric generator: Generates electricity from the rotating wheels while braking, transferring that energy back to the traction battery pack. Some vehicles use motor generators that perform both the drive and regeneration functions.

Electric traction motor: Using power from the traction battery pack, this motor drives the vehicle's wheels. Some vehicles use motor generators that perform both the drive and regeneration functions.

Exhaust system: The exhaust system channels the exhaust gases from the engine out through the tailpipe. A three-way catalyst is designed to reduce engine-out emissions within the exhaust system.



Fuel filler: A nozzle from a fuel dispenser attaches to the receptacle on the vehicle to fill the tank.

Fuel tank (gasoline): This tank stores gasoline on board the vehicle until it's needed by the engine.

Internal combustion engine (spark-ignited): In this configuration, fuel is injected into either the intake manifold or the combustion chamber, where it is combined with air, and the air/fuel mixture is ignited by the spark from a spark plug.

Power electronics controller: This unit manages the flow of electrical energy delivered by the traction battery, controlling the speed of the electric traction motor and the torque it produces.

Thermal system (cooling): This system maintains a proper operating temperature range of the engine, electric motor, power electronics, and other components.

Traction battery pack: Stores electricity for use by the electric traction motor.

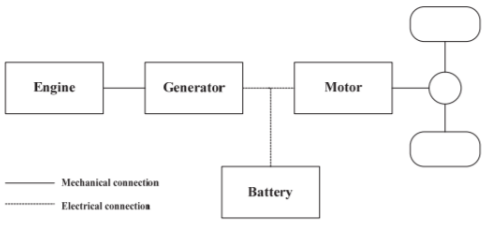
Transmission: The transmission transfers mechanical power from the engine and/or electric traction motor to drive the wheels.

Classification of Hybrid Vehicle

Hybrid power system according to the structure divided into three main forms, including series, parallel and hybrid

Series Hybrid Electric Vehicle

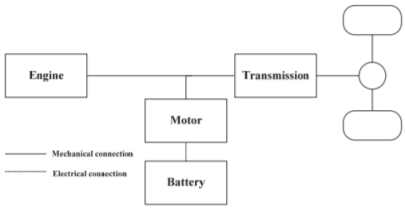
Series Hybrid Electric Vehicle (Series Hybrid Electric Vehicle, SHEV) is the main characteristic of the drivingforce of the vehicle only from the motor. SHEV drive system of the three powertrains: engine, generator and drivemotor are composed of a series of ways, the engine does not directly participate in the SHEV drive, it is combinedwith the generator only as a power supply system.



Series hybrid system structure.

Parallel Hybrid Vehicle

The main feature of a parallel hybrid electric vehicle (PHEV) is that the engine and the motor can provide thedriving force of the vehicle simultaneously or separately. The PHEV drive system consists of two main power sources:

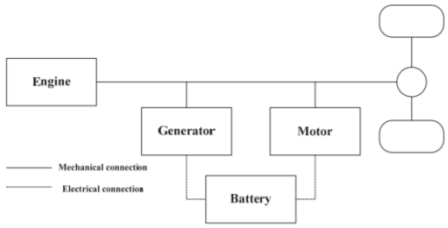


Parallel hybrid system structure.

When the load is low, the engine or the motor is used alone as the power source, and when the high power is needed,the motor and the engine can be used simultaneously as the power source to drive the vehicle. Since the two powersupplies of the PHEV drive system are superposed on each other in the form of mechanical energy and requirecorresponding mechanical transmission, the system is not as simple as the tandem type, and the arrangement of theapparatus has some limitations.

Combined Hybrid Vehicle

Combined Hybrid Electric Vehicle (CHEV) directly combines the series and parallel, which can work in seriesmode or in parallel mode. Hybrid electric hybrid system is characterized by the internal combustion engine systemand the motor drive system with mechanical transmission mechanism, the two sets of agencies or through the geartrain or planetary gear structure connected to regulate the relationship between the internal combustion engine and themotor speed. Compared with parallel hybrid systems, hybrid powertrain systems have more flexibility to adjust theengine's power output and motor operation based on operating conditions.



Combined Hybrid System Structure

This connection system is complex andcostly. When the vehicle starts or runs at a low speed, the engine is shut down and only the motor is used to provide the power output. When the car is running at high speed, the engine runs while the generator takes on power generation or speed regulation according to the actual working conditions. When the vehicle is braked, the system is also capable of converting mechanical energy into electrical energy stored in a battery pack.

Nature of power source

Electric-IC engine hybrid: It can be created in many ways. Variety of designs differentiate upon howelectric motor and combustion engine power trainare connected (Series, parallel, series-parallel),what percent of power is produced by electricmotor and IC engine, the time at which both portions operate

Fuel Cells:Main source of energy ishydrogen. They need ultra-capacitor to increasepower density required to start the vehicle. Theyhave high energy efficiency. Use of hydrogenresults in low use of crude oil as vehicular fuel andlow carbon emissions as well.

Challenges in design

New technologies and products are required to enhance fuel efficiency and reduce harmful emissions, without sacrificing performance, cost-efficiency and safety. Vehicle electrification and hybridization have been increasingly recognized as the most promising road transportation solution to both the global energy crisis and increasingly stringent requirements related to environmental protection and vehicle safety, prompting collaborations among governments, academia, and industrial institutions to search for a solution to reduce vehicle emissions, while reducing the consumption of fossil fuels.

However, electrification of automotive systems presents significant design challenges, specifically related to drivetrain systems, chassis design and layout, multidisciplinary power management and optimization, system integration, and vehicle dynamics and control.

Conclusion

Storage devices like batteries take up a part ofload in turn reducing the need for larger IC engines.Battery contributing leads to prudent use of fuelsincreasing fuel efficiency. Thus, downsizing of ICengines is possible saving space. Regenerative braking system installed in most of the hybrid vehicles captures some amount of energynormally lost due to friction. This energy is storedin the batteries and can be used for propulsion.Hybrid also avoids energy losses associated withengine operation where normal IC engine isinefficient at different speed and load combinations.Hence in this competitive world with latesttechnologies emerging, hybrid concept is extremelypragmatic.

Quantum Programming

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Introduction

Quantum programming is the process of assembling sequences of instructions, called quantum programs that are capable of running on a quantum computer. Quantum programming languages help express quantum algorithms using high-level constructs. The field is deeply rooted in the open-source philosophy and as a result most of the quantum software discussed in this article is freely available as open-source software.

Qubit

Quantum computers are machines that work with qubits (quantum bits) rather than regular bits.

A regular bit is a transistor that registers either a high or low voltage, which corresponds to 1 or 0 respectively. Through advances in technology over the years, we have bits that are nearly the size of atoms, which is absolutely incredible.

A quantum bit is a 2-state quantum "device." Many things can be used as qubits, such as a photon's horizontal and vertical polarization, or the spin up or spin down of an electron. What this means for us as computer scientists is that a qubit can be a 0, 1, or both.

Qubits also have 2 other very important properties:

Superposition - this is where a qubit is, while left unobserved, all of its possible states. Once observed, it will collapse into one of the possible states.

Entanglement - This is where one qubit's state is linked to another. When entangled with eachother, a change in one of the entangled qubits will change the other instanty. At any distance. Take take that both of those words are fully intended. Instantly and *any* distance, which is what Einstein referred to as "Spooky action at a distance," since this appeared to violate various rules like transmitting information faster than the speed of light. This is referred to as quantum non-locality.

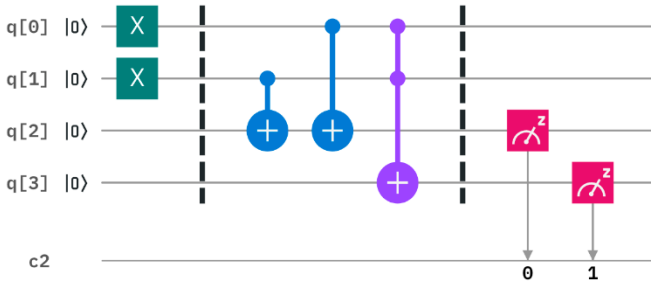
Quantum Environments

There are different frameworks or programming languages or tools to perform quantum algorithms, of these we will highlight five:

- Qiskit
- Cirq
- QDK
- Silq
- Strawberry Fields

If you think quantum mechanics sounds challenging, you are not alone. All of our intuitions are based on day-to-day experiences, and so are better at understanding the behavior of balls and bananas than atoms or electrons. Though quantum objects can seem random and chaotic at first, they just follow a different set of rules. Once

we know what those rules are, we can use them to create new and powerful technology. Quantum computing will be the most revolutionary example of this.

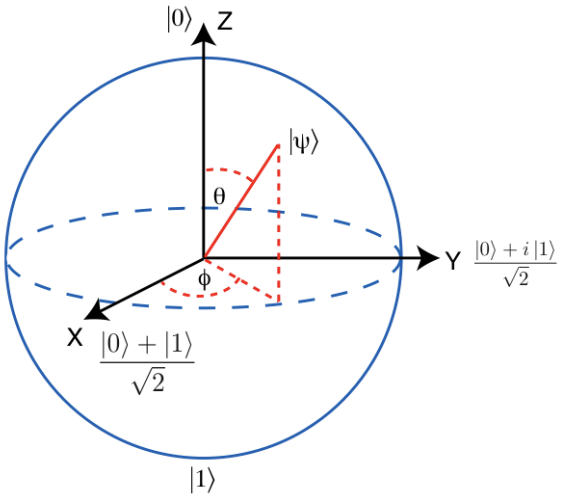


To get you started on your journey towards quantum computing, let's test what you already know. Which of the following is the correct description of a bit?

- A blade used by a carpenter.
- The smallest unit of information: either a 0 or a 1.
- Something you put in a horse's mouth.

Actually, they are all correct: it's a very multi-purpose word! But if you chose the second one, it shows that you are already thinking along the right lines. The idea that information can be stored and processed as a series of 0s and 1s is quite a big conceptual hurdle, but it's something most people today know without even thinking about it. Taking this as a starting point, we can start to imagine bits that obey the rules of quantum mechanics. These quantum bits, or qubits, will then allow us to process information in new and different ways.

For this, we'll need some way of keeping track of what they are doing when we apply gates. The most powerful way to do this is to use the mathematical language of vectors and matrices.



Qiskitares usedin Python-based framework for quantum computing, it would also be useful to know the basics of Python.

Hello World in Qiskit

Download qiskit from the anaconda terminal by running the following command. Be sure to update your python to a 3.7 version or above, as Qiskit is optimized for these versions of python.

```
pip install qiskit
```

We have installed Qiskit by running the command. There is alternative to writing Qiskit programs, which is to do it via the IBM quantum experience cloud. The next thing we'll do is start building the quantum register. We will have to first encode the input, do some computation and extract an output. First we will import Qiskit library and its associated packages.

```
fromqiskitimport *
```

Next, initialize a quantum register having 2 qubits. A qubit is the fundamental unit of a quantum circuit, the analogue of a bit in classical computing! We will also initialize a classical register having 2 qubits. Most circuits will be a combination of classical and quantum registers, as the quantum registers will be used to perform quantum mechanical operations on qubits, and classical registers will be used to perform classical operations on the measurements obtained.

```
qr=QuantumRegister(2)
cr=ClassicalRegister(2)
circuit=QuantumCircuit(qr,cr)
```

In Qiskit, option to visualize how the quantum circuit looks by running the following command.

```
%matplotlibinline
circuit.draw()
```

two quantum bits and two classical bits.

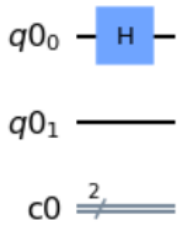
effect of applying a quantum gate on a single bit, the Hadamard gate, which is a gate used for creating superposition

We will do this by running the following command to the first qubit in the quantum register. Note that indexing starts from 0 in Python.

```
circuit.h(qr[0])
```

To visualize the circuit, we will run the command

```
circuit.draw(output='mpl')
```

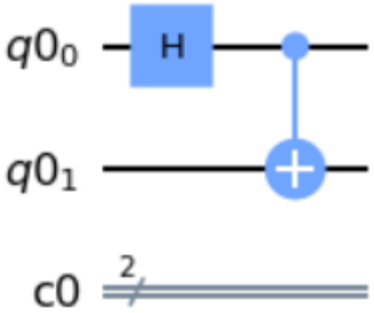


Let us explore more fundamental gates, like the cx gate which is a controlled-x gate, and the gate performs a NOT on the target qubit if the control qubit is in state 1. By default, all qubits are initialized to state 0.

```
circuit.cx(qr[0],qr[1])
```

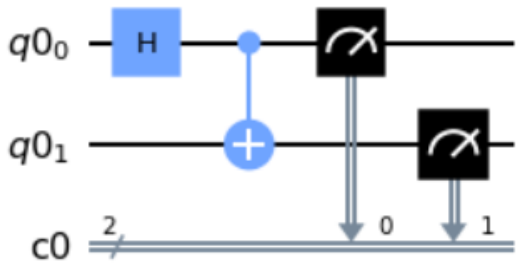
The control qubit is the first parameter or qr[0] in this case and the target parameter is qr[1]

In the following circuit, the target qubit is a circle with an addition sign and the control is a dot.



This circuit is used to implement entanglement between two qubits. After initializing a quantum circuit and performing computation by implementing quantum gates, we will extract the outputs by using .measure() function in Qiskit. In this example, the classical bits will be used to store the outputs.

```
circuit.measure(qr,cr)
```



The arrows point from the qubits, to the classical bits which are used to store the extracted outputs.

Now, the fun part is executing the circuit we built on a quantum computer. There are many quantum devices that Qiskit has. In order to use these devices, we will first have to load an IBMQ account (Note: follow this link https://quantum-computing.ibm.com/account to create an account)

```
IBMQ.load_account()
```

Next, we will have to give details of the IBMQ provider and quantum computer that we choose to execute our circuit on.

```
provider=IBMQ.get_provider('ibm-q')
quantum_computer=provider.get_backend('ibmq_vigo')
```

Use the execute() function to run our quantum circuit using ibmq_vigo as our backend.

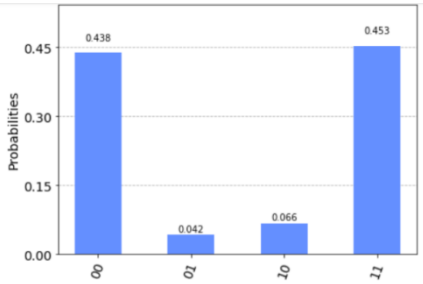
```
execute_circuit=execute(circuit,backend=quantum_computer)
```

To see the results, simply run the following command.

```
result=execute_circuit.result()
```

To visualize the results, run the following command.

```
plot_histogram(result.get_counts(circuit))
```



Theoretically, we can compare the results we get on a quantum computer vs the results simulated on a quantum simulator.

Run the following command to get the simulator backend (use the qasm_simulator)

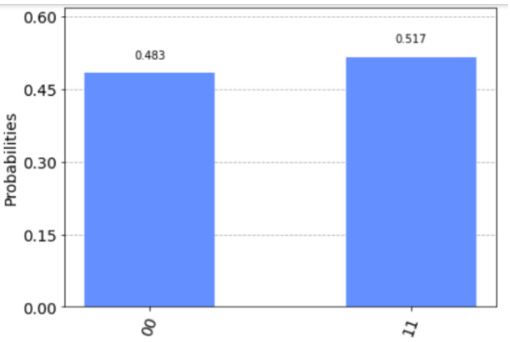
```
simulator=Aer.get_backend('qasm_simulator')
```

Next, execute the circuit.

```
result=execute(circuit,backend=simulator).result()
```

Plot the histogram of results to see the probabilities of getting each state in the output.

```
plot_histogram(result.get_counts(circuit))
```



Comparing the results, we see that on the quantum computer we get a small probability for obtaining states other than 00 and 11. This means that the quantum computer does not give 100% accurate results, but gives us an approximation. This is because quantum computers are not prone from noise, and in our next tutorial we will explore quantum noise and how to mitigate noise.

Production of Electricity from the Artificial Nano Trees

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Introduction

Today much debate has been going on in scientific circles about how real is the phenomenon of global warming and what would be mankind's response in averting the consequence of it. Realizing this, steps have been taken to reduce the use of fossil-based energy and substituting the same with renewable sources such as solar and wind energy etc. Till now we are producing the electrical energy with the means of either wind mills (only the effect of wind) or solar panels (only the effect of solar energy) so far but all the two forms of these energies we are not using in same system. If we will do so then surely we can get the more efficient system than ever we had. So here in this paper we will demonstrate how an artificial tree will produce the electrical energy by using both (wind as well as solar) energies .For constructing the artificial tree the first step is to construct the nano leaves .The nano leaf will consist of two transparent conducting layers one at the top and other one at the bottom .Between these two layers we are placing thin film photo voltaic layer to convert the sunlight into electrical energy and thin film thermo voltaic layer to convert the thermal radiation into electricity [1].The nano leaves then connected to twigs and branches using tiny piezoelectric elements that convert the movements of the leaves caused by wind and rain into more electricity. It will be interesting to know that one tree depending on the size and location, can produce between 2000 and 12000 kHz per year plus the trees provide shade and function as a windbreak.

Nano Leaves:

We know very well that piezoelectric crystals, photo voltaic cell and thermo voltaic cells are used to convert the one form of energy into electrical energy but till now we are not using these all the techniques in the single system. Think if we are mingling these all the techniques in single system then surely different types of energies coming to the system can be converted into huge amount of electrical energy. So for this, the only and the best solution is the Nano leaves because the leaves on a tree get all these types of energies such as solar energy from sun, wind energy as well as stress from the rain and for converting these all the energies into electrical energy all the above mentioned techniques we are having in a single nano leaf. The other main motive to choose nano leaves is that the size is small and compact. The other main advantage of using Nano leaves is that it can produce more electrical energy than the solar panels.

Comparison b/w solar cells &nano trees in production field.

Solar Cells	Nano leaves
90kwh/in2	130kwh/in2
It can produce power from solar energy only	It can produce power from solar, wind and from rain also

Overview of Nano leaves Technology:

One of the emerging nanotechnologies related to renewable energy is nano leaves and stems of artificially created trees or plants. They are intended to harness energy provided by the wind and sun, thereafter converting it into electrical energy. Moreover, to better understand the fundamental of Nano leaves, we have to dig into an innovative field of technologic development, called Bio mimicry

Overview of Bio mimicry Technology:

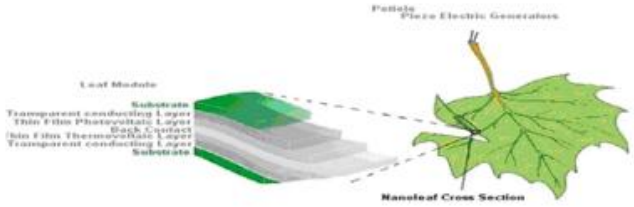
The nano leaves have been specially designed to imitate the natural process of photosynthesis. A mechanism by which, typical plants absorb the light emitted by the sun and CO2 in the atmosphere. The artificial trees do even copy the natural re cycling process oxygen.

It is very recent that nano leaves technology started to reap even more advanced levels. It can now harvest thermal energy as well. Moreover, the leaves fixed on artificial trees are also able to collect energy derived through movement of the wind, known as kinetic energy, which is as well converted into electrical energy.

The nano-technology was initially developed to harness solely solar energy. However, nowadays it has widespread uses. It exploits various alternative sources of energy like wind, solar and thermal energy. Furthermore, these highly advanced artificial plants and/or trees use tiny cells to capture energy.

Construction of Nano leaves:

In order to construct the nano leaves we need solar panel, thermo voltaic cell, piezo voltaic cell and photo voltaic cell. The construction of nano leaves is very easy. In this first of all we are creating two transparent conducting layers of silica which will act as the outer body of the leaf. After this we are placing one solar cell in between these two layers which is used to convert the solar energy into electrical energy then we are placing the piezovoltaic cell, thermo voltaic cell and photo voltaic cell. These all the cells are interconnected to the highly conducted metal film to complete the circuit for the flow of electrons and protons.



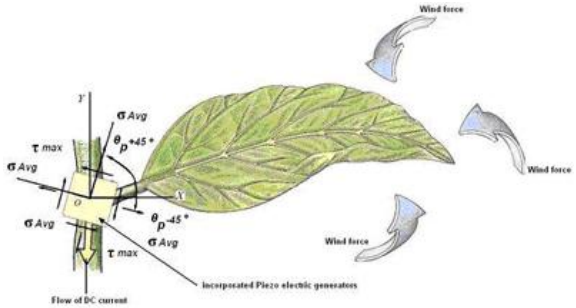
Construction of Nano Leaf

The piezoelectric generator is placed on the bottom of the leaf which is used to convert the stress due to rain and wind into the electrical energy. Now these leaves are connected to the twigs of the artificial tree. Then these small twigs are connected to the stem of the tree with the means of the piezoelectric crystal to covert the stress of the twig also into electrical energy. The

electrical energy from the all leaves and twigs is stored at the bottom of the tree by using the storing device.

Working of Nano Leaf

Piezoelectric is a simple concept to generate electricity that comes from the pressure. We have used the exact meaning of the term, in order to create a sustainable energy resource by using light, heat and wind.



When the force from the outside, like the wind blowing the leaves [with the volume a little or a lot].Pd on the spot, mechanical stresses appear in the leaves, twigs, stems and braches. This process can then generate millions of watts of Pico which efficiently be converted into electricity. That way, the stronger the wind, the energy produced will be more and more distinguished. During the day, nano leaves reflect the green light in sunlight and use photoelectric nano spheres to convert the rest of the visible light into electricity. Thermoelectric nano wires /antennas convert heat from infrared light, or thermal radiation, into electricity throughout the day, since the earth continuously absorbs thermal radiation and then radiates it, even after dark. It has also found out in the research that with the right material shape and size, nano antennas could harvest up to 92% of the energy at infrared wavelengths.

Advantages

- A positive environmental impactopposes to a negative one..
- On street lighting in the area, Poweroutages have no impact.
- In all locations Solar street lights can beeasily erected.
- No air pollution energy sources.
- In poor country people would accesselectricity
- People can save money
- Land requirement is very less

Conclusion

Nano tree was developed the firstmultifunctional renewable energy systemsthat actively converts light, heat and windinto useable electricity, day and night, andwe are continuously looking for ways tomake them as efficient as possible. Itconvert the visible light into electricity".These super eco-friendly synthetic treeswill make use of renewable energy fromthe sun along with wind power, which arean effective clean and environmentallysound medium of gathering solar radiationand wind energy. Solar nanotechnologyhas wide-ranging potential. Using suchtechnology, power producing solarproducts could be applied to just about anysurface downtown or anywhere.

Artificial Intelligence in Power System

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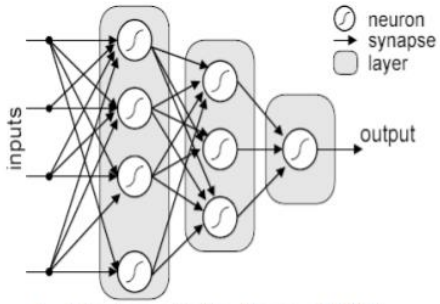
Introduction

Artificial intelligence is the science of automating intelligent behavior which is achieved by humans. Power station has grown highly over many decades. Due to concern about liberalization of electricity supply and global impact on the environment securing a reliable power supply has become an important issue worldwide. To ensure need details investigation developments are in power distribution system. Manual calculation s, technical analysis and conclusions first adopted, the facility grew it become more complicated being to technical achievements. Power system keep on increasing on the basis of geographical regions , assets additions, and introduction of new technologies in generation ,transmission and distribution of electricity. A continuous and reliable supply of electricity is necessary for the functioning of today's modern and advanced society.

Artificial Neural Networks (ANN)

Artificial Neural Networks are biologically inspired systems which convert a set of inputs into a set ofoutputs by a network of neurons, where each neuron produces one output as a function of inputs. A fundamentalneuron can be considered as a processor which makes a simple nonlinear operation of its inputs producing asingle output. The understanding of the working of neurons and the pattern of their interconnection can be usedto construct computers for solving real world problems of classification of patterns and pattern recognition. They are classified by their architecture: number of layers and topology: connectivity pattern, feedforward orrecurrent.



Architecture of a feedforward ANN

Input Layer: The nodes are input units which do not process the data and information but distribute thisdata and information to other units.

Hidden Layers: The nodes are hidden units that are not directly evident and visible. They provide thenetworks the ability to map or classify the nonlinear problems.

Output Layer: The nodes are output units, which encode possible values to be allocated to the case underconsideration.

Advantages:

(i) Speed of processing.

(ii) They do not need any appropriate knowledge of the system model.

(iii) They have the ability to handle situations of incomplete data and information, corrupt data.

(iv) They are fault tolerant.

(v) ANNs are fast and robust. They possess learning ability and adapt to the data.

(vi) They have the capability to generalize.

Disadvantages:

(i) Large dimensionality.

(ii) Results are always generated even if the input data are unreasonable.

Need for AI in Power Systems

Power system analysis by conventional techniques becomes more difficult because of:

(i) Complex, versatile and large amount of information which is used in calculation, diagnosis and learning.

(ii) Increase in the computational time period and accuracy due to extensive and vast system data handling.The modern power system operates close to the limits due to the ever increasing energy consumptionand the extension of currently existing electrical transmission networks and lines. This situation requires a lessconservative power system operation and control operation which is possible only by continuously checking thesystem states in a much more detail manner than it was necessary. Sophisticated computer tools are now theprimary tools in solving the difficult problems that arise in the areas of power system planning, operation,diagnosis and design. Among these computer tools, (iii) They are not scalable i.e. once an ANN is trained to do certain task, it is difficult to extend for other tasks without retraining the neural network.

Applications

Power system problems concerning encoding of an unspecified non-linear function are appropriate for ANNs. ANNs can be particularly useful for problems which require quick results, like those in real timeoperation. This is because of their ability to quickly generate results after obtaining a set of inputs. Many areas of applications in power systems match the abilities of expert systems like decisionmaking, archiving knowledge, and solving problems by reasoning, heuristics and judgment. Expert systems are especially useful for these problems when a large amount of data and information must be processed in a short period of time.

Areas of applications in power systems include:

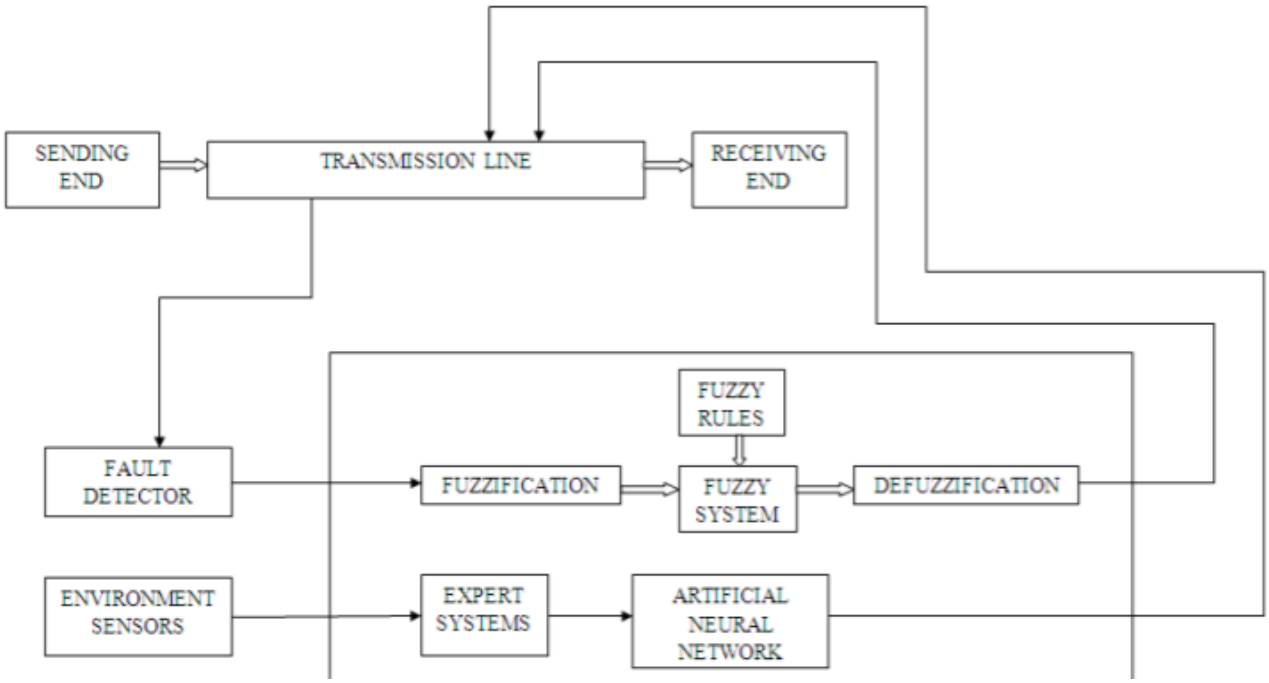
(i) Planning – Wind turbine positioning, reactive power optimisation, network feeder routing, and capacitorplacement.

(ii) Operation – Hydro-thermal plant coordination, maintenance scheduling, loss minimisation, load management, control of FACTS.

(iii) Analysis – Harmonic distortion reduction, filter design, load frequency control, load flow.

Application of AI Systems in Transmission Line

Consider a practical transmission line. If any fault occurs in the transmission line, the fault detectordetects the fault and feeds it to the fuzzy system. Only three line currents are sufficient to implement thistechnique and the angular difference between fault and pre-fault current phasors are used as inputs to the fuzzysystem. e. Fuzzy systems can be generally used for fault diagnosis.



Artificial Neural Networks and Expert systems can be used to improve the performance of the line. The environmental sensors sense the environmental and atmospheric conditions and give them as input to the expert systems. The expert systems are computer programs written by knowledge engineers which provide the value of line parameters to be deployed as the output. The ANNs are trained to change the values of line parameters over the given ranges based on the environmental conditions. Training algorithm has to be given to ANN. After training is over, neural network is tested and the performance of updated trained neural network is evaluated. If performance is not upto the desired level, some variations can be done like varying number of hidden layers, varying number of neurons in each layer. The processing speed is directly proportional to the number of neurons. These networks take different neurons for different layers and different activation functions betweeninput and hidden layer and hidden and output layer to obtain the desired output. In this way the performance of the transmission line can be improved.

Conclusion

The main feature of power system design and planning is reliability, which was conventionally evaluated using deterministic methods. Moreover, conventional techniques don't fulfill the probabilistic essence of power systems. This leads to increase in operating and maintenance costs. Plenty of research is performed to utilize the current interest AI for power system applications. A lot of research is yet to be performed to perceive full advantages of this upcoming technology for improving the efficiency of electricity market investment, distributed control and monitoring, efficient system analysis, particularly power systems which use renewable energy resources for operation

Advanced Driver Assistance Systems (ADAS)

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Introduction

Advanced Driver Assistance Systems (ADAS) are now an up surging technology in the automotive space. As these technologies become more pervasive, it becomes increasingly important for consumers to be informed about the systems on their vehicle and their functionality.Almost all vehicle accidents are caused by human error, which can be avoided with Advanced Driver Assistance Systems (ADAS). The role of ADAS is to prevent deaths and injuries by reducing the number of car accidents and the serious impact of those that cannot be avoided.

Essential safety-critical ADAS applications include:

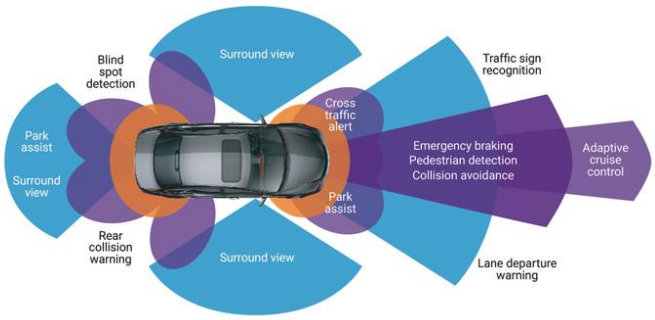
- Pedestrian detection/avoidance
- Lane departure warning/correction
- Traffic sign recognition
- Automatic emergency braking
- Blind spot detection

These lifesaving systems are key to ensuring the success of ADAS applications, incorporating the latest interface standards and running multiple vision-based algorithms to support real-time multimedia, vision co-processing, and sensor fusion subsystems.

Working of ADAS

Automobiles are the foundation of the next generation of mobile-connected devices, with rapid advances being made in autonomous vehicles. Autonomous application solutions are partitioned into various chips, called SoCs (systems on a chip). These chips connect sensors to actuators through interfaces and high-performance ECUs (electronic controller units).

Self-driving cars use a variety of these applications and technologies to gain 360-degree vision, both near (in the vehicle's immediate vicinity) and far. That means hardware designs are using more advanced process nodes to meet ever-higher performance targets while simultaneously reducing demands on power and footprint.



ADAS Applications

Significant automotive safety improvements in the past (e.g., shatter-resistant glass, three-point seatbelts, airbags) were passive safety measures designed to minimize injury during an accident. Today, ADAS systems actively improve safety with the help of embedded vision by reducing the occurrence of accidents and injury to occupants.

The implementation of cameras in the vehicle involves a new AI function that uses sensor fusion to identify and process objects. Sensor fusion,

similar to the human brain process information, combines large amounts of data with the help of image recognition software, ultrasound sensors, lidar, and radar. This technology can physically respond faster than a human driver ever could. It can analyze streaming video in real time, recognize what the video shows, and determine how to react to it.

1. Adaptive Cruise Control

Adaptive cruise control (ACC) is particularly helpful on the highway, where drivers can find it difficult to monitor their speed and other cars over a long period of time. Advanced cruise control can automatically accelerate, slow down, and at times stop the vehicle, depending on the actions other objects in the immediate area.

2. Glare-Free High Beam and Pixel Light

Glare-free high beam and pixel light uses sensors to adjust to darkness and the vehicle's surroundings without disturbing oncoming traffic. This new headlight application detects the lights of other vehicles and redirects the vehicle's lights away to prevent other road users from being temporarily blinded.

3. Adaptive Light Control

Adaptive light control adapts the vehicle's headlights to external lighting conditions. It changes the strength, direction, and rotation of the headlights depending on the vehicle's environment and darkness.

4. Automatic Parking

Automatic parking helps inform drivers of blind spots so they know when to turn the steering wheel and stop. Vehicles equipped with rearviewcameras have a better view of their surroundings than traditional side mirrors. Some systems can even complete parking automatically without the driver's help by combining the input of multiple sensors.

5. Autonomous Valet Parking

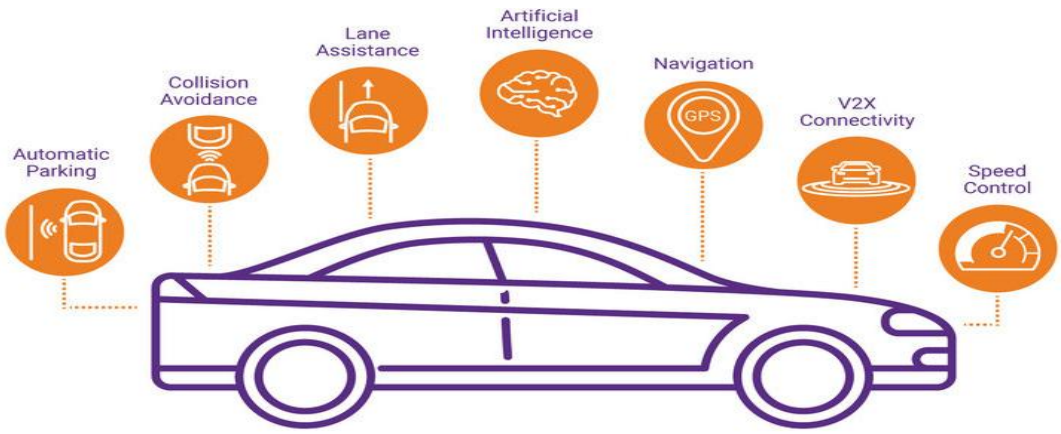
Autonomous valet parking is a new technology that works via vehicle sensor meshing, 5G network communication, with cloud services that manage autonomous vehicles in parking areas. The vehicles sensors provide the vehicle with information about where it is, where it needs to go, and how to get there safely. All this information is methodically evaluated and used to perform drive acceleration, braking, and steering until the vehicle is safely parked.

6. Navigation System

Car navigation systems provide on-screen instructions and voice prompts to help drivers follow a route while concentrating on the road. Some navigation systems can display exact traffic data and, if necessary, plan a new route to avoid traffic jams. Advanced systems may even offer Heads Up Displays (HuD) to reduce driver distraction.

7. Night Vision

Night vision systems enable drivers to see things that would otherwise be difficult or impossible to see at night. There are two categories of night vision implementations: Active night vision systems project infrared light, and passive systems rely on the thermal energy that comes from cars, animals, and other objects.



8. Blind Spot Monitoring

Blind spot detection systems use sensors to provide drivers with important information that is otherwise difficult or impossible to obtain. Some systems sound an alarm when they detect an object in the driver's blind spot,

9. Automatic Emergency Braking

Automatic emergency braking uses sensors to detect whether the driver is in the process of hitting another vehicle or other objects on the road. This application can measure the distance of nearby traffic and alert the driver to any danger. Some emergency braking systems can take preventive safety measures.

10. Crosswind Stabilization

This relatively new ADAS feature supports the vehicle in counteracting strong crosswinds. The sensors in this system can detect strong pressure cting on the vehicle while driving and apply brakes to the wheels affected by crosswind disturbance.

11. Driver Drowsiness Detection

Driver drowsiness detection warns drivers of sleepiness or other road distractions. There are several ways to determine whether a driver's attention is decreasing. In one case, sensors can analyze the movement of the driver's head, and heart rate to determine whether they indicate drowsiness. Other systems issue driver alerts similar to the warning signals for lane detection.

12. Driver Monitoring System

The driver monitoring system is another way of measuring the driver's attention. The camera sensors can analyze whether the driver's eyes are on the road or drifting. Driver monitoring systems can alert drivers with noises, vibrations in the steering wheel, or flashing lights. In some cases, the car will take the extreme measure of stopping the vehicle completely.

Conclusion

ADAS is the single-most-important type of development going on today. Of course, there are hybrid and electric-powered developments going in parallel, which are also extremely important for reducing greenhouse gases and the use of fossil fuels. ADAS goes directly to the most important aspect of travel: human safety. Since more than 90% of road accidents, injuries and fatalities are due to human error, every advancement in ADAS has a clear and absolute effect on preventing injuries and deaths.

Smart Sensors for Embedded Systems

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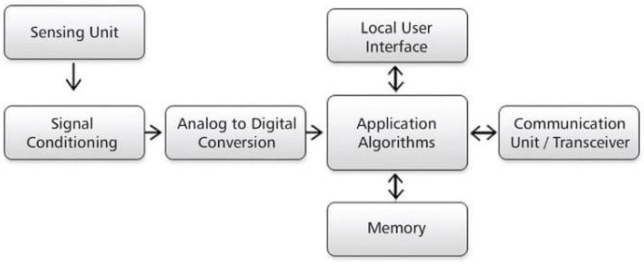
Introduction

Smart sensors are devices that take information from a physical environment and use embedded microprocessors and wireless communication to monitor, examine, and maintain various systems. They have the ability to collect environmental data more accurately with less erroneous noise. Though they're used for a variety of applications, they're most commonly found in monitoring mechanisms, such as smart grids, science applications, and security systems.

Smart sensors are built as IoT components that convert the real-world variable that they're measuring into a digital data stream for transmission to a gateway. Figure shows how they do this. The application algorithms are performed by a built-in microprocessor unit (MPU). These can run filtering, compensation, and any other process-specific signal conditioning tasks.



Smart sensor building blocks

The MPU's intelligence can be used for many other functions as well to reduce the load on the IoT's more central resources; for example, calibration data can be sent to the MPU so the sensor is automatically set up for any production changes. The MPU can also spot any production parameters that start to drift beyond acceptable norms and generate warnings accordingly; operators can then take preventative action before a catastrophic failure occurs.

If appropriate, the sensor could work in "report by exception" mode, where it only transmits data if the measured variable value changes significantly from previous sample values. This reduces both the load on the central computing resource and the smart sensor's power requirements — usually a critical benefit, as the sensor must rely on a battery or energy harvesting in the absence of connected power.

If the smart sensor includes two elements in the probe, sensor self-diagnostics can be built in. Any developing drift in one of the sensor element outputs can be detected immediately. Additionally, if a sensor fails entirely — for example, due to a short-circuit — the process can continue with the second measuring element. Alternatively, a probe can contain two sensors that work together for improved monitoring feedback.

Main functions of Smart Sensors:

- Measurement
- Configuration
- Verification
- Communication

Measurements are taken by detecting physical signals and converting them into

electrical signals. This helps measure and monitor things, such as traffic, temperature, and industrial applications. Configuration is an important feature because it allows the sensor to detect alignment or installation errors, while the verification function has a variety of uses, such as continuous supervision of the intelligent sensor's behavior, using a set of supervisory equipment/circuits implemented in the sensor. Finally, the communication feature enables the sensor to talk to the main microprocessor or microcontroller.

A perfect example of smart sensors is a connected home. Lights turn on when motion is sensed. Thermostat changes when people return home. With their monitoring and tracking capabilities, smart sensors are used in a wide range of applications.

Various industries have turned to smart sensors to help them with different monitoring tasks, including, but not limited to:

- Flood and water level monitoring
- Animal and agriculture tracking
- Environmental monitoring
- Traffic monitoring and control
- Remote system monitoring and equipment fault diagnostics
- Transport and logistics
- Industrial applications

But the biggest role smart sensors play is in the IoT. Cell phone navigation, wearable devices, and autonomous cars all rely on smart sensors in some way. More markets are replacing basic sensor systems with smart ones for their efficiency, ease of use, and advanced communication features. And because these systems are so versatile, they can easily be adopted for different industries and applications.

The smart sensor market is only getting bigger and better. As we've seen, smart sensors can handle a variety of tasks across many different industries. What they can do continues to grow as more people find new and innovative ways to use them. With their advanced technology, monitoring capabilities, and efficiency it's only a matter of time before they replace all basic sensors.

Types of Smart Sensors

There are five main types of smart sensors used in industrial environments. Although there are many types of special purpose sensors in use today, they are generally based on one of five types of sensors.

Level sensors. A level sensor is used to measure the volume of space taken up in a container. A vehicle's fuel gauge might be connected to a level sensor that monitors the level of fuel in the tank.

Temperature sensors. A temperature sensor is a sensor that can monitor a component's temperature so a corrective action can be taken if necessary. In an industrial setting for example, a temperature

sensor can be used to make sure machinery is not overheating.

Pressure sensor. Pressure sensors are often used to monitor the pressure of gasses or fluids in a pipeline. A sudden drop in pressure might indicate a leak or a flow control issue.

Infrared sensors. Some infrared sensors, such as those used in thermal imaging cameras or noncontact infrared thermometers are used for temperature monitoring. Other infrared sensors are optical sensors tuned to a frequency that enables them to see light in the infrared spectrum. These types of sensors are used in medical equipment, such as pulse oximetry devices, and in electronic devices designed to be operated by remote control.

Proximity sensors. A proximity sensor is used to detect the location of a person or object with relation to the sensor. In retail environments, proximity sensors can track customer movements throughout the store.

Smart sensors Vs Base sensors

Smart sensors include an embedded Digital Motion Processor (DMP), whereas base sensors don't. A DMP is, essentially, just a microprocessor that is integrated into the sensor. It enables the sensor to perform onboard processing of the sensor data. This might mean normalizing the data, filtering noise or performing other types of signal conditioning. In any case, a smart sensor performs data conversion digital processing prior to any communication to external devices.

A base sensor is simply a sensor that isn't equipped with a DMP or other compute resources that would enable it to process data. Whereas a smart sensor produces output that is ready to use, a base sensor's output is raw and must typically be converted into a usable format.

Smart sensors are generally preferred over base sensors because they include native processing capabilities. Even so, there are situations where it might be more advantageous to use a base sensor. If an engineer is designing a device and needs complete control over sensor input, then it will probably make more sense to use a base sensor than a smart sensor. Base sensors also cost less than smart sensors because they contain fewer components.

Although smart sensors are most often associated with industrial equipment, IoT couldn't exist without smart sensors.

Conclusion

In recent technologies, WSN has got the spotlight on itbecause of its unbeatable potential, significance and widerange of application areas. As wireless sensor technologyhas evolved, it has become possible to predict the future byusing Smart environment which was not possible in the past. “Smart Sensors" is Wireless Sensor Network’s one stepfurther. This paper is mainly focused on the study of smartsensors and their possible and existing usage in various fields. The future work for Smart Sensors can include but notlimited to Smart Grid for improved electric powerefficiency, Smart Antenna for satisfying demands for drastichigh data rates for certain users with high quality of service, Smart Highways for handling traffic and accident relatedissues

Innovative Product Development

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Introduction

Innovative product development is a product development methodology that borrows from digital product engineering processes and applies them to business innovation. The goal is to produce product innovations that meet user needs and to improve products for real-world use. Often building upon the agile development methodology, Innovative product development transforms new ideas into useful products.

Companies that shift to an innovation product development method also shift company culture to one that supports continuous improvement and innovation. This change in focus, along with adequate development tools, can help teams rapidly build minimally viable innovative products. Accelerating the development cycle means new innovative products enter the market faster than through traditional incremental development methodologies while also reducing cost. The rapid development process allows companies to more quickly respond to market demands.

Innovative product development accelerates the product development lifecycle by speeding the digital product development process from discovery to launch. When combined with the right digital tools, the product development process allows for rapid prototyping and continuous feedback. The Innovative development process includes regular review of customer data and feedback. Rather than separating development from user experience design, a multi-discipline team collaborates to solve problems with existing products based on customer feedback or problem statements.

8 Steps of the Innovative Product Development Process

1. Idea Generation

The new product development process starts with idea generation. Idea generation refers to the systematic search for new-product ideas. Typically, a company generates hundreds of ideas, maybe even thousands, to find a handful of good ones in the end. Two sources of new ideas can be identified:

Internal idea sources: the company finds new ideas internally. That means R&D, but also

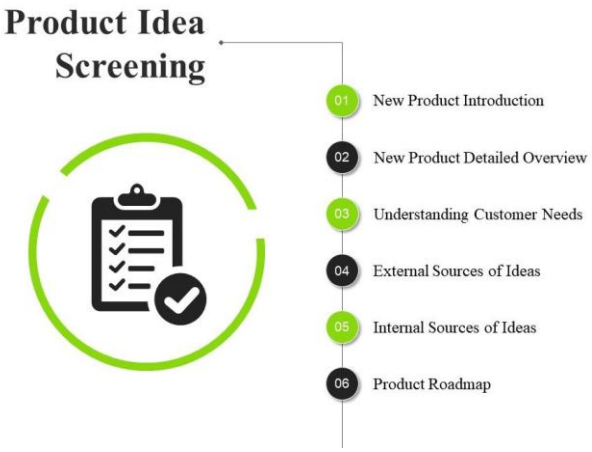
contributions from employees. For instance, many companies use a so-called suggestion box, which employees can throw new ideas into. In many cases, employees are the best source of new ideas, as they work with the product, but also the feedback of customers every day.

External idea sources: the company finds new ideas externally. This refers to all kinds of external sources, e.g. distributors and suppliers, but also competitors. The most important external source are customers, because the new product development process should focus on creating customer value. Collecting new product ideas from customers becomes ever more important and simple in the digital era, where the conversation between companies and customers is as interactive as never before. Actively listening to customers' suggestions can be a great source of innovation.

2. Idea Screening

The next step in the new product development process is idea screening. Idea screening means nothing else than filtering the ideas to pick out good ones. In other words, all ideas generated are screened to spot good ones and drop poor ones as soon as possible.

While the purpose of idea generation was to create a large number of ideas, the purpose of the succeeding stages is to reduce that number of ideas. The reason is that product development costs rise greatly in later stages. Companies cannot afford to take every single idea to the next stages. Therefore, it is necessary to filter and go ahead only with those product ideas that are likely to turn into profitable products. Dropping the poor ideas as soon as possible is, consequently, of crucial importance.



At this early stage, filtering for the potentially profitable ideas can be tricky. A key to success is to initiate the conversation with customers early and look for feedback. For instance, by surveys and focus group interviews, companies can get early insights whether their ideas might meet customer demands in a better way than existing products.

3. Concept Development and Testing

To go on in the new product development process, attractive ideas must be developed into a product concept. A product concept is a detailed version of the new-product idea stated in meaningful consumer terms. You should distinguish the following sub-stages:

A product idea – this is really just an idea for a possible product.

A product concept – this is a detailed version of the idea stated in meaningful consumer terms.

A product image – this is the way consumers perceive an actual or potential product.

Concept development and testing is a crucial stage in the new product development process. Therefore, let's go into the two sub-stages in more detail.

Concept Development

Imagine a car manufacturer that has developed an all-electric car (BEV). The idea has passed the idea screening stage and must now be developed into a concept. The marketer's task is to develop this new product into a number of alternative product concepts. Then, the company can find out how attractive each concept is to customers and choose the best one.

A product concept should at least capture the realization or form the product will take, the target group it caters to, as well as the main use cases.

Concept Testing

New product concepts, such as those given above, need to be tested with groups of target consumers. The concepts can be presented to consumers either symbolically or physically. The question is always: does the particular concept have strong consumer appeal? For some concept tests, a word or picture description might be sufficient. However, to increase the reliability of the test, a more concrete and physical presentation of the product concept may be needed. After exposing the concept to the group of target consumers, they will be asked to answer questions in order to find out the consumer appeal and customer value of each concept.

At the end of the concept testing stage, you should have a clear idea of which product concept is the best in terms of customer feedback. In some cases, it may be that several concepts seem to work great. For instance, two different versions may prove to cater well to two different sub-target groups. Provided each of the target groups provides a sufficiently large and relevant target market, the company may choose to go ahead with both product concepts.

4. Marketing Strategy Development

The next step in the new product development process is the marketing strategy development. When a promising concept has been developed and tested, it is time to design an initial marketing strategy for the new product based on the product concept for introducing this new product to the market. The marketing strategy statement consists of three parts and should be formulated carefully:

A description of the target market, the planned value proposition, and the sales, market share and profit goals for the first few years.

An outline of the product's planned price, distribution and marketing budget for the first year.

The planned long-term sales, profit goals and the marketing mix strategy.

5. Business analysis

Once the company has decided upon a product concept and marketing strategy, management can evaluate the business attractiveness of the proposed new product. The fifth step in the new product development process involves a review of the sales, costs and profit projections for the new product to find out whether these factors satisfy the company's objectives. If they do, the product can be moved on to the product development stage.

In order to estimate sales, the company could for instance look at the sales history of similar products and conduct market surveys. Having a precise view of the likely demand for the eventual product is absolutely crucial. There are countless cases where this stage was underestimated. For example, think of cars that turned out to be flops when introduced to the market. Often, companies tend to skip this stage or spend too little time on it. The reason is in many cases a bias to focus too much on the company perspective, rather than listening to customers. When you come up with a new idea, think it through, design the product, include all those features you like and so on, you may have developed a great product for yourself. However, this does not mean that it will be a great product for the market. Customer feedback is therefore a critical element along all stages of the new product development process.

Once the initial demand analysis has been estimated, the company should be able to estimate minimum and maximum sales to assess the range of risk. Based on the sales forecast, the company should estimate the expected costs and profits for a product, including marketing, R&D, operations etc. All the sales and costs figures together can eventually be used to analyze the new product's financial attractiveness.

6. Product development

The new product development process goes on with the actual product development. Up to this point, for many new product concepts, there may exist only a word description, a drawing or perhaps a rough prototype. But if the product concept passes the business test, it must be developed into a physical product to ensure that the product idea can be turned into a workable market offering. The problem is, though, that at this stage, R&D and engineering costs cause a huge jump in investment.

The R&D department will develop and test one or more physical versions of the product concept. Developing a successful prototype, however, can take days, weeks, months or even years, depending on the product and prototyping methods.

Also, products often undergo tests to make sure they perform safely and effectively. This can be done by the firm itself or outsourced.

In many cases, marketers involve actual customers in product testing. Consumers can evaluate prototypes and work with pre-release products. Their experiences may be very useful in the product development stage.

7. Test marketing

The last stage before commercialization is test marketing. In this stage of the new product development process, the product and its proposed marketing program are tested in realistic market settings. Therefore, test marketing gives the marketer experience with marketing the product before going to the great expense of full introduction. In fact, it allows the company to test the product and its entire marketing program, including targeting and positioning strategy, advertising, distributions, packaging etc. before the full investment is made.

The amount of test marketing necessary varies with each new product. Especially when introducing a new product that requires a large investment, when the risks are high, or when the firm is not sure of the product or its marketing program, a significant amount of time may be spend on test marketing.

8. Commercialization

Test marketing has given management the information needed to make the final decision: Launch or do not launch the new product. The final stage in the new product development process is commercialization. Commercialization means nothing else than introducing a new product into the market. At this point, the highest costs are incurred: the company may need to build or rent a manufacturing facility. Large amounts may be spent on advertising, sales promotion and other marketing efforts in the first year.

Some factors should be considered before the product is commercialized:

Introduction timing – For instance, if the economy is down, it might be wise to wait until the following year to launch the product. However, if competitors are ready to introduce their own products, the company should push to introduce the new product sooner.

Introduction place – Where to launch the new product? Should it be launched in a single location, a region, the national market, or the international market? In many cases, companies may lack the confidence, capital and capacity to launch new products into full international distribution from the start. Instead, they usually develop a planned market rollout over time.

Conclusion

In all of these steps of the new product development process, the most important focus is on creating superior customer value. Only then, the product can become a success in the market. As you can imagine, only very few products actually get the chance to become a success. The risks and costs are simply too high to allow every product to pass every stage of the new product development process. Given these risks and costs, it is of crucial importance to get these 8 steps of the new product development process right.

Distributed Control System for Industrial Automation

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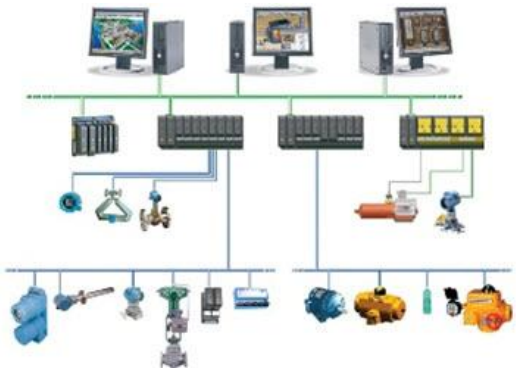
Introduction

Distributed Control System is a specially designed control system used to control complex, large, and geographically distributed applications in industrial processes. In this, controllers are distributed throughout the entire plant area. These distributed controllers are connected to both field devices and operating PCs through high-speed communication networks as shown in the figure.

Discrete field devices such as sensors and actuators are directly connected to input and output controller modules through a communication bus. These field devices or smart instruments are capable of communicating with PLC's or other controllers while interacting with real-world parameters like temperature, pressure, etc.

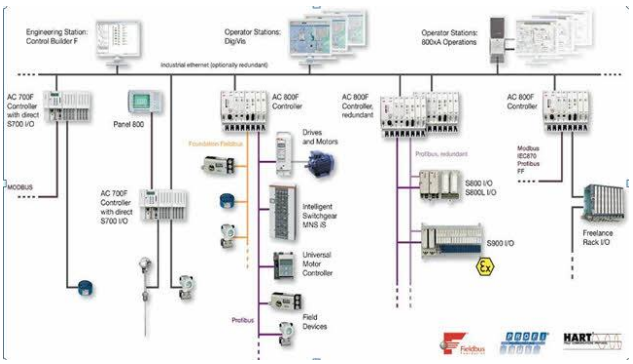


DCS Architecture

Controllers are distributed geographically in various sections of the control area and are connected to operating and engineering stations which are used for data monitoring, data logging, alarming, and controlling purpose via another high-speed communication bus. These communication protocols are of different types such as foundation filed bus, HART, Profibus, Modbus, etc. DCS provides information to multiple displays for the user interface.

Basic Elements of Distributed Control System

Distributed Control System continuously interacts with the processes in process control applications ones it gets instruction from the operator. It also facilitates variable set points and opening and closing of valves for manual control by the operator. Its human-machine interface (HMI), faceplates, and trend display give the effective monitoring of industrial processes.



Elements of DCS

Engineering PC or controller

This controller is the supervisory controller over all the distributed processing controllers. Control algorithms and configuration of various devices are executed in this controller. Network communication between processing and engineering PC can be implemented by a simplex or redundant configurations.

Distributed controller or Local control unit

It can be placed near to field devices (sensors and actuators) or certain locations where these field devices are connected via the communication link. It receives the instructions from the engineering station like set point and other parameters and directly controls field devices.

It can sense and control both analog and digital inputs/outputs by analog and digital I/O modules. These modules are extendable according to the number of inputs and outputs. It collects the information from discrete field devices and sends this information to operating and engineering stations.

In the above figure, AC 700F and AC 800Fcontrollers act as a communication interface between field devices and engineering stations. Most of the cases these act as local control for field instruments.

Operating station or HMI

It is used to monitor entire plant parameters graphically and to log the data in plant database systems. The trend display of various process parameters provides effective display and easy monitoring.

These operating stations are of different types such as some operating stations (PCs) used to monitor only parameters, some for only trend display, some for data logging, and alarming requirements. These can also be configured to have control capabilities.

Communication media and protocol

Communication media consists of transmission cables to transmit the data such as coaxial cables, copper wires, fiber optic cables and sometimes it might be wireless. Communication protocols selected depend on the number of devices to be connected to this network.

For example, RS232 supports only for 2 devices and Profibus for 126 devices or nodes. Some of these protocols include Ethernet, DeviceNet, the foundation filed bus, Modbus, CAN, etc.

In DCS, two or more communication protocols are used between two or more areas such as between field control devices and distributed controllers and another one between distributed controllers and supervisory control stations such as operating and engineering stations.

Important Features of DCS

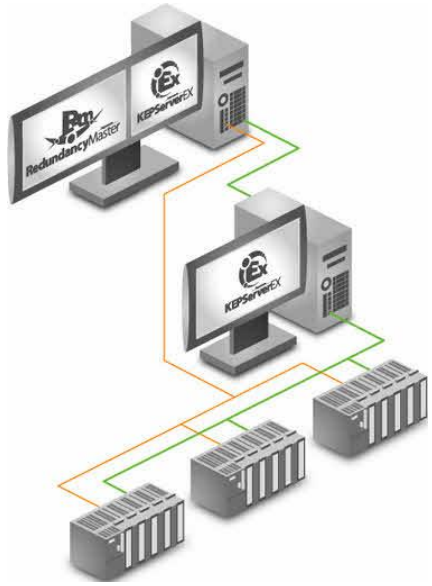
In the factory automation structure, PLC-Programming Logic Controller is used to control and monitor the process parameters at high-speed requirements. However, due to the limitation of a number of I/O devices, PLCs cannot handle complex structures.

Handling Complex Processes

Hence DCS is preferred for complex control applications with more number of I/O's with dedicated controllers. These are used in manufacturing processes where designing of

multiple products are in multiple procedures such as batch process control.

System redundancy:



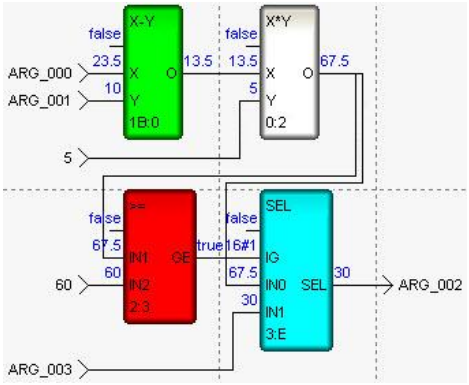
System Redundancy

DCS facilitates system availability when needed by redundant features at every level.

Resuming the steady-state operation after any outages, whether planned or unplanned is somewhat better compared to other automation control devices.

Redundancy raises the system reliability by maintaining system operation continuously even in some abnormalities while the system is in operation.

A lot of Predefined function blocks:



Predefined Function block

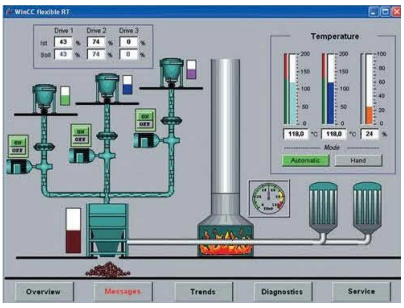
DCS offers many algorithms, more standard application libraries, pre-tested and pre-defined functions to deal with large complex systems. This makes programming to control various applications being easy and consuming less time to program and control.

Powerful programming languages:

It provides more number of programming languages like a ladder, function block, sequential, etc for creating custom programming based on user interest.

More sophisticated HMI:

Similar to the SCADA system, DCS can also monitor and control through HMI's (Human Machine Interface) which provides sufficient data to the operator to charge over various processes and it acts as the heart of the system. But this type of industrial control system covers large geographical areas whereas DCS covers the confined areas.



Sophisticated HMI

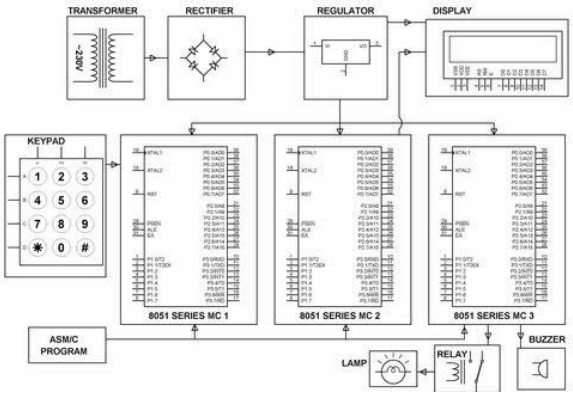
DCS completely takes the entire process plant to the control room as a PC window. Trending, logging, and graphical representation of the HMI's give an effective user interface. Powerful alarming system of DCS helps operators to respond more quickly to the plant conditions

Scalable platform:

The structure of DCS can be scalable based on the number I/O's from small to large server systems by adding more clients and servers in the communication system and also by adding more I/O modules in distributed controllers.

System security:

Access to control various processes leads to plant safety. DCS design offers a perfect secured system to handle system functions for better factory automation control. Security is also provided at different levels such as engineer level, entrepreneur level, operator level, etc.



Application of DCS

Here the input is given from a keypad to a microcontroller, which communicates with the other two microcontrollers. One of the microcontrollers is used to display the status of the process as well as the loads, while the other microcontroller controls the relay driver. The relay driver, in turn, drives the relay to operate the load.

Advantages:

Safety and system availability

The inherent redundancy built into Distributed Control Systems enables safe and disruption-free operation to be maintained in the event of a problem.

Reduced downtime

Auto-mated decision-making also reduces the potential for mistakes made by human operators, such as missing, misinterpreting or ignoring an alarm condition.

Visualisation

Functions such as datalogging and alarm management help to provide a clear picture of what is happening, enabling the operator to make informed decisions based on current plant data.

Scalability

A key benefit of Distributed Control Systems is their scalability, with extra control or process units able to be added to meet changing demands,

Security

With multiple layers of security for different levels of access, Distributed Control Systems offer a secure platform for handling key factory automation control functions.

Conclusion

As DCS contains the distribution of the control processing around nodes in the system, the complete system is reliable and mitigates a single processor failure. It will affect one section of the plant process; if a processor fails and the whole process will be affected when the central computer fails. This distribution of computing power to the field Input / Output (I/O) field connection racks also ensures fast controller processing times by removing possible network and central processing delays.

Program Outcomes (POs)

PO1	**Engineering Knowledge:**Apply the knowledge of mathematics, science, and engineering fundamentals to solve thecomplex electrical engineering problems.
PO2	**Problem Analysis:**Identify, formulate, reviewresearchliterature, andanalyzecomplex Electrical and Electronics Engineering problems enabling attainment of conclusions usingfirst principles of mathematics, natural sciences,andengineering sciences.
PO3	**Design/Development of Solutions:**Designsolutions, components or processforcomplexElectricalEngineering problemsto meet thespecifiedneedsconsidering publichealth, safety and environmental considerations.
PO4	**Conduct Investigations of complex problems:** Exercise researchknowledge and technical methodology for design,analysisandinterpretation of data to converge to a suitable solution.
PO5	**Modern Tool Usage**: Use modern engineering tools, softwares and equipments to predict, analyze and model engineering problems.
PO6	**The Engineer & Society:** Apply reasoning skills toassess societal,health,safety,legalandcultural issuesrelevanttothe professional engineering practice and take consequent responsibilities in the society
PO7	**Environment and Sustainability:** Realize theimpactof theprofessional engineering solutions anddemonstrate the knowledgefor sustainable developmentin environmental context
PO8	**Ethics:** Apply and realize theprofessionalethicsandresponsibilities in Electrical engineering practice.
PO9	**Individual and Team Work:** Exhibit Individuality, Leadership and Team spirit in multidisciplinarysettings.
PO10	**Communication:** Communicate, comprehend, write reports, design documentation and presentation effectivelyoncomplexengineeringactivities
PO11	**Project Management & Finance:** Demonstrate the Electrical engineeringandmanagementprinciples adhering to financial strategies to manage projects as a member or leader in a team
PO12	**Life Long Learning:** Inculcate independent and life-long learning inthe broadest context oftechnological change.

Program Specific Outcomes (PSOs)

PSO 1: Electrical drives and control: Graduates will Analyze, design and provide Engineering solutions in the field of Power Electronics and Drives

PSO 2: Embedded system: Graduates will Simulate, experiment and solve complex problems in Embedded System.

KSR INSTITUTE FOR ENGINEERING AND TECHNOLOGY

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VISION

To become a globally recognized Institution in Engineering Education, Research and Entrepreneurship.

MISSION

- Accomplish quality education through improved teaching learning process.
- Enrich technical skills with state of the art laboratories and facilities.
- Enhance research and entrepreneurship activities to meet the industrial and societal needs.

Department of EEE

VISION

To produce world class Electrical and Electronics Technocrats and Entrepreneurs with social responsibilities.

MISSION

- Impart quality education in the field of Electrical and Electronics Engineering through state of the art learning ambience.
- Enrich interdisciplinary skills and promote research through continuous learning.
- Enhance professional ethics, entrepreneurship skills and social responsibilities to serve the nation.

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