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GYANVESHAN

In Pursuit of Knowledge

The philosophy behind the name...

You may notice that "AN" is smaller than other letters in the title. It signifies something important. GYANVESHAN is a name built by combining two words – GYAN and ANVESHAN (with the common AN being merged into one) with GYAN meaning knowledge, and ANVESHAN meaning search or pursuit. That brings us to the tagline "In pursuit of knowledge".

Muthoot
Institute of Technology & Science

From Editor's Desk

Welcome to the seventh edition of our Technical Magazine! As we said earlier, 'Gyanveshan' provides you the perfect platform to exhibit your knowledge and insights in technical, literary and artistic domains. Carrying forward our agenda of information clubbed with inspiration, this edition also features a variety of scholarly articles.

'Going far beyond the normal, redefine the same, doing more than what others anticipate…' that is what we target with our caption 'passion for excellence'. And it comes from striving, maintaining the highest standards, looking after the smallest detail and running the extra mile'. This is exactly what we try to achieve as a MITSian. As you glance through the pages, you will realize that the seventh edition of 'Gyanveshan' is also a sincere attempt towards the aforementioned target.

The editorial board extends its special thanks to Executive Director, Principal and Vice Principal for their valuable comments and immense support to make this happen. Gyanveshan shall be a resourceful companion in your quest for technical knowledge!

Hope you enjoy this issue as much as we did making this for you. Happy Reading!!

Dr. Abhilash Antony
Faculty Chair, R&C Cell

GYANVESHAN, The Book of Articles - Vol 7, December 2022

"The greatest glory in living lies not in never falling, but in rising every time we fall."

- Nelson Mandela

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Air injection – A Mitigation Method to Soil Liquefaction

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Abstract

Soil liquefaction induced by earthquake has repeatedly damaged several engineering structures. Regular measures adopted for liquefaction mitigation are expensive for normal buildings and structures. Those traditional methods have limitations like environmental impact, disturbance to existing structures when subjected to vibrations and deformations, size of the area to be treated, etc. Air injection method is a new cost effective and ecofriendly method for mitigating the soil liquefaction. Desaturation of the soil can reduce excess pore water pressure generated during dynamic loading in order to reduce liquefaction. In this method, desaturation of the soil is achieved by artificially injecting pressurised air into the saturated, liquefiable soil without causing any significant hydro fractures.

Index Terms - liquefaction, air injection, desaturation

Introduction

Liquefaction is a phenomenon wherein a mass of soil loses a large percentage of its shear resistance, when subjected to monotonic, cyclic, or shocking loading, and flows in a manner resembling a liquid until the shear stresses acting on the mass are as low as the reduced shear resistance. The generation of excess pore water pressure under un-drained loading condition is the hallmark of this phenomenon. The saturated, cohesionless soil may undergo liquefaction during the earthquake loading, depending on the several parameters such as relative density, degree of saturation, effective confining stress and the boundary conditions that determine the pore fluid drainage.

Liquefaction

Soils have the tendency to densify when they are subjected shear stress. It will further lead to the generation of excess pore water pressure and decrease of effective stress. Consider a sand deposit at a depth z from the ground surface with the water table at the ground surface. If the sand deposit is shaken due to an earthquake or other oscillatory loads, extra pore water pressure (u') builds up and the shear strength equation becomes,

$$S = (\gamma' z - u') \tan\emptyset'$$

As the excess pore water pressure increases, the shear strength decreases. In extreme case, when the pore water pressure increases so high that the soil loses all its shear strength, then,

$$\gamma' z - u' = 0$$

As an after effect of this, sand boiling, lateral spreading, flow failures, ground oscillation, floatation, settlement etc occurs in the region. Unsaturated soil is more resistance liquefaction compared to saturated soil because of presence of air in soil pores, high confining pressure, lower initial pore pressure and matric suction.

Air Injection Method

Air injection is a cost-effective and eco-friendly liquefaction mitigation technique since it requires only the use of air, and its impact on the environment is insignificant. This approach basically relies on artificially injecting air into saturated, liquefiable soils without causing significant hydro-fracture. It has been reported that injection of air into the ground can substantially lower the degree of saturation of the subsoil. The unsaturated condition of the desaturated soil lasts for an extensive time period [1,2].

Factors Affecting Air Injection Method

- Pressurized air should be gradually injected into the soil to avoid settlement during the air injection process.
- Flow of air in the soil initiated only when injected air pressure exceeds the sum of hydrostatic pressure and air entry value. The hydrostatic pressure is exerted at the point of injection and air entry value is the matric suction value at which air starts to penetrate into the large pores of the soil [3].
- Air injection pressure should be less than in-situ effective stress to avoid the airflow induced soil crack or fissures around the injection point.

Mechanism of Air Injection

Air injection probe connected to the flexible tube is deployed in the borehole at targeted depth of soil. The pressurized air from the compressor is artificially injected into the soil at controlled pressure rate. Then the flow of air through the soil will start when injected air pressure exceed sum of hydrostatic pressure and air entry value of the soil. Ample time is provided for the uniform distribution of air though out the soil. The desaturation process is controlled mainly by the pressure of the injected air and by the soil permeability. By air injection process, degree of saturation of soil can be successfully reduced to a range of 80 to 86% within 4m around the injection point [4].

Cohesion less soils like sand have a tendency to compress when load is acting on it. If this soil is saturated, the spacing between the soil particles is filled by water. During the sudden and cyclic loading, water doesn't get enough time to squeeze out before the next cycle of loading. This will lead to the generation of excess pore water pressure in the soil. But in desaturated soil, air presence in the pores of the soil will absorb the excess pore water pressure generated during the dynamic loading [5]. Figure illustrates the concept of partial desaturation by air injection.

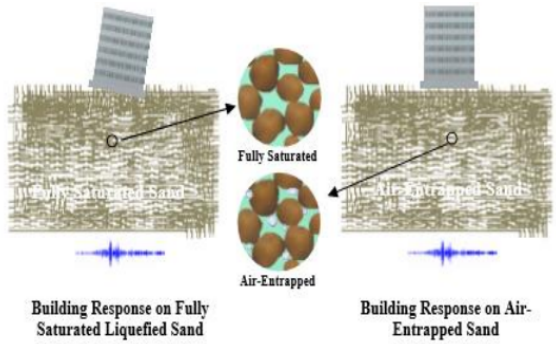

Fig: Concept of Partial Desaturation through Air Injection (Source: Ece Eseller et al. 2013)

Effectiveness of Air Injection on Liquefaction Resistance of Soil

Resistance of soil against liquefaction is generally determined by running undrained cyclic triaxial tests on undisturbed soil specimens. In this test, cyclic stress with constant amplitude is loaded repeatedly and the number of cycles is counted until either the excess pore water pressure becomes equal to the initial effective stress or peak to peak axial stain equal to the 5%. For determining liquefaction resistance of partially desaturated soil, frozen samples were collected from location where air injection process has been done, using ground freezing method. For the tests on saturated specimen, the frozen specimen was thawed in the triaxial cell under a confining pressure of 20 kPa, followed by a saturation process. On completion of the thawing process, the confining pressure and back pressure equivalent to the in-situ effective overburden pressure and the hydrostatic pressure respectively were applied to the specimen. The specimen was subjected to a cyclic deviator stress with a frequency of 0.1 Hz under undrained condition [3].

The cyclic stress ratio, σd /$2\sigma' c$, to cause double amplitude axial strain, DA = 5% after the 20 cycles is termed as the liquefaction resistance, R. Here, σd = deviator stress and $\sigma' c$ = initial confining pressure of the soil. Test carried out on the samples verified that liquefaction resistance of the desaturated sample indeed augmented, approximately twofold, relative to the fully saturated [4].

Conclusion

Viable ground improvement methods to mitigate liquefaction risks for existing structures are limited and costly. Research results shows that a small reduction in the degree of saturation of fully saturated sand can improve the shear strength of the soil significantly. It is clear that air injection technique can double the liquefaction resistivity of the soil by partial desaturation. Sometimes, this may lead to settlement of foundation soil during air injection process if the pressurized air is applied rapidly. Hence care must be taken to make sure that the application of pressurized air is done gradually.

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Breast Cancer Detection using Thermograms

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Abstract

Breast cancer is the most common invasive cancer in women. Early detection of breast cancer reduces mortality. There are different modalities for detection like Mammography, Ultrasound, MRI, Thermography etc. Mammography is the most widely used method for breast cancer detection, in which the screening technique uses low dose X-rays whereas thermogram uses infrared camera. Thermogram do not have ionizing radiations and they are non invasive. For a patient with dense breast, thermogram is better compared to others modalities, as dense tissues camouflages tumour. With the advancement in the quality of infrared camera, thermography can be recommended as an adjunct to mammography.

Index Terms – Breast cancer, modalities, thermogram

Introduction

Breast cancer is one of the important cause of cancer related deaths among women . If it can be diagnosed and treated at a very early stage, the mortality can be reduced. It usually develops in breast cells. The cancer cells divides and hence it gets multiplied in an uncontrolled way and it also enters in to healthy breast tissue and can travel to the lymph nodes under the arms. The primary pathway that helps the cancer cells move to other parts of the body is the lymph nodes.

Cancer affects lobules, which are the milk producing glands and it can also happen in the ducts which are the pathways that carry the milk from the glands to the nipple. Fatty tissue or the fibrous connective tissue within the breast can also get affected. Infrared thermography has shown to be a promising technique to early diagnosis of breast pathologies for the past ten years.

Thermography is recognized as an adjunctive diagnostic breast cancer screening procedure in 1982 by Food and Drug Administration. There are different types of breast cancer like DCIS, LCIS, IDC and ILC. Ductal carcinoma in situ has abnormal cells in the duct and is a non-invasive condition. In DCIS, there is a change in the cells that line the ducts in the breast and it looks cancerous. But it is not a dangerous situation because DCIS cells will not be invading the surrounding breast tissue. Cancer that grows in the lobules are Lobular Carcinoma in situ (LCIS). It is diagnosed in women with age between 40 and 50 and right before menopause. Invasive Ductal Carcinoma is the most common type and it starts with the milk ducts and then nearby tissue in the breast is invaded. Invasive lobular carcinoma (ILC) develops in the lobules of breast. It spreads to nearby tissue and organs.

Different modalities are available for breast cancer detection. The importance of thermography lies in the fact that they are painless, non ionizing functional exam and is suitable for women with dense breast tissues. In some studies, for the women with premenopause, radiation risk assessed is 2% . The cost of thermogram is less compared to other modalities and hence can be used as an adjunct with others.

Importance of Thermography

Temperature variations in the body is detected in the imaging technique called Infrared breast thermography. The radiations emitted from the human body are higher around the regions where a tumour is present because of increased blood vessel circulation and metabolic activity. Digital Infrared Thermal Imaging (DITI) is a functional imaging technique rather than structural imaging technique and it records the thermal pattern of the body. Thermography is useful for women with dense breasts (age less than 40) and the method is non invasive.

When combined with mammogram, thermography has 83% of sensitivity and 95% of specificity. Surface temperature of breasts is detected in thermograms. Color analysis, asymmetric analysis, segmentation approaches, sequential feature selection, artificial neural networks etc are employed. In thermographic screening, breast is screened first and the thermal changes are analysed. The image obtained will be subjected through various image processing techniques like pre-processing, segmentation, feature.

Infrared images do not use ionizing radiation, venous access, or other invasive procedures. It is painless and has no contact with the skin surface, causing no nuisance to the patient. It also has advantages for the diagnosis in young women, because dense tissues present difficulty for early visualization. For instance, micro calcifications and masses are usually well visible only in mammograms of women in non-reproductive ages. Moreover, thermography is very useful for detecting non palpable breast cancer; that is, those that cannot be detected by other exams. This also applies to non-palpable but histological advanced or those with fast and aggressive growth.

Physics of Thermal Breast Imaging

Human body emits infrared electromagnetic radiation. Thermographic sensors capture the natural thermal radiation generated by an object at a temperature above absolute zero. All objects that have temperatures above this value (0 K or -273 degree C) emit infrared radiation from its surface. Relationship between the energy radiated by an object and its

temperature is described by the Stefan–Boltzmann law. "From a surface the total amount of energy radiated is proportional to the fourth power of its absolute temperature". The measured infrared radiation emitted by one point of the skin can be converted directly into a temperature value that represents this point and then mapped to a pixel in a false-color image of the scene.

Image Processing Techniques

The images obtained from the Infrared camera should go through a series of preprocessing tasks. Noise removal or any other artifacts can be removed using preprocessing steps. Then the preprocessed images are segmented. The region of interest can be segmented and then features are extracted. Combination of various features can be employed for the detection.

Then the images are classified using supervised or unsupervised classification methods. Process of dividing an entire image in to different partitions is called Segmentation. It includes thresholding methods, histogram-based methods, edge detection methods, Region growing methods etc. Deep learning methods have the ability to automatically extract features from a training dataset.

Conclusion

Among women, breast cancer is the leading cause of cancer related deaths all over the world. It will take years to become cancerous from a precancerous condition. So the detection at an early stage helps in getting a better medical recovery. There are lots of breast cancer detection modalities like mammography, ultrasound, thermography, MRI etc. Although mammography is the most popular and effective detection method, it is not free from problems. In mammogram patient discomfort is there, as their breast is getting compressed while taking an x-ray. Patients with age less than 50 and with dense breast, thermogram is a better option. Thermogram do not have a risk of radiation and they are non invasive. Hence thermogram can be used as a screening tool along with other modalities. For better detection of breast cancer we can improve the segmentation and feature extraction techniques along with incorporating deep learning models.

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Cloud, Fog, and Edge Computing: The Future of IoT

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Abstract

Cloud, Fog, and Edge Computing paradigms have been established for data-driven organizations in order to promote data computation and processing in an easier manner. Considering that there has been a vast multiplication in the amount of data produced over the past couple of years, and it is anticipated that the amount of data produced will exponentially stretch, recent research has focused on utilizing these paradigms in order to serve the growing demand of fast computation and data storage.

Index Terms – IoT solutions, Cloud computing, Fog computing, Edge computing.

Introduction

A Statista study shows that the number of IoT devices connected worldwide reached 10.07 billion in 2021, which is reckoned to grow to over 25 billion by the end of the year 2025. Such a large number of devices in constant communication would be in need of huge amounts of data that is brisk to process and yet sustainable. Cloud computing and fog cloud computing techniques have been conventionally implemented for IoT solutions. However, this trend is alternating with the entry of edge computing. Will cloud and fog computing methodologies eventually lose against edge computing?

Cloud computing: The global facet

Cloud computing is the process of delivering on-demand services or resources over the internet that allows users to gain seamless access to resources from remote locations without expending any additional time, cost or workforce. Switching from building in-house data centres to cloud computing helps the company lessen its investment and maintenance costs significantly. The key benefits of cloud computing are:

- Cost efficiency – A significant chopping in operational costs.
- Resource unification – Many users can use the same resource in real-time.
- Upscaling – Companies can begin projects at a minuscule level and lengthen during the course of the project.

Since cloud computing manages resources in remote locations, the collection and processing of data experiences a time lag. This time lag, although insignificant in most cases, becomes a profound issue with real-time projects or time-sensitive applications like online gaming, e-commerce sites, etc.

Fog computing: Sportier but tinier

Fog computing is a type of computing architecture that utilises a series of nodes to receive and process data from IoT devices in real-time. It is a dispersed infrastructure that provides ingress to the entry points of various service providers to compute, store, transmit and process data over a networking area. This method significantly ameliorates the efficiency of the process as the time utilised in the transmission and processing of data is reduced. In addition, the implementation of protocol gateways ensures that the data is settled. Some of the advantages of fog computing are:

- Latency – Low latency ensures absolute processing of data in real-time.
- Integration – Multiple nodes of data transmission as well as IoT devices can be employed.
- Mobility – Fog computing bears the mobility of IoT devices to a certain extent.
- Privacy – User's sensitive data can be analysed locally instead of sending it to the centralised cloud infrastructure.

Fog computing provides added security to the network. However, encryption protocols and gates lead to denser data which is tedious for arbitrary devices to process. Achieving data consistency is another dare faced by the architecture.

Edge computing: the dark horse

Cloud or fog data prove to be unreliable when dealing with applications that require instantaneous responses with tightly managed latency. Edge computing deals with processing persistent data located near the data source in a region considered the 'edge' of the apparatus. Implementation of edge computing has some indispensable benefits:

- Latency – The time elapsed in the transmission and processing of data is trivial.
- Feasibility – Reduced cost of cloud services and their processing costs results in a cost-effective architecture.
- Portability – The IoT devices can be moved around in the general area covered by 'edge'.
- Operational autonomy – With local storage and computation, it permits the solutions to function seamlessly, even if it is not connected to the network.

Although the adoption of edge computing has significantly increased with the rise of real-time applications, it still depends on cloud computing for large scale propagation from remote locations.

Cloud and Fog: Interplay with IoT

The coordination between IoT and cloud computing gives tremendous opportunities for companies to utilise

turbulent growth in terms of location, scale and speed of access. Companies like AWS, Microsoft Azure, etc., play different roles in the IoT ecosystem by providing a torrent of services for applications like smart agri IoT, device lifestyle management, smart-home solutions, etc.

The users become progressively efficient as they harness the symbiosis of fog computing with IoT in applications like video streaming, online gaming, real-time healthcare monitoring, smart traffic light systems, etc.

Is the future cloudy, foggy or edgy?

The future of edge and cloud computing is swiftly evolving with increased connectivity, reduced storage costs, etc. According to Forbes.com, some analysts claim that edge computing will replace cloud computing. Edge computing has played a pivotal role in 5G applications as low latency plays a crucial role in high-speed networking. However, edge computing relies heavily on cloud and fog computing when it comes to projects spanning large areas. In the current scenario, brands follow the trend of utilising an amalgam of the three architectures in tandem with each other.

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Computer vision in a glance

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Abstract
Computer vision is a field of artificial intelligence (AI) that enables computers to derive meaningful information from visual input. This article will give an overall idea about the computer vision.

Index Terms - Computer Vision, Artificial Intelligence.

Introduction

Artificial intelligence is branch of computer science which makes computer mimic human behaviour i.e. to think and respond like humans do. Computer vision is a field of artificial intelligence (AI) that enables computers to derive meaningful information from digital images, videos and other visual inputs — and take actions or make recommendations based on that information. If AI makes computers able to think like humans, computer vision makes them to see, observe and understand like humans do.

Computer vision trains machines to perform functions which human sight can do, say tell what object is it, how far away are they, whether they are moving, their location etc. But it has to do it in much less time with cameras, data and algorithms rather than retinas, optic nerves and a visual cortex

Tasks of Computer Vision

The main tasks of computer vision are Image Classification, Object Detection, Semantic Segmentation and Instance Segmentation. Image Classification basically means identifying which class the object belongs to. Object Detection is the ability to detect objects in any given image correctly along with their spatial position in the given image, in the form of rectangular boxes (known as Bounding Boxes) which bound the object within it. Image segmentation is the process of dividing an image into different regions often based on the characteristics of pixels to identify objects or boundaries to simplify an image and more efficiently analyse it. Semantic segmentation treats multiple objects within a single category as one entity. Instance segmentation, on the other hand, identifies individual objects within these categories.

Applications of computer Vision

Most popular field of application of computer vision are in

Transportation (Example: Self-driving cars, Pedestrian detection, Traffic law enforcement, Automatic Traffic management etc.)

Healthcare (Example: X-ray analysis, Cancer Detection etc.)

Manufacturing (Example: Defect inspection, Reading text and barcode etc.)

Construction (Example: Predictive maintenance, PPE detection etc.)

Agriculture (Example: Livestock health monitoring, Crop and yield monitoring, Insect detection etc.)

Retail (Example: Self-checkout, Automatic replenishment etc.)

Different Approaches used in Computer vision

In traditional computer vision based approaches involved an in-depth analysis of the input and output to extract mathematically representable features from an image and these hand crafted features are coupled with an efficient algorithm to produce the desired result. With the invent of deep learning based approaches there's no longer need of defining the features and do feature engineering. The neural do that for you.

Computer vision tools

Most Popular Computer Vision Tools are: OpenCV, Viso Suite, TensorFlow, CUDA, MATLAB, Keras etc.

Conclusion

Today, without us even noticing, computer vision is already enhancing our lives. Despite the recent progress, which has been impressive, are only scratching the surface of this technology's potential, which is nearly limitless

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Effect of Openings on the High Performance Concrete Shear Walls

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Abstract

Shear walls are used to carry lateral loads along with the gravity loads in the case of tall structures. Openings are integral part of these walls for accommodating windows, doors, service ducts, etc. These openings affect the entire behaviour of structures. This article discusses an experimental study conducted on High Performance Concrete (HPC) slender shear walls with openings. Three shear wall specimens having three storeys (one-fourth scaled down) were studied to understand the effects of openings on HPC shear walls. One specimen was solid shear wall and other two specimens were having regular and staggered openings. The experimental results indicated that the openings reduce the stiffness, strength and energy dissipation capacity of shear walls significantly. Also, the openings located closer to the boundary elements had more undesirable effects than regular openings positioned at the middle of the shear walls.

Index Terms – High Performance concrete, Openings, Shear wall

Introduction

Shear walls are structural elements used in tall buildings to resist the lateral loads such as seismic and wind loads. For buildings having more than ten storeys, shear walls are more economical than moment-resisting frames. Shear walls are positioned such that the centre of lateral rigidity of shear walls coincides with the centre of mass of floor. Researchers have studied the behaviour of reinforced concrete (RC) shear walls from 1950s [1,2]. Openings are provided in shear walls to accommodate the functional requirements like doors, windows and ducts. These openings reduce the strength and stiffness of the RC shear walls. Various studies were conducted and published on the effect of openings in RC shear wall [3-13]. Researchers studied the effect of the size of openings [1,5], orientation of openings [4, 6, 8, 9], shapes of openings [6, 10] and reinforcement around openings [1, 6].

High-Performance Concrete (HPC) has any one of the enhanced properties like strength, durability, air entrainment, sustainability etc. Properties of HPC had been under investigation by numerous researchers and these studies were compiled in the state of the art report by Strategic Highway Research Program [14]. The effect of different admixtures on the behaviour of HPC is still a topic of research around the world. This article includes experimental studies on the effects of openings on the behaviour of HPC slender shear walls. In the experimental study, HPC with a minimum cube compressive strength of 60 N/mm^2 was used. Three slender shear wall specimens with and without openings were tested against reverse cyclic lateral loading.

Experimental study

Three HPC slender shear wall specimens were cast and tested under lateral reverse cyclic loading to understand the effects of opening orientation. Detailed literature review on the effect of various admixtures on HPC mix revealed that the use of silica fume improves the short and long term properties while fly ash improves long term properties of HPC and the combined use of silica fume and flyash enhances the strength, transport and durability properties significantly. Hence these two mineral admixtures were used to develop HPC mix in the current study. Details of materials, mix proportioning, specimen dimensions, test setup and instrumentation (Figure 1), loading pattern and test results are given in [15].

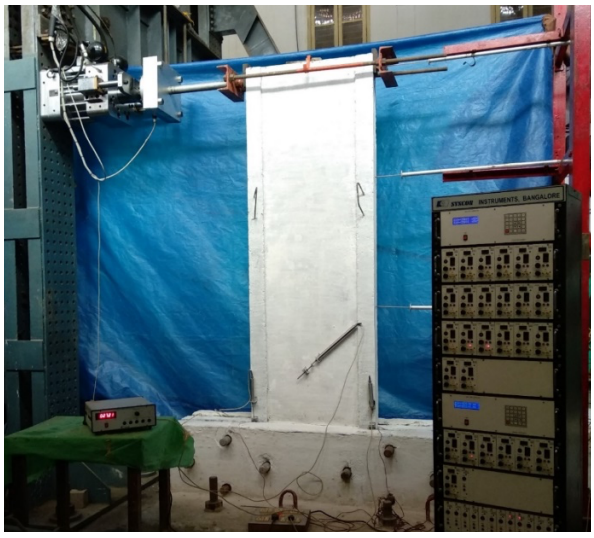

Figure 1 Test setup and instrumentation

HPC mix having a minimum cube compressive strength of 60 N/mm^2 was designed based on the method suggested by Aïtcin (1998) [16] which follows the guidelines given in ACI 211.1 (1991) [17].

Data collected in the controller of the actuator were used to plot the load-top displacement hysteresis curves of the specimens. Stiffness degradation and energy dissipation capacity of the specimens were developed from these hysteresis curves. Crack pattern (Figure 2), load-displacement behaviour (Figure 3), first crack load and ultimate load (Table 1), stiffness degradation and energy dissipation capacity of the specimens are given below.

(a) (b) (c)

Figure 2 Crack patterns of HPC specimens (a) S1 (b) S2 (c) S3

Table 1 Experimental results of specimens (a) S1 (b) S2 (c) S3

Specimen	First crack load (kN)	Ultimate load (kN)		Mean ultimate load (kN)
		+ve	-ve	
S1	21	59.3	49.12	54.21
S2	22	48.3	46.03	47.17
S3	16	45.94	45.69	45.82

Conclusion

This article presents an experimental study of HPC slender shear wall with openings focusing on the effect of orientation on the behaviour of shear walls. HPC having a compressive strength of 60 N/mm^2 was obtained by following the recommendations on the mix design by Aïtcin [16]. The following conclusions can be drawn from experimental study.

1. The openings (15.6% opening area) caused around 15% reduction in the strength of slender HPC shear walls.

2. Among the opening orientations, staggered openings caused more reduction in strength and stiffness. This was due to the presence of openings near the boundary element.

3. Regular and staggered openings caused nearly 50% reduction in the cumulative energy dissipation capacity of solid shear wall specimen.

4. The short diagonal reinforcement bars provided at the corners of the openings prevented the local failure that may have occurred due to the stress concentration.

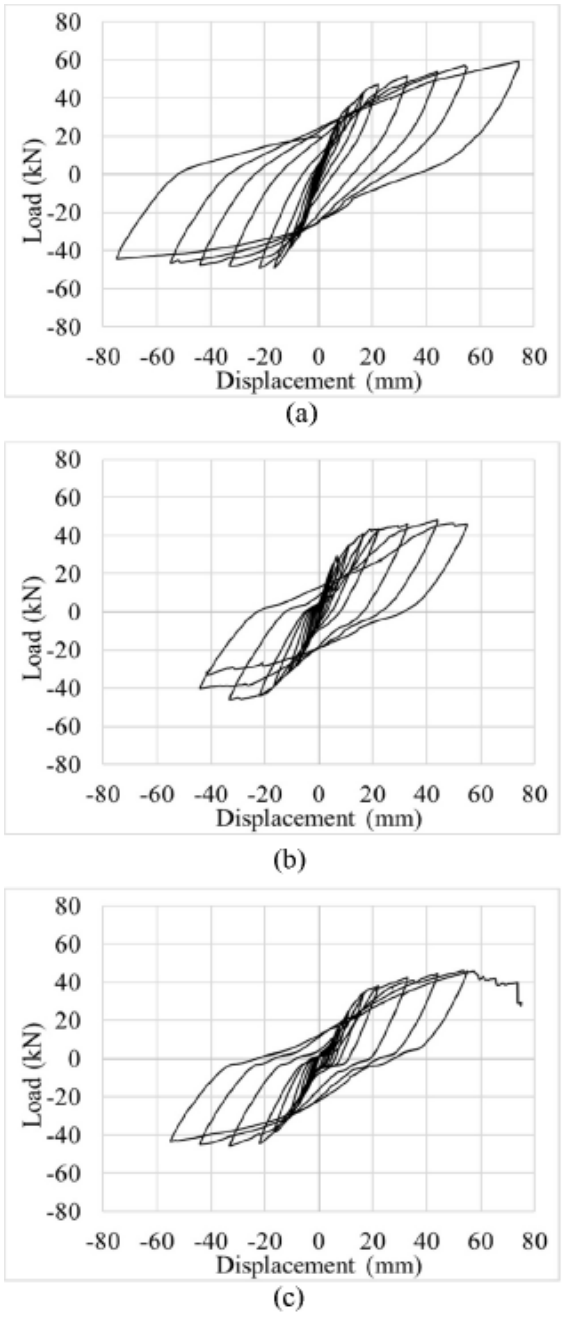

Figure 3 Load – displacement hysteresis

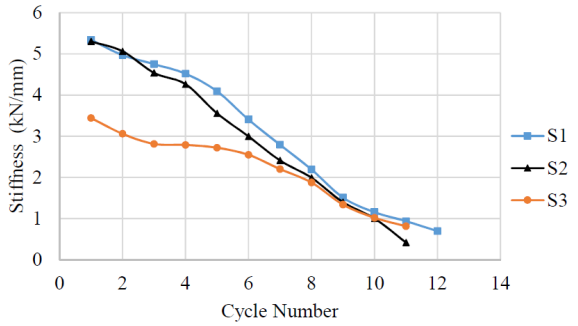

Figure 4 Stiffness degradation

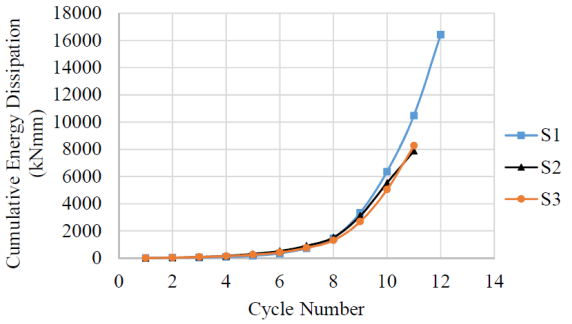

Figure 5 Cumulative energy dissipation

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FAQs on Electric Vehicles, charging infrastructure and impact on the electric grid

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Abstract
The issue of pollution, especially due to emissions from IC engine-based vehicles is very much in public focus. One of the solutions that is being offered is a shift to Electric Vehicles. The Battery Electric Vehicle (BEV) is seen as the most viable EV solution among various configurations possible. The most immediate incentive for the consumer is the present economic advantage of low running cost. The added comfort of having contributed to a greener solution is a secondary factor. There are many questions regarding the claims of zero emissions of BEVs. There are rumors of an imminent electric grid overload and possible collapse of the existing electric grid due to added power demand from EVs. For a more informed academic community, the questions require more detailed and quantitative answers. Here we try to pose some commonly encountered questions and their brief response.

1.The BEVs are not always zero emission, but then how much environment friendly are they?

If we limit ourselves on the emissions during the running of the vehicle and neglect the carbon footprint during the manufacturing and disposal, the emissions depend on the emissions due to the mix of electricity generating stations connected to the grid. If it is predominantly hydro-based, the emissions are lower and if they are more thermal power plants, the emissions are higher. If the BEV is charged only from renewable sources like solar PV, then of course the operating emissions are zero. But again, the Solar Plant components during its manufacture and disposal have a definite carbon footprint. The BEVs are going to bring down the air pollution in the city center, but they are not zero emission by any stretch of imagination. Battery from EVs require very careful recycling and environmentally sensitive disposal arrangements.

The Combined Margin(CM) value for the Indian grid during the year 2017-18 with interstate energy transfers is 0.91 ton/MWh. For Hydro Power stations, it is said to be 0.11 – 0.15 ton/MWh.

2.How do we incentivize the setting up of fast chargers? Why is the roll-out very slow? Can we use renewables like Solar PV to supply the charging stations and make EV operation truly zero emission?

The depletion of fossil fuels and increasing environmental concerns are major factors working in favor of Electric Vehicles (EVs). The battery and Electric motors are the main components for energy storage and drive/propulsion. The limited energy storage capacity of present battery technologies (in comparison to fossil fuels) and more importantly, the limited rate of charging are main irritants for EV users. A wide availability of fast DC chargers and low rates for charging will incentivize the user to ignore the range limitations and increase the EV adoption. From the perspective of the Electric Utility, the additional load demand due to EV charging is both a boon and a curse. The utility can increase its revenue but needs to invest in increasing the capacity of the distribution network. This investment can be minimized with optimal placement of the EV chargers. Private players investing in setting up EV chargers need to be educated on the optimal charging placements and need to be financially incentivized to use these grid optimal locations. The optimal charger locations also need to studied on basis of economic viability of the locations and ensure good Return on Investment (ROI). A planned infrastructure development for Electric Mobility will beneficial for long term growth in EV based transportation. A scheme for tax rebates, low interest loans etc. can help increase the number of fast DC Chargers. The present charging rate in DC fast charging stations vary between Rs 10 – Rs 25/- per kWh. If the government tries to compensate the revenue loss due to decreasing sales of petroleum products by increasing the taxes on energy consumption from Fast Chargers, the financial advantage of EVs will reduce and the adoption of EVs will slow down. The higher population density in cities and higher cost of land make entirely Solar PV based chargers unviable. Solar panels without energy storage can support charging only during daytime sunshine hours and a kW of generation requires approximately 5 – 6m2 area. (one standard panel of 2m2 can generate 425- 440 Watts peak). One kW of Solar panel generates 4-4.5 kWh of energy in a day. A charging station with 200kW power requirement will require 1000m2 of panel area (10,770 sq feet) and would generate 800 – 900 kWh of energy per day. This would suffice to fully charge 30 SUVs of the ratings similar to Tata Nexon EV. This kind of roof area would require large investment. If the distribution network allows free-wheeling of energy, the Solar PV plants can be installed away from city areas and the power generated can be used in these chargers.

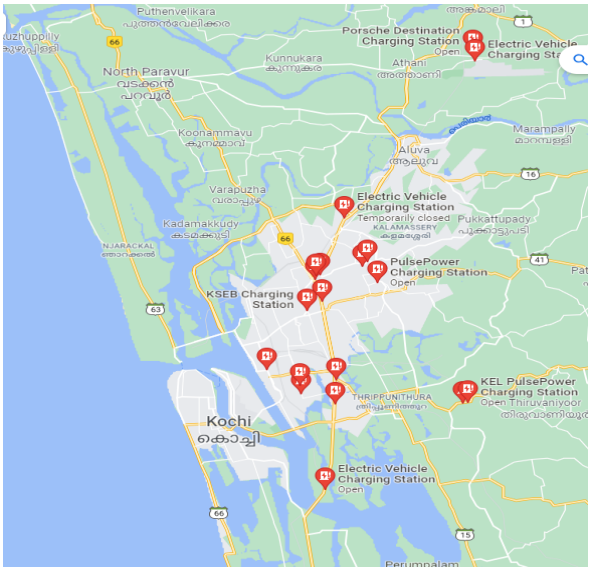

Fig 1. The EV fast chargers in Ernakulam area.

3.What are the energy requirements EV operation? Is there a way to estimate the additional energy required due to addition of EVs?

The size and rating of passenger vehicles in India have been lower in comparison to their counterparts in US or other developed countries. This trend is expected to hold good in case of EVs also. An average passenger car in the EV avatar can be expected to have a battery size of 20-30kWHr with a certified range of 200-300kms on a single charge. The number of Electric two wheelers will be large but the power ratings of these will be small. The ratio of two wheelers to four wheelers in India is 74:26 or approximately 3:1. The battery capacity of two wheelers range from 2.5-3.0kWHr, which is 1/10th of the passenger car battery capacity. In essence we can conclude that the ratio of energy requirement of the two wheelers to that of four wheelers is 1:3 taking into account their unit energy requirements and the total numbers. (numbers in 3:1 and energy in 1:10 ratio)

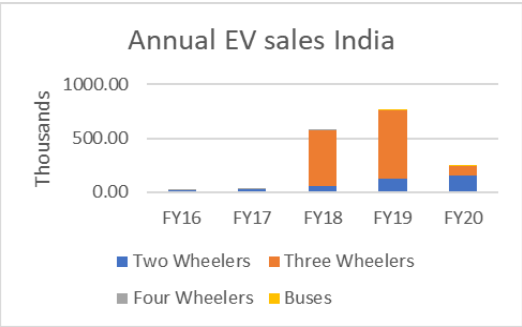

Fig 2. EV sales in India. The decline in 2020 is due to the pandemic.

Kerala Scenario:

The available data from the year 2016 for the state of Kerala is given below:

Table 1. The vehicle statistics in Kerala-2016

Region	Cars	3 W	2 W
Trivandrum	2,87,495	70,698	8,34,151
Ernakulam	3,53,721	58,271	10,04,232
Kozhikode	1,65,334	51,449	6,39,437
Kerala state	21,78,202	6,10,235	64,72,302

In near future, even going by an optimistic EV adoption rate of 20% of two wheelers and 10% of four wheelers and assuming a modest annual growth of 10% in vehicle numbers, we end up with 3,50,801 four-wheeler EVs (0.1*21,78,202*1.15) and 20,84,741 EV two wheelers (0.2*64,72,302*1.15) in 2021.

The average daily running for a four-wheeler can be taken as 30km and 15km for a two-wheeler. Tata Nexon EV delivers 220kms for a full charge of 30kWHr and therefore has an energy/km of 0.14kWHr. For an electric scooter, the average energy/km is 0.033KWHr. Therefore the additional electrical energy requirement per day is (0.14* 30* 3,50,801 + 0.033 * 15 * 20,84,741)= 25,05,310 kWHr. The annual energy increase due to EVs is 91,44,38,513kWhr (914 MU). The component of large transport like trucks and 3 wheelers in commercial segment can be taken to be equal to the passenger segment calculation and we can conclude that total additional electric load that may arise will be 2000MU.

The annual electricity consumption of Kerala State is shown in Fig(1). The extra demand of 2,000MU due to EVs is 8% of the total annual demand of 25,178MU. As the standard of living improves, the use of electrical appliances increases and the per capita electricity consumption increases. The contribution due to EVs remains small and therefore the impact due to larger penetration of EVs will be manageable.

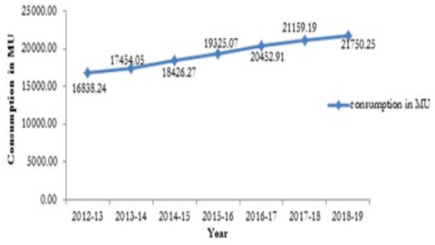

Fig 3. Annual Electricity consumption in MU

Another check on the expected Electricity demand can be from Kerala's 750kWhr per capita annual electricity demand and population of 35,699,443. This gives a projected annual demand of 26,774MU.

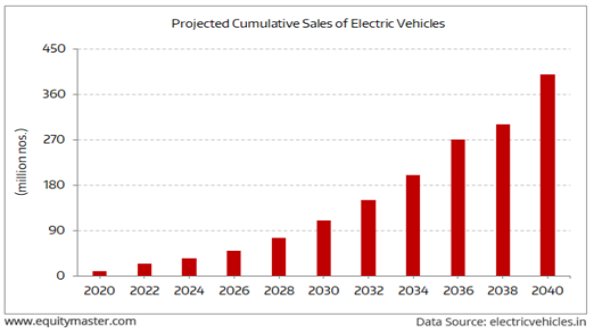

Fig 4. Predicted EV growth. Optimistic projection

4.Extreme Scenario: What will happen if all passenger cars are EVs?

Statistics show that Kerala has 250 registered vehicles per 1000 and an average vehicle user travels 35km per day. If we take an energy consumption of 0.14kWHr/km for EVs, we end up with a figure of 15,961MU (35699*250*35*0.14*365 = 15,961MU for passenger vehicles alone). Additional increase will come from the goods vehicles and public transport sector. This confirms the common belief that the electricity demand will almost double if all vehicles are converted to EVs. As the population grows standards of living improve, the vehicles per 1000 will increase and consequently the energy demand for EV charging will also increase. This will be accompanied by savings in imported oil bill and decrease in vehicular pollution.

As far as Kerala is concerned, the highest vehicle population was recorded in Ernakulam District with 17,96,868 vehicles (14.9 per cent) followed by Thiruvananthapuram with 15,23,414 (12.7 per cent). Wayanad District has the lowest number of 1,76,093 (1.5 per cent) vehicles. The area of Ernakulam district is 3032km2. This gives a vehicle density of 592 per km2.

The growth of EVs will be concentrated in urban pockets. The need for DC chargers will be more in urban areas and the grid needs to be modified to handle the extra load.

5.What about the goods transport sector? Will they adopt Electric Vehicle technology?

An electric truck consumes 1.14kWhr/km and can be assumed to transport a payload of 10 Tons. Therefore, for a minimum acceptable operating range of 300kms, it will require a battery pack of 350kWhr.

This truck claims 1.5kWhr/km and a 200km range with full payload. It has a battery pack of 240kWhr. The range of 200kms for a long haul truck is very low and a working range of 500 – 750kms is very desirable. The battery pack size for such a range and its cost is prohibitive at present. The running cost reported by Ms Infraprime is Rs 10/km for a 60 ton vehicle. This is 1/3rd of the Rs 30/km cost for a diesel truck. The highways need to have DC fast chargers of 160 – 300kW capacity to handle the needs of the truck industry.

Fig 5: India's Heavy truck – EV India's 60 Ton by InfraPrime Logistics Technology (IPLT)

Concluding comments

•Going by the present consumer sentiment and government policy, the EVs will be widely accepted and their penetration will grow. The Indian dependence on imported oil is detrimental to its economic growth and EVs provide a way to reduce this dependence.

•Government will eventually shift the oil taxation fully or partially to EV charging tariff. The main benefit of adopting EVs will be lower emissions and lesser maintenance. It will not be so much on the lower running cost.

•A comprehensive policy for setting up Fast Chargers in a planned manner is very essential for faster adoption of EVs. The present haphazard growth by different private and public sector agencies will be costly in terms of grid efficiency and power quality.

•Long haul transport may opt for hybrids or battery swapping techniques, because one hour stop-over every 200-300kms is not going to be practical for long distance commuting.

•A promising battery development is the Blade Battery with LFP(Lithium Iron Phosphate) chemistry. The battery demonstrates better crash safety (much needed for EV applications) and effective life of 3000 Charge discharge cycles. For a Tata Nexon type SUV with 30kWHr battery pack delivering 250kms, the battery pack will last 3000*250 = 0.75 million kms. If the battery pack rating is 60kWHr, the range would almost double to 1.35 million kms (larger rated battery will be heavier and thus the vehicle range will be reduced).

•A state like Kerala with very high population density and higher vehicle per person, EVs are a very desirable option. The state is blessed with ample hydroelectric resources and good sunshine. A long-term plan for integration of renewables with proper redesign of the electric grid will pay rich dividends.

•The dominance of PRC (People Republic of China) in the raw materials, battery technologies, electric motors and its rare earth magnets combined with its expansionist agenda poses real challenges for India. A counter move by Oil Producing Countries in reducing

oil prices may slow the EV adoption. Environmental considerations alone do not determine the actions of the developed countries.

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The article uses opinions and figures from a wide variety of internet sources. Specific journal articles have not been quoted as they are not directly related to the specific conditions of Kerala. The long-term growth forecasts have a lot of uncertainty in terms of Government policy formulations and global energy trade policies.

Malayalam Word Sense Disambiguation Using Support Vector Machines

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Abstract

Word sense disambiguation is a major part in the area of Natural language processing. In different contexts, a word may give an absolutely different meaning. The detection of the correct sense of these ambiguous words from their context is known as WSD. The major part of this work includes WSD in Malayalam using a Machine Learning model approach.

Index Terms - Artificial Intelligence; Natural Language Processing; Support Vector Machine; Word Sense Disambiguation; Trigrams'nTags(TnT) tagging; Malayalam Processing

Introduction

"Word Sense Disambiguation" is one of the most influential parts in language processing technology. WSD means selecting the sense of a specific word from a set of predefined possibilities based on its context [5]. Hence WSD can be called a classification problem in natural language processing. Due to the increasing growth of technologies and applications, automatic WSD systems are now available for many languages [8,9,10]. But when it comes to Malayalam, the richness in agglutination and morphological operations makes our language processing tedious. It is a challenge to have so many colloquial words in Malayalam and to have the networks of the same word that give many different meanings. Here is an example that shows an example of semantic disambiguation in Malayalam.

1.നല്ല ഉത്തരങ്ങൾ നല്ല ചോദ്യങ്ങൾക്കു ലഭിക്കുന്ന സമ്മാനം ആണ്.(In this context the word "ഉത്തരം" means answer)

2.ആ ഉത്തരത്തിന് അത്ര ബലം പോരാ . (In this context "ഉത്തരം" means a beam for support or attic)

Here the word 'ഉത്തരം' has different meanings in two sentences. The "Malayalam Word Sense Disambiguation" task is important in determining what sense of such words are used in those sentences and how accurate or apt they are in those sentences.

Many standard machine learning techniques can be used for resolving this issue. The issues faced in designing an automatic WSD in Malayalam was the lack of a standard corpora. Here three polysemic Malayalam words (which is shown in Table 1) were chosen and a corpus has been constructed containing 300 contexts, specifically for this purpose. Even though some works in Malayalam automatic disambiguation has been conducted, they did not result in the creation of corpora. Naive Bayes, Support Vector Machine, Maximum Entropy, Decision Tree etc. are some among them [5]. In this work, a multi-class linear based support vector machine approach is used. There are many WSD works done in other languages, especially in English, Chinese etc., but very few in Malayalam. Mainly this paper includes 4 sections:

First section includes related works in this area. Second section presents a brief description about the proposed systems. Third section includes the results and discussion. Finally, the fourth section ends the paper with a conclusion.

Table I: Ambiguous words and their senses

Ambiguous Words	Senses
അടി ("Adi")	Slap, Downwards
താമസം ("Thamasam")	Delay, Stay
ഉത്തരം ("Utharam")	Beam, Answer

Related Works

Some works done related to WSD with different methods in different languages are specified below. English word sense disambiguation [2]: This work shows that WSD can be performed by a number of machine learning methods. It presents a corpus-based approach that builds a whole naive Bayes classifier, each of which is based on lexical features that represents co-occurrence of words in different sized windows of context. Tamil word sense disambiguation [1]: In this paper, an SVM based approach is used for word sense disambiguation. The SVM algorithm can classify the context according to different senses of ambiguous words with great accuracy. SVM classifier predicts the correct sense of target words using a set of feature values.

Malayalam word sense disambiguation using maximum entropy model [4]: In this work, semi supervised machine learning techniques mainly maximum entropy is used for Malayalam, which shows result, for a set of trained corpora of Malayalam words. Accuracy of WSD depends on the size of the corpus.

Word sense disambiguation using deep neural networks [7]: This method can be considered as a

hybrid between knowledge based and supervised approach. It proposes a general disambiguation method based on English word embedding representation of words and context, along with a diverse comparison method between them, to select a specific meaning.

Unsupervised approach to word sense disambiguation in Malayalam [6]: This thesis proposes and implements the WSD based on context similarities, which is an unsupervised method. Based on similarity between the given input text and sense clusters most similar senses are selected as the sense of ambiguous words. Unsupervised algorithms work directly from annotated raw corpora.

Proposed System

Here, the major steps involved in the Malayalam word sense disambiguation, using SVM classifier, is described. Fig. 1 shows the block diagram of the model.

Dataset

Since our language does not have a standard dataset for WSD, a task-specific dataset for this purpose was created. The dataset for this experiment consists of 300 sentences which contains 100 instances of each of the ambiguous word താമസം, അടി, ഉത്തരം. The dataset is balanced with 50 instances for each sense. The dataset has been preprocessed and tagged manually with its meaning.

Preprocessing

Initially some preprocessing steps are performed to clean the collected data. There are three major steps involved in the data preprocessing.

Tokenization

The collected data is converted into sentences, and then to word tokens.

E.g.: "അടി കൊണ്ട ഉടനെ പശു അവിടെ വീണു ചത്തു." is converted into "അടി", "കൊണ്ട", "ഉടനെ", "പശു", "അവിടെ", "വീണു", "ചത്തു".

Stop word removal

Stop words are the words that are frequently occurred among the data, which do not really contribute to the meaning of the discourse

E.g.: "അത് ", "അവിടെ", "അവ", "ഇത്". etc

In order to remove stop words from the word tokens, a list of such words was developed.

Stemming

After removing the stop words, the resultant words are stemmed into their root words.

E.g.: "അടിക്കുക", "അടിക്കുന്നു", "അടിച്ചു", "അടിച്ചില്ല", "അടിക്കുക"

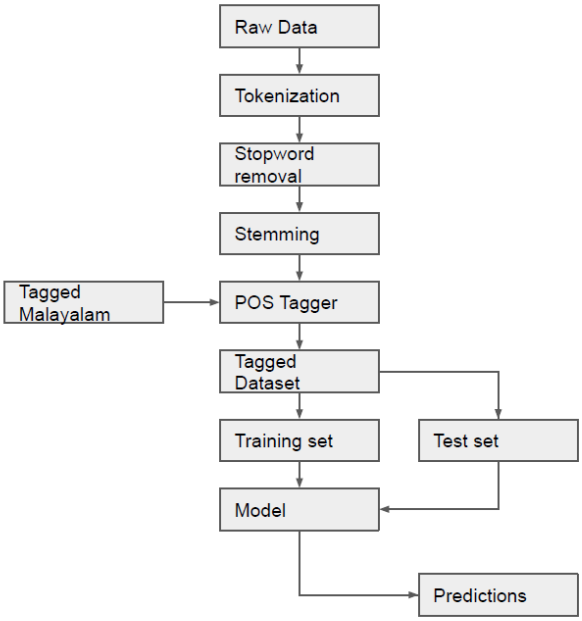

Fig.1: Proposed System

PosTagging

To convert the cleaned data into useful dataset, a corresponding POS tag is attached to it. The POS tagging is important because, as the meaning of a word changes with the context, the POS tag of that particular word may also change [4].

E.g.: അടിക്കുക: /V_VM_VINF

Figure: 2. POS-Tagged Dataset

TnT tagger is used for this purpose, which can be used for training corpus from a number of languages. A sample of tagged Malayalam corpus is used to train the TnT tagger. Then the preprocessed data is tagged using the trained TnT tagger and the result is stored in a csv file along with the ambiguous word, label, and sense of that ambiguous word. Labeling is performed by numbering according to the sense, and hence the dataset. Dataset required for the supervised Malayalam word sense disambiguation using SVM classifier, is stored in the form of a csv file as tokens, sentence by sentence. Dataset of each

```
sentence,ambigous_word,label,sense
"['സ്ഥിരമായ/JJ',
'വീടുകളില്ലാത്ത/JJ',
'മലക്കാരന്മാരുടെ/N_NN',
'താമസം/N_NN',
'പാറപ്പുറത്തുകളിലും/N_NN',
'മരപ്പൊത്തുകളിലുമൊക്കെയാണ്/N_NN']",താമസം,1,
താമസിക്കുക
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ambiguous word is stored in separate such csv files. Figure 2 shows the tagged dataset obtained after POS tagging with TnT tagger.

Vectorization and implementation of SVM classifier

The dataset containing text along with POS tags is converted into corresponding feature vectors in order to make the machine understand. A sample converted vector format is given below in Figure3. Count vectorizer from the scikit-learn library was used for vectorization purposes. To implement SVM, the dataset is splitted into training set and test set; then the model is trained with the training set and predicts the labels of the test set. After comparing the predicted result to the actual result, the accuracy is determined. The training was performed with both stemmed and unstemmed data. The unstemmed data results in better accuracy.

(0, 122)	0.17213244188373364
(0, 228)	0.34090901536599605
(0, 136)	0.2911564266639601

Figure: 3. List of vectors generated after vectorization

Result and Discussion

More than 300 instances of each of the ambiguous word താമസം, അടി, ഉത്തരം had collected. In total the dataset contains contexts from each of these words. It has been preprocessed and manually tagged with its meaning and correct form of the ambiguous word.

The accuracy of this model for each word under varying conditions, is given in two tables. Table1. gives the accuracy for both stemmed and unstemmed data separately. It is observed that unstemmed data gives more accurate results than stemmed data, which could be because of the inaccuracies in stemming. The root-pack package was used for stemming in Malayalam. Datasets with varying training sizes were also used to study the performance of the system.The accuracy of the model with varying data size is shown in Table 2, with contexts in the training dataset as 50,75 and 100 and test dataset as 10,20 and 25. The graphical representation of each of these words with varying training data size is shown in figure 4, figure 5 and figure 6. It is very clear that accuracy of model increases with increase in data size except for the word അടി.

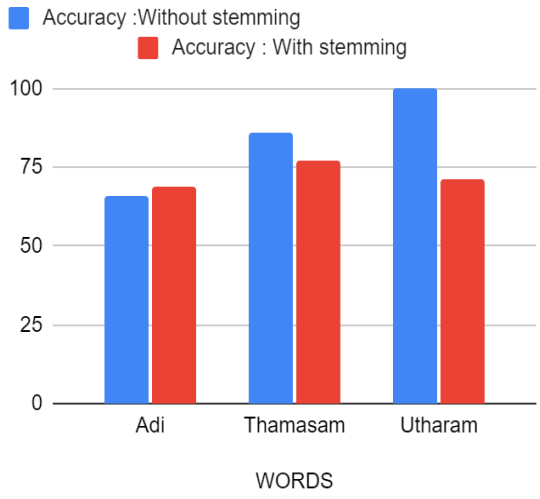

Figure 4. WSD Comparison between ambiguous words when training data size=50

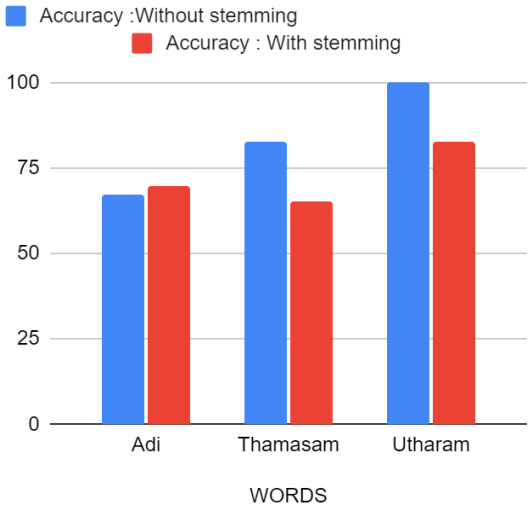

Figure 5. WSD Comparison between ambiguous words when training data size=75

Table II: Accuracy with stemmed and unstemmed data

Words	With-out stemming			With stemming		
Amount of data	50	75	100	50	75	100
"Thaamasam"	78.2	85.7	82.6	69.5	77.1	65.2
"Adi"	60.89	65.7	67.39	65.21	68.57	69.56
"Utharam"	91.30	100	100	73.9	71.42	82.60

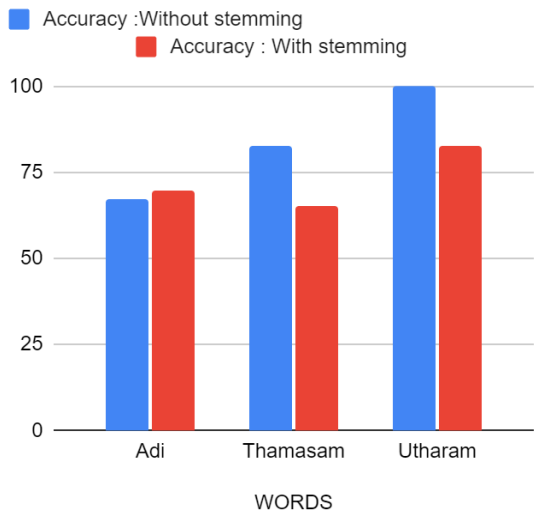

Figure 6 . WSD Comparison between ambiguous words when training data size=100

Conclusion

The automatic WSD techniques are now abundantly used in English and many other languages. But, WSD techniques for Malayalam are very rare because of the language's complexity. So, this work is relevant in this scenario. The accuracy of this model depends upon some factors like the size of corpus and preprocessing techniques. From observations it is clear that when more data is provided, a more efficient model could be created. It is also observed with better accuracy when an unstemmed dataset is used. A standard dataset for WSD in Malayalam is being created, so that upcoming researchers in this field could also be benefitted. With a larger dataset in hand, one can use deep transformer based pre-trained models like BERT, GPT-3, fastext etc. for generating contextualized embeddings, which could result in better performance of the system.

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Metal Oxide Nanostructure based Gas Sensors

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Abstract

Toxic gases are major factors behind environmental pollution and dangerous to human health and nature balance. Hence, control measures for detection and removal of such toxic gases are of utmost significance. Highly sensitive and selective gas sensors are required for environmental gas monitoring, and public security with a good detection limit. Fabrication simplicity with low number of metal levels, low power consumption and low cost of the device make metal oxide gas sensors attractive for industrial applications. Nanostructured metal oxide-based gas sensors can provide better sensitivity towards specific target gases.

Index Terms – Gas sensors, Metal oxides, Nanostructures, Sensitivity

Introduction

Detection of flammable, toxic and exhaust gases are important for protection of environment and for energy saving. Gas sensors have been in use both in for domestic and industrial environment for detecting flammable and toxic gases. Among the different types of gas sensors Semiconductor metal oxide gas sensors are generating interest as these material fulfil the requirement of an ideal sensor to a very great extent[1].

Chemical sensors are categorised as per their physics behind operation. Commercial gas sensors suffer from severe limitations due to low sensitivity and high operating temperature [2]. Therefore, it is important to design a sensor with better sensitivity, stability and quick response with low cost. Metal Oxide Gas Sensors (MOGS) are ideal candidates for gas sensing applications due to chemical stability and easy fabrication techniques. The dependence of oxide conductance on the gas environment results in their applications as gas sensor [3]. Nanocrystalline metal oxide thin films offers a combination of high response and fast response time for target gases which are beneficial for industrial applications [4,5].

In the early 60s, the absorption and desorption of gas molecules on the surface of metal oxide semiconductor has been introduced, and first metal oxide gas sensor was announced to the market [6,7]. Metal oxide thin film such as ZnO and SnO_2 were introduced as gas sensing devices. Demands for these MOGS increased with incrementing applications over time [7]. There are extensive research studies on different metal oxide gas sensor to improve three characteristics of the sensor: sensitivity, selectivity and stability even at low operating temperature. There are two types of semiconductor metal oxide; n type and p type. The majority of charge carriers in n-type and p-type semiconductors are electrons and holes respectively. Due to different charge carrier type, metal oxide performs differently to reducing/oxidizing gases. Figure.1 shows the study on n type and p type semiconductor gas sensors.

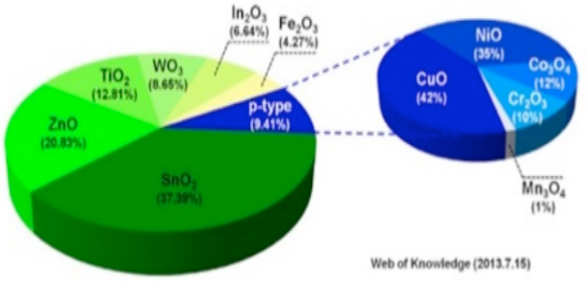

Fig.1. Studies on n- and p-type oxide semiconductor gas sensors [8]

Working of Nanostructure based MOGS

Metal oxide semiconductor gas sensors detect target gases through redox reactions between the target gases and the oxide surface. During the redox reactions, O− distributed on the surface of the materials would react with molecules of target gases, leading to an electronic variation of the oxide surface; and then this variation is transduced into an electrical resistance variation of the sensors. The resistance variation is measured using an electrode placed beneath the metal oxide layer. The roughly introduced surface redox-reaction processes of the adsorbed oxygen surface states with the target gas will take place faster only at elevated temperatures. For this a micro-hotplate is placed beneath the electrode. Different metal oxide will have different operating temperature. The top view of a gas sensor is shown in Figure.2.

Sensitivity of MOGS is a parameter to evaluate the detection of the variation of the gas target concentration values in the surrounding environment. It can be considered as the change in the measurement signal per concentration unit of the gas target. Another parameter, selectivity is used to evaluate the property of a sensor to respond selectively to group of gas targets or even specifically to a single one when it is present with others in the measuring environment.

Sensors with nanowires possesses high sensitivity towards target gas than one with thin film. NiO nanomaterial is used when the target gas is acetone and NiO is projected as a promising candidate for detecting acetone. Sol-gel method can be used for synthesizing nanostructures which are characterized generally using scanning electron microscopy.

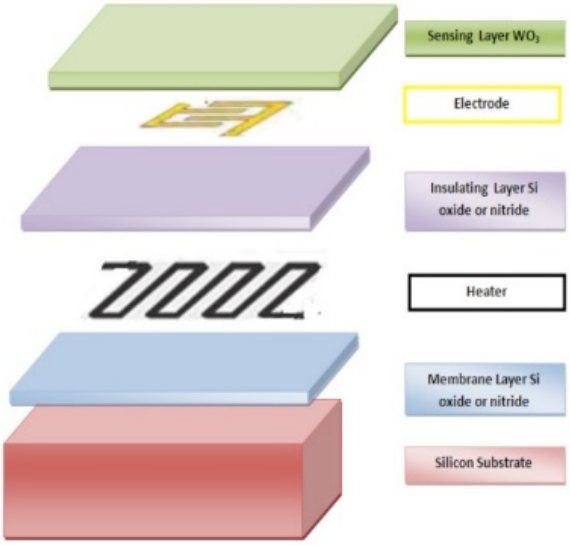

Fig. 2. Block diagram of a metal oxide gas sensor

Limitations

Despite the advantages like low cost, low power consumption etc, MOGS has issues like cross sensitivity and low selectivity. Different methods were shown in literature to improve the sensitivity like varying operating temperature and doping the semiconductor with other metals or metal oxides. Using sensor arrays can improve the selectivity of the sensor and also doping technique also improves selectivity. Most of the gas sensor uses n-type semiconductors as the sensing material. p-type semiconductors are rarely used. Also. very few sensors are available for detecting volatile organic compounds.

Conclusion

Gas sensors with high sensitivity is crucial for sensing gases at low concentration. Gas sensors using metal oxide semiconductors have been the subject of extensive investigations for more than three decades, primarily focusing on SnO_2. In more recent research, the interests shifted to some other promising metal oxides, with interesting properties as gas sensing materials. Using metal oxides has several advantages, features such as simplicity in device structure, low cost for fabrication, robustness in practical applications and adaptability to a wide variety of reducing or oxidising gases. Using nanostructures of metal oxides instead of thin films can improve the sensitivity of the sensor as nanostructures provide extremely high surface-to-volume ratios.

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On the Maintenance Transformation of Machine Tool Systems through Industry 4.0 Technologies: A Brief Review

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Abstract

The surfeit of technological developments and innovations in the manufacturing sector has deeply transformed the global industrial landscape. Industry 4.0 is considered the new landscape where several technological and intelligent computational methodologies are converging to provide a digital solution to various challenges in the industry. Maintenance is one of the most critical and challenging issues and the industries are approaching their digital transformation for an economically efficient solution. This digital transformation has also influenced machine tool systems and their operational and maintenance strategies. Predictive maintenance of machine tools is gaining wide attention in the manufacturing sector for achieving higher production rates and closer tolerance of machined parts. This article presents a brief review of the maintenance transformation of machine tool systems through industry 4.0 technologies.

Index Terms - Industry 4.0, Predictive Maintenance, Remaining Useful Life (RUL), Smart Machine Tools.

Introduction

The fourth industrial revolution – also named Industry 4.0 was introduced at the Hannover Fair of Industrial Technologies, in 2011. The former three industrial revolutions led to substantial improvement in the overall industrial productivity which was driven by mechanization, electricity, and information technology. The underlying technologies in Industry 4.0 are represented by the Cyber-Physical System (CPS), which aims to transform machinery-dominant manufacturing into a smart manufacturing paradigm. CPS enables efficient communication among all the critical machines/machinery components through multiple sensory input/output devices [1].

Manufacturing systems are now designed as highly sophisticated machine tools with advanced Computer Numerical Control (CNC) support to be in phase with the global competition. The reliability of manufacturing systems is revealed by the operating condition of the functional components and subsystems of machine tools. As the manufacturing industry continues to adopt more digital technologies the shortage of an appropriate machine tool maintenance strategy could prove adverse.

Most manufacturing industries consider maintenance management one of the initial steps to be applied in the Industry 4.0 context, to accomplish a critical transition from breakdown and periodic maintenance to predictive and proactive maintenance strategies [1, 2].

Maintenance Management in Manufacturing Industry and its Evolution

Maintenance management is the practice of keeping the machines in proper functioning condition to produce quality products with maximum efficiency. Maintenance management primarily involves the machinery health management of industrial equipment to maximize asset availability ensure the quality of products manufactured or services offered and ensure a safe working environment for their workforce. Due to the continuous operation of machine tools and the nature of work performed on it, wear and tear occurs on the sliding and rotating components causing gradual mechanical damage. These mechanical damages to critical machine tool components adversely affect the quality of machined products and productivity. An efficient machinery health management strategy for the machine tool systems is necessary to withstand the manufacturing industry at zero unexpected failure rates and minimal machinery downtimes [3].

Industrial maintenance has evolved over time, starting from fundamental breakdown reactive maintenance through periodic preventive maintenance, and has come to condition-based maintenance (CBM). The reactive or corrective maintenance strategy is an unplanned maintenance approach where the machine is allowed to operate until failure and then restored. Preventive maintenance is a planned maintenance strategy where time-based or periodic maintenance actions are scheduled in advance to prevent failures. However, this maintenance approach causes redundant maintenance activities causing unnecessary expenditures. Reactive and preventive maintenance approaches consume time and resources which otherwise could be utilized for production. Fig. 1 illustrates the reactive and preventive maintenance strategies on machinery performance index and service life [1, 3].

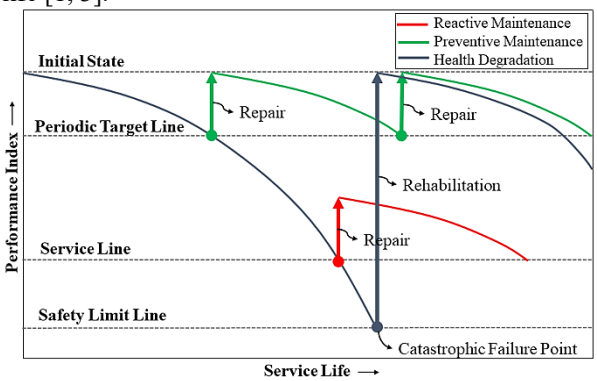

Fig. 1 Illustration of conventional maintenance strategies on machinery performance index and service life

CBM is a maintenance strategy that monitors the actual condition of an asset for deciding when what maintenance needs to be done. CBM is based on the condition monitoring data collected from operating machinery. Predictive maintenance is an advanced version of CBM, where data analysis tools and intelligent computational techniques are used to predict any upcoming failures far before their actual point of occurrence. Thus, the predictive maintenance approach allows users to well-plan the maintenance activities to perform the right maintenance action at the right point in time with minimal production loss and expenditure.

Predictive Maintenance

The predictive maintenance paradigm belongs to Industry 4.0 that it is propped up by several technological enabling factors including a wide range of sensors capable to register any source of information (vibrations, acoustic emissions, temperature, etc.) sent from operating machinery, advanced computational resources for analyzing the acquired data, modern Internet of Things (IoT) enabled remote connectivity means, and big data cloud storage and computing technologies that provide real-time update of machinery information for the prognostic analysis.

Predictive maintenance generally uses historical and real-time machine health degradation information to recognize equipment failure patterns and further this information is used to forecast upcoming failures. The predictive maintenance strategy uses condition monitoring tools to track the performance of the machine's functional components. In any mechanical system, the machine operating condition is monitored using time-series data such as vibration signal, shock-pulse, acoustic emission, bearing temperature, oil debris, oil pressure, and electric current variations. This involves the application of different sensors, data acquisition systems, data processing, and computation techniques. Machine vibration monitoring is the most widely employed condition-monitoring parameter for mechanical systems. The machine health degradation patterns are extracted for the vibration signals for machinery failure prognostic analysis [4].

The appealing contribution of the latest technological advancements to the industry is the Industrial Internet of Things (IIoT), which establishes an efficient communication paradigm between various industrial machinery, systems, and users. IIoT utilizes advanced sensor technologies supporting the IoT, cloud space, and cloud computing facilities for intelligent computational algorithms. These technological advancements can be used to augment the predictive maintenance paradigm for industrial machinery.

The machinery health prognostics involves the Remaining Useful Life (RUL) estimation by analyzing the current operating condition of the machine against the historical machine failure trend pattern. The physics-based approaches, statistical model-based approaches, Artificial Intelligence (AI) approaches, and hybrid approaches are employed for RUL computations.

The physics-based approach demands a thorough knowledge of the physics of failure mechanism, which is difficult to execute for complex machinery. Statistical model-based and AI approaches are data-driven approaches, which utilize machinery health degradation data for prognostic analysis. Statistical model-based approaches require only empirical knowledge to establish a relationship between the failure mechanics and statistical model, whereas the AI models use minimal technical aspects of the system. AI approaches use intelligent learning algorithms to learn machinery health degradation patterns, but its implementation involves various challenges due to the black-box nature of the learning process and the requirement of computers with high computational power [2, 4].

The advanced predictive maintenance paradigms in the Industry 4.0 context can ensure a maintenance decision support system and remote access to the industrial machinery health status information and control of industrial activities.

Conclusion

The scope of implementing predictive maintenance of manufacturing systems contributes to enhancing the controls, costs, and quality of production. Predictive maintenance is not a substitute for traditional maintenance approaches, rather it is considered a valuable addition to the total industrial production management. It cannot totally wipe out the need for traditional reactive or preventive maintenance approaches. In any industry, the user should identify if the predictive maintenance suits the machinery concerning the huge installation costs and the fact that only those component faults that can be monitored using sensor technology could be considered.

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Periocular Biometrics for Partially Masked Faces

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Abstract

COVID pandemic has necessitated authorities to make sure that every candidates are being worn mask. So, wearing of masks can definitely occlude a major area of face. In this scenario, periocular recognition acts as the best solution for the biometric identification. Periocular region has great importance in matching of medically altered faces too.

Index Terms - Periocular region, Principle component Analysis, Feature descriptor

Introduction

Periocular region is the feature rich region around the eye which may include features like eyelids, eyelashes, eyebrows, tear duct, eye shape, skin texture and many more as shown in Fig 1. Periocular region based authentication system is a good trade-off between face and iris based biometric authentication systems as they need high user cooperation. In general, face recognition requires certain conditions such as fully frontal face images as well as consistent lighting. Furthermore, facial recognition is not applicable for healthcare professionals wearing surgical masks. Also Face masks, cosmetics, face injury due to accidents and beard can occlude face recognition. Due to COVID 19, everyday life is now dominated by such face masks, as well.This pandemic scenario has forced us to find some alternative identification strategy where physical contact is not needed. To overcome these challenges, periocular recognition can be used, which recognizes a person through the area around their eyes.Though biometric identification methods are reliable, the majority of them rely on close proximity or body contact.This systems take the area around the eye to correctly authenticate the candidate. Conventionally facial features are used for recognition in biometric identification.Advancements made in object classification and identification can be used in authenticating individuals on periocular images [3]. validated.

Modules of Periocular Biometric System

The periocular region, that is the feature rich region around the eye is considered. A sequence of operations consisting of image alignment, feature extraction, and matching are performed on the periocular images. Colour, shape and texture are taken as the representative features and uses to detect key points as in the Figure 2. The number of matching key points between two images are used to assign a match score which is calculated using the Euclidean distance[1]. Experiments are done with varying features taken into consideration, such as the use of left or right side periocular image and with the presence or absence of eye brows. During the extraction of features, one can chose between global, that is the entire region or from a local region after detection of key points. However, it is also possible to fuse these feature descriptors in order to create a more reliable means of acquiring features.When using FaceVACS (commercial face recognition engine) on the periocular images, an accuracy of 100% has seen for face recognition. Periocular biometric is thus a viable alternative when conventional means are not viable.

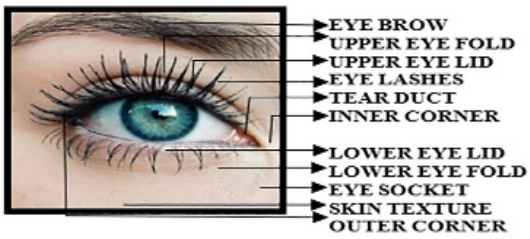

Fig 1. Periocular region

1. Image Preprocessing

This module is to enhance the images in order to extract useful features from them. The various techniques available for pre-processing such as histogram equalization for contrast enhancement, image resizing, image alignment etc.[4].Histogram equalization picks the most frequent intensity value from the image histogram and based on that it adjusts the global contrast of the image. Multiscale retinex (MSR) algorithm [5] is a subsequent of single scale retinex algorithm which use the combined output of more than one smoothing kernel of different sizes as center-surround image filters for handling different lighting conditions.

2. Region of Interest(ROI) extraction

There is no standard procedure which can be used to define the optimum size of periocular ROI. Some researchers considered the centre of iris as reference point and calculated the size of ROI as width = 6 radius of iris and height = 4 radius of iris. Another method is to use eye corners as a reference point to calculate ROI as they are least affected by gaze, pose variation and occlusion.

3. Feature extraction

Features are distinctive properties which can be used to differentiate the categories of input patterns[2]. Feature descriptors can be classified into global feature descriptor and local feature descriptor. Texture based features, colour based features and shape based features are the different global feature descriptors.

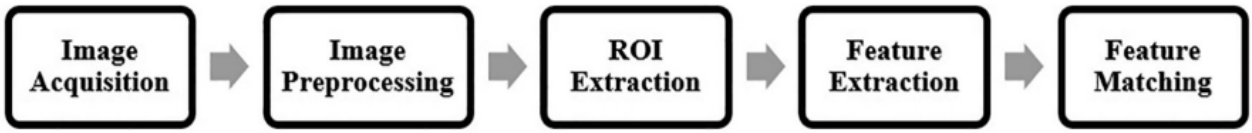

Fig. 3. Flow chart of Automatic weight selection algorithm

After feature extraction, different dimensionality reduction techniques like Principal Component Analysis and Linear Discriminant Analysis can be applied for the optimization of feature sets[6].

4. Feature extraction

The goal of the feature matching module is to match probe sample with gallery sample to generate matching scores. Few examples of distance measures used for matching are, Bhattacharya Distance, Hamming Distance IDivergence metric and Euclidean distance .

Conclusion

The primary objective of this paper is to provide an explanatory view of periocular biometrics literature and about what features, feature extraction methods and matching schemes. With the fast-growing technological world, it is necessary that the system used for identification and verification of the persons must ask for less user cooperation and periocular biometrics is a very good solution for this problem. Periocular region can be considered as a very promising trait both as a single modality and as a support for face and iris biometric. Periocular region achieved better result in many cases where face biometric suffers from different constraints like pose, illumination variation, occlusion and aging effect.

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Robust Attitude Control Of Launch Vehicle Using H_∞ Control

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Abstract

A launch vehicle (LV) or carrier rocket is a rocket driven vehicle used to move a payload from the surface of the Earth to space, typically to orbit above the Earth. A typical LV consists of lateral and longitudinal dynamics. This paper addresses the control of a LV's longitudinal dynamics. The control strategy focuses predominantly on the control of pitch angle. This paper considered only the rigid body dynamics of a launch vehicle system. Here, a H_∞ controller is designed for governing the pitch angle. MATLAB software is used for the simulation of the controller. The desired specifications are chosen for the nominal plant and the controller is designed by appropriate weight selection process. The simulation results shows that the designed controller is robust.

Index Terms - Launch Vehicle (LV), pitch angle, rigid body dynamics, h infinity, robust.

Introduction

Launch vehicles (LV) are rocket propelled system used to carry space objects into space. During its motion, it experiences aerodynamic moments and forces. In general, LV systems are aerodynamically unstable with continuously varying parameters[1]. LV system is said to be aerodynamically stable if it can maintain its orientation in the presence of external disturbances. This paper focuses on attitude control of LV. The first step of designing the LV system is to obtain the rigid body mathematical model [2].

In rigid body dynamics is it assumed that the vehicle parameters do not change over a short period of time.Other assumptions taken for the study are, small angle approximation and neglected non-linearities. All these assumptions make the system a Linear Time Invarient(LTI) system[3]. The dynamics of rigid body motion is governed by the combined action of different external forces, moment and inertia of the body. The control of longitudinal dynamics mainly consist of pitch angle control and lateral dynamics of launch vehicle is controlled by yaw rate [4].The pitch attitude control refers to controlling the orientation of the object with respect to an inertial frame of reference and stabilizing the system.

H_∞ control is used, in order to achieve robust performance and stabilization. The control problem is expressed as a mathematical optimization problem for finding the controller solution. H_∞ loop shaping is commonly used for controller synthesis, since the performance requirements can be included as performance weights, in the design stage [5],[6]. The weight selection can be done either by trial and error method or by using the automatic weight selection algorithm[7]. General approach of weight selection is trial and error method but an automatic weight selection approach for active magnetic bearing is described in [8].

This article focuses on longitudinal dynamics i.e. pitch angle control of Launch Vehicle. For getting pitch angle control, the linear analysis of rigid body dynamics is done. An automatic weight selection algorithm is proposed for LV system. Appropriate weight functions are selected using automatic weight selection algorithm and the H_∞ loop shaping is applied on the LV system. These weight functions are used to form the controller transfer function. The robustness of the system with controller is validated.

Launch vehicle modelling

A. *Launch vehicle dynamics*

The geometry of launch vehicle in pitch plane is considered.

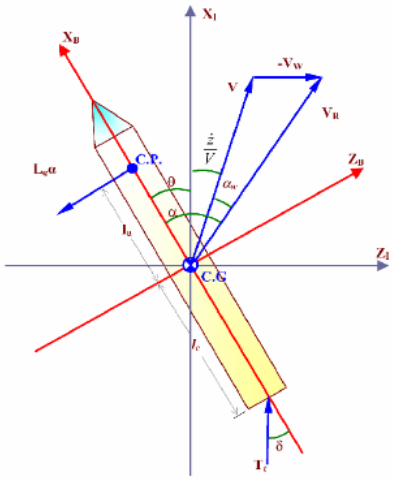

Fig 1. Perturbation forces along lateral body axis

The dynamics of the launch vehicle as a rigid body can be represented with sufficient accuracy as follows:

$$\frac{\theta}{\delta} = \frac{\mu_c}{s^2 - \mu_\alpha}$$

where $\mu_c = \frac{T_c l_c}{I}$ denotes the control moment coefficient

$\mu_\alpha = \frac{L_\alpha l_\alpha}{I}$ denotes the aerodynamic moment coefficient

Design of H_∞ Controller

All systems have some uncertainties which are difficult to measure and thus need to model appropriately. To cope up with these characteristics and to get a robust control, H1 based controller is proposed. H1 controller synthesis is based on three criterion [6].

Stability Criterion: It states that if the roots of the characteristic equation lies on the left half of s plane, stability is ensured.

$$1 + G(s)K(s) = 0$$

Performance Criterion: It states that for all frequencies where disturbances and set point changes are high, sensitivity S(s) is small.

$$S(s)=1/(1+G(s)K(s))$$

Robustness Criterion: It states that not only for the nominal model, but also for a collection of neighbouring plant models resulting from the inevitable existence of modelling errors, stability and performance should be maintained.

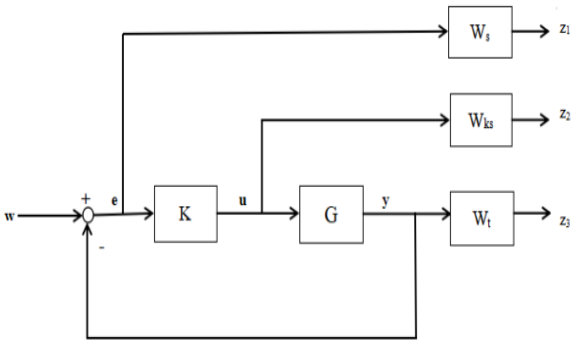

Fig. 2. Plant model for the synthesis of H controller [6]

Automatic Weight Selection Algorithm

The ultimate aim of the robust control is to reduce the impact of disturbance on the output of the system. This can be achieved by reducing the values of sensitivity function S and the complementary function T. This is achieved as follows:

$$|S(j\omega)| < \frac{1}{W_S(j\omega)} \quad and \quad |T(j\omega)| < \frac{1}{W_t(j\omega)}$$

The cost function γ is minimized, by solving the algebraic Riccati equations and thereby, a stabilizing controller K(s) is achieved. Bisection algorithm is employed to optimize the cost function γ.

Simulation Results

After the implementation of the H_∞ controller, the LV system follows the desired characteristics (i.e, overshoot < 25% and rise time< 1.5s). The weights selected and the controller transfer function are given in equations below.

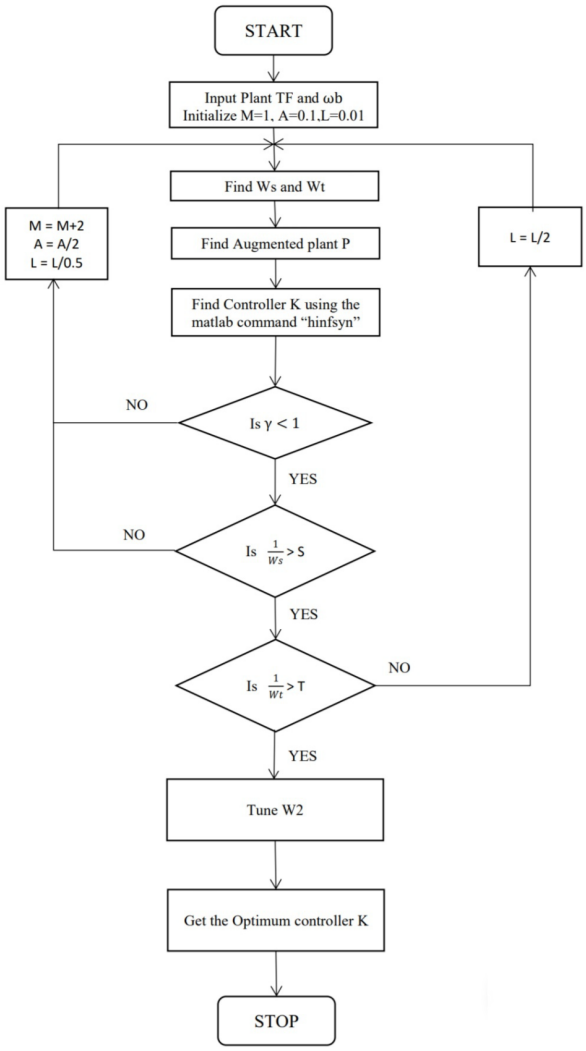

Fig. 3. Flow chart of Automatic weight selection algorithm

$$W_s = \frac{0.33333(s+12)}{s+0.2}$$

$$W_{ks} = 0.001$$

$$W_t = \frac{10(s+50)}{s+1000}$$

$$K = \frac{3.502e05s^3 + 3.512e08s^2 + 1.042e09s + 7.042e08}{s^4 + 1789s^3 + 8.576e05s^2 + 6.828e07s + 1.362e07}$$

Figures 4 and 5 represents the singular value plot and step response of the system with controller respectively.

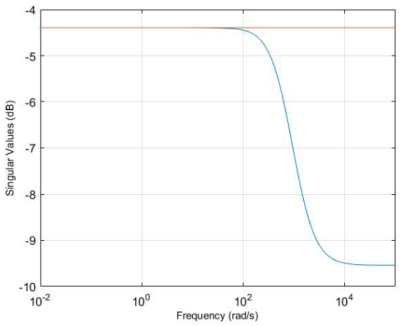

Fig. 4. Singular Value Plot of the system

Fig. 5. Step Response

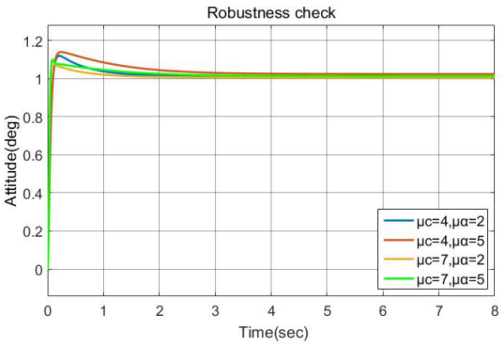

Fig. 6. System response with extreme limits

Conclusion

Rigid body dynamics of launch vehicle is modelled. From the transfer function obtained it is evident that the system is unstable. To stabilize the system a H∞ controller is implemented. Automatic weight selection algorithm is used for proper selection of weights. The robustness of the system is verified from the simulation results.

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Tessellations

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Abstract
Certain polygons tessellate in the given planar region whereas others may do so by forming combinations with any other polygons. A study of how polygons tessellate & its practical applications are discussed in this article.

Introduction

Nature has gifted us with beautiful patterns which take away our minds, but always the doubt is whether we appreciate them or not. Truly speaking, the mankind is nothing in front of Mother Nature since we have always adopted these kinds of patterns in many artificial structures and in our daily life. These added to beauty of our monuments & have a wide range of application in our daily life.

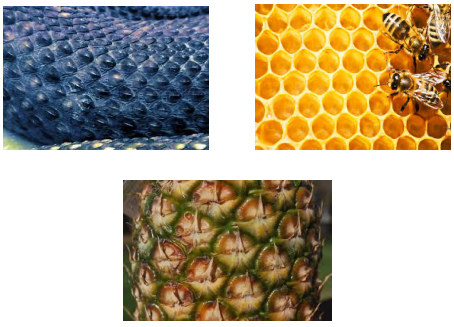

Fig. 1: Some geometrical pattern of objects around us

Before moving to exactly what are Tessellations, have a look at these photographs of some of our ancient monuments.

Fig. 2(a)

Fig. 2(b)

Fig. 2(c)

Fig. 2(d)

Fig. 2 (a) Ceiling inside a Fort, Fig. 2 (b) Partitions in Qutub Minar, Fig. 2 (c) Wall at Taj Mahal, Fig. 2 (d) Wall at Juma Masjid

As depicted in these patterns and the ones which were shown earlier, we can see that one will get deeply impressed by the complexity and beauty with which the geometry and art are blended together. Among these interesting patterns, we notice that a group of motifs were joined together such that they covered the entire plane. It's always interesting to see how this single motif fits so well with each other without any gaps so as to extend in all directions of the plane.

Hence, Tessellations are either a shape or collection of shapes being repeated on a planar surface so that these shapes fill the plane, with no gaps and no overlaps. The pattern can be extended in all directions of the plane. Such designs are known as tilings or tessellations. In Greek language, 'tessell' or 'tesera' means 'tile'. The defining features of a tessellation are: i) an infinite collection of congruent shapes ii) the shapes fit together to fill a two dimensional plane with no gaps and no overlaps.

Mathematics behind the Tessellations

Let us go through what are regular tessellations. We know very well what regular polygons are, and then it is simple to understand what regular tessellations means. You just need to tessellate a plane with the help of these regular polygons, but don't pre assume that it can be made possible with all regular polygons.

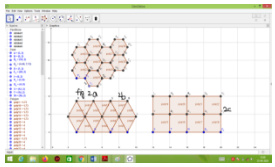

Fig.3(a):Regular tessellations made of 3, 4, 6 sided polygons.

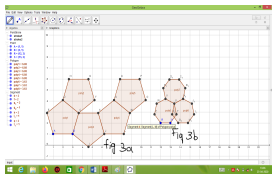

Fig.3(b):Structure of pentagons & heptagons that don't tessellate.

It's evident that the shapes made of equilateral triangle, square & regular hexagon tessellates whereas that made up of a regular pentagon leaves a gap and a regular heptagon overlaps and hence doesn't tessellate.

Now, let us think of what makes three regular polygons tessellate? The answer is very simple…to have no gaps and not to overlap, the polygons must fit with each other to make exactly 360^0 around each vertex. With the idea of basic geometry i.e., angle around a point is always 360^0. This is possible in the case of equilateral triangle, square & regular hexagon

as their internal angles are $60^0, 90^0, 120^0$ and also are divisors of 360^0, whereas this wasn't true for the other regular polygons considered. No wonder they didn't tessellate! This can be further explained: in the case of regular pentagon, the internal angle is 108^0 and hence when we place three regular pentagons, we find a gap of $360^0 - (108 \times 3)^0 = 36^0$. Similarly, taking the case of regular heptagon, the sum of three interior angles exceeds 360^0 and hence they overlap and don't tessellate.

So, automatically there arises a question whether a combination of regular polygons can tessellate or not.

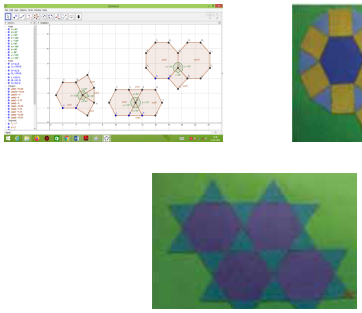

Fig. 4: Combinations of regular polygons & tessellation made using these combinations.

By angle properties, we can understand whether the combination of regular polygons would tessellate or not. Hence we get to know that three equilateral triangles can tessellate as the angles add upto 360^0. Also, an equilateral triangle, a regular decagon and a regular pentadecagon together; two regular pentagons and a decagon together etc. can tessellate. Few of the combinations in which the regular polygons may be chosen are [3,3,3,3,3,3], [3,3,3,4,4], [3,8,24], ...

Notation

The combination [3,8,24] means that each vertex in the tessellation is shared by an equilateral triangle, a regular 8 sided polygon a regular 24 sided polygon. Getting the sum of interior angles as 360^0 doesn't ensure that the combination can tessellate. Considering the case of three equilateral triangles and two squares, we see that the interior angles add to 360^0, but this combination yields two possible spatial arrangements.

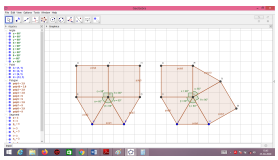

Fig. 5(a): Combination of 3 equilateral triangles & 2 squares in two different ways.

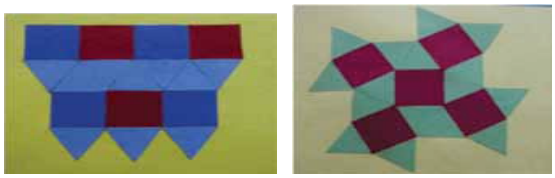

Fig. 5(b): Spatial arrangement obtained with above combination of regular polygons.

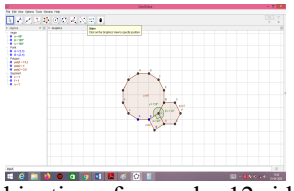

Fig. 6(a) Combination of a regular 12 sided polygon, a square & an equilateral triangle.

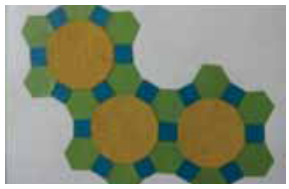

Fig. 6(b): Tessellation made of the above combination

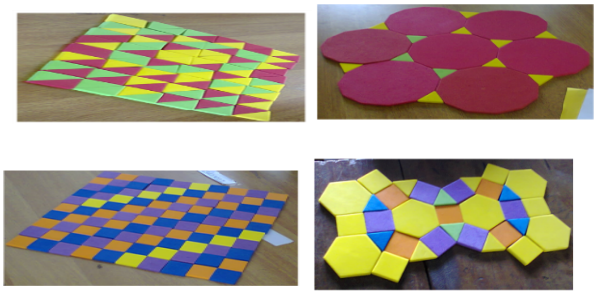

Fig. 7: Some Tessellations from different Regular Polygons

Areas of Application

Close examination of their geometrical properties helps to deconstruct and recast the polygons to produce irregular motifs that will tile or tessellate.

Fig. 8: Shapes of irregular motifs that can tessellate

The modified shape tessellates with translation symmetry. If blended with some imaginative designs, the effect is enhanced.

Fig. 9: Examples of square, triangular & regular hexagon tessellation modified to form irregular tessellations.

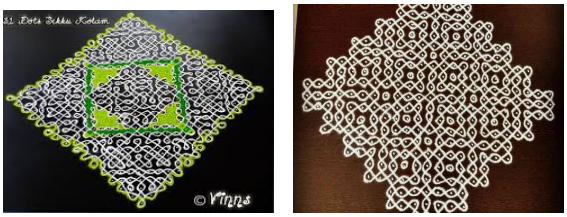

Fig. 10: *Kolams*

The above picture shows typical connection of art with Mathematics and is called '*kolam*' which can be treated as a form of line drawing using white or coloured powder (usually rice). This consists of **straight** and curved lines, dots to form a complex design with many symmetries and congruencies, but if you observe closely, you can see that its nothing but a type of tessellation. In a way this can be related to 'Graph Theory' also.

Let's examine a practical application of tessellations.

Fig. 11: Pavement tiles

It's nothing but the pavement tiles and flooring tiles which has got wide popularity these days in roads, pavements, wall decorations etc. This technique is widely used in flooring designs too. The ancient architects have used this brilliance in the construction of the great monuments to make them real wonders.

Today, the study of tessellations has a wide range of applications including X – Ray crystallography, quantum mechanics, cryptology, minimization of waste materials in cutting metal sheets for different purposes, textile printing etc.

Conclusion

Through the study of tessellations, we understand that it has a wide range of applications & uses in our day to day life. May be with or without knowing the scientific explanation our ancestors had many traditions to follow which actually has a meaning.

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Speech Recognition Systems – An Overview

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Abstract

Speech is a series of sounds that produces a one-dimensional, essentially non-stationary, time-varying signal. Speech may be modelled as a stationary process on a short time scale. Speech transmissions are inherently unpredictable. Given that noise can easily taint voice signals, recognition plays a crucial part in speech processing. Both speaker dependent and speaker independent models exist in speech recognition systems. The task of speech recognition is crucial for human-machine interaction. The illeterate/ semi-literate will be able to use technology to a larger extent without knowing how to operate a computer keyboard or pen thanks to speech recognition interfaces in their native tongue.Many applications have been developed over the years to successfully utilise ASR systems. The research in the field of automatic speech recognition is still quite active because robustness to noise, reverberation, and transducer characteristics are a challenge that has not yet been resolved.

Index Terms - Speech recognition, Acoustic, Phonetic,ASR

Introduction

Speech Recognition, often known as Automatic Speech Recognition, is the process of turning spoken words into text by using a computer software that implements an algorithm from a voice signal.[1] Modern speech-recognition systems have been built invariably based on statistical principles, as pioneered by the work of Baker (1975) and Jelinek (1976) and exposed in detail in Huang et al. (2001).The representation of knowledge regarding acoustics, phonetics, microphone and environment variability, gender and dialect disparities among speakers is done by acoustic models. Language models are a system's understanding of what makes a word conceivable and what words are most likely to occur, co-occur, and if so, in what order. [2] Systems for automatic voice recognition are designed to address a specific issue. The ASR system's design is influenced by a number of factors. Determining the working range of any speech recognition system that is designed requires addressing a number of difficulties. Among them are speaking modes like isolated, connected, continuous, spontaneous; speaker modes like speaker trained, adaptive, speaker independent, and speaker dependent; modelling units like words, syllables, and phonemes used for recognition; vocabulary sizes like small, medium, and big; task syntax like simple to difficult task utilising N-gram language models; task perplexity; speaking environments like quiet rooms and loud areas; and transducers, which may be high-quality microphones, telephones, and mobile phones.

Architecture

The basic ASR system consists of acoustic front end, acoustic model, lexicon , language model and decoder.

Methodologies

ASR methodologies are broadly classified into three approaches, namely, acoustic-phonetic approach, pattern-recognition approach and artificial intelligence approach. Additionally there is the HMM-GMM Generative Learning Approach, Discriminative learning HMM-ANN and Deep Learning HMM-DNN.

Acoustic Phonetic Approach

The speech signal is divided into stable acoustic areas in the following phase of segmentation and labelling, after which one or more phonetic labels are applied to each segmented region to characterise the speech's phoneme lattice. In the last phase a word (or string of words) that is legitimate is derived from the phonetic label sequences generated from segmentation to labelling.[3,4].

Pattern Recognition Approach

Two crucial processes, pattern training and pattern comparison, are part of the pattern-matching technique. The approach's pattern-comparison stage compares each potential pattern that was learnt during the training stage directly with the unknown speeches in attempt to identify the unknown based on how well the patterns match.

Artificial Intelligence Approach

Combining both the acoustic phonetic technique and the pattern recognition approach, artificial intelligence approach is a new method for processing data.A distance between an observed voice sequence and the class patterns is determined during recognition. Modern systems favour HMM-based pattern matching over DTW because it has greater generalisation features and requires less memory.

HMM-GMM -Generative Learning Approach

The sequential structure of speech signals is represented by hidden Markov models (HMMs) based on Gaussian mixture models (GMMs) in conventional speech recognition systems. Because a voice signal may be considered as a short-term stationary signal, HMMs are utilised in speech recognition. A combination of Gaussian is often used in each HMM state to describe a spectrum representation of the sound wave. The fact that Gaussian mixture models are statistically ineffective for

modelling data that are on or close to a non-linear manifold in the data space, however, is one of their fundamental shortcomings.

Discriminative learning – HMM-ANN

The discriminative learning paradigm includes either utilising a discriminative model or incorporating discriminative training into a generative model. A hybrid MLP-HMM, or excellent discriminative sequence model, may be produced by feeding the output of the MLP into the HMM since the output of the MLP can be understood as the conditional probability.

Deep Learning HMM-DNN

Gaussian mixtures have been effectively supplanted by deep learning for voice recognition and feature coding on a growing number of systems. By using the Bayes rule, this kind of design may become discriminative. Deep Boltzmann machines, sum-product networks, the original Deep Belief Network (DBN) and its expansion to the factored higher-order Boltzmann machine in its bottom layer are examples of this kind.

Challenges in ASR

Yes, speech recognition has improved over the years claims Google . But try recording a normal meeting in a loud conference room on your phone, then running the generated audio through one of the top automated speech recognition programmes. You can end up with meeting minutes that resemble word salad more than anything else. The problem is that the majority of these tests were performed using the same collection of audio recordings, namely the Switchboard corpus, which is made up of many audio recordings of phone conversations covering a wide range of subjects. Although such claims of outperforming human transcriptionists are based on a very particular kind of audio, uniformity may lead to a sort of tunnel vision. (Google is an exception; it employs a proprietary, internal test corpus that is inaccessible to others.

Open Source Tools in ASR

Automatic speech recognition researchers have a variety of open-source toolkit options to choose from when developing a recognition system. The following stand out among them: HTK, Julius (both written in C), Sphinx-4 (written in Java) of Carnegie Mellon University, and Kaldi, a free, open-source toolkit for voice recognition research [5]. The RWTH Aachen Automatic Speech Recognition System (RASR), Segmental Conditional Random Field Toolkit for Speech Recognition (SCARF), Improved ATROS (iATROS), SRI International's Decipher, idiap's Juicer, and SHoUT speech recognition toolkit are some of the other less well-known open-source systems and kits.

Performance Metrics

Speed is quantified using the actual time factor, however accuracy may be measured in terms of performance accuracy, which is often graded using word error rate (WER). The Command Success Rate (CRS) and Single Word Error Rate (SWER) are further measurements of accuracy (CSR). Word Error Rate (WER) and Word Recognition Rate (WRR) are used to assess the speech recognizer's performance.

Conclusion

Multimodal speech recognition, robust speech recognition, and multilingual speech recognition are a few of the study fields that are gaining traction. English, French, and Czech ASR has reached a mature stage, while Chinese and Japanese ASR are also undergoing significant progress. There is a large amount of ASR research being conducted in Hindi, Punjabi, and Dravidian languages in India, and researchers are working to create useful interfaces in these languages so that even rural people may utilise the technology. This article aims to divert your attention to an area of research that is gaining momentum and has a lot of scope for improvement.

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Metal Organic Framework And Applications

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Abstract

Metal-organic framework (MOF) is a promising class of materials composed of both organic and inorganic moieties which are metal centres or metal clusters and organic linkers. These are porous crystalline materials in which metal or metal cluster is locked into a position to produce rigid and porous geometry and connected through different organic groups. They possess a greater surface area with an advantage of changing pore sizes as well as variety of structures. Due to structural flexibility, large surface area and tailorable pore size, MOFs have wide applications in field of gas adsorption and storage, separation, catalysis, sensing, molecular recognition, drug delivery, non-linear optics, luminescence etc[1]

Index Terms - Metal Organic framework, organic linker, Metal node, Gas storage and separation, Catalysis.

Introduction

The field of synthetic metal- organic chemistry is a clear extension of the coordination chemistry and the first reported synthetic coordination complex is that of iron complex which is Prussian blue pigment. The emergence of Metal Organic Framework is from coordination of metal and organic molecule in a well-defined geometry to form 3D network.

Up to mid-1990s neutral donor linkers like bipyridines and nitriles were used to prepare coordination networks. But these compounds faced chemical as well as architectural instability due to size, charge etc of the linkers. In order to overcome these limitations, charged chelating linkers with binding groups such as carboxylates were used. These linkers provide the following advantages over the usual nitriles like: a) increased bond strength and thus increased chemical stability b) carboxylates can neutralise the metal centres, thereby ignoring the necessity of counter ions c) since it is chelating in nature, structural rigidity, directionality and connectivity is enhanced [2].

MOF s consists of inorganic metal known as node and an organic linker known as a connector.

Inorganic building units (metal clusters)

The term "secondary building unit" or SBU was originally used to describe the rich structural chemistry of zeolites by deconstructing them into finite or infinite structural subunits. This concept has been used in MOF chemistry, where the term SBU is used to describe the inorganic building units in MOF structures. These units are typically polynuclear clusters of metal ions, where the polydentate binding groups of the linkers are an integral part. SBUs are commonly formed in situ, thus allowing for the slow and reversible assembly of the overall structure, error correction, and consequently the formation of highly crystalline products[3].

As an after effect of this, sand boiling, lateral spreading, flow failures, ground oscillation, floatation, settlement etc occurs in the region. Unsaturated soil is more resistance liquefaction compared to saturated soil because of presence of air in soil pores, high confining pressure, lower initial pore pressure and matric suction.

Organic Linkers

Linkers are organic compounds that which serve as a connector between metal node. Porphyrins are widely used as organic linkers due to its charge neutralising capacity, rigidity etc. Organic linkers can determine the connectivity, directionality and rigidity of the framework.

Applications

MOFs find wide application in gas storage, catalysis, luminescence, drug delivery etc. due to its crystallinity, porosity and strong metal -ligand interaction. Even though it finds its applications in different areas, the important among them is the gas storage and separation, catalysis.

Gas storage and separation: Conventional gas storage methods require high pressure tank, multistage compressor and are expensive in nature. MOF can serve as a good storage material due to its porosity and high surface area. The main advantage is its easy preparative method and tuneable pore size making it use in the field of separation of molecules too. MOF-177 is used in H2 storage 4. Other H2 storage MOFs are MOF-5, MOF-205etc.

Catalysis: The MOFs due to their porosity and high metal ligand interaction can serve as a heterogenous catalyst. The pores of MOFs are usually trapped by solvent molecules after synthesis. They can be removed by the activation of MOFs, leading to free coordination sites in the metal centres which can act as a potential catalyst. Till now different MOFs are been reported for heterogenous catalysis. eg Ni (II) porphyrin MOF which catalyses the conversion of nitroaromatics to nitroamines

Conclusion

Metal Organic Framework can thus be tuned in terms of porosity, geometry, connectivity, crystallinity etc to serve different purpose as per one's demand. ie.

One can design the metal organic framework structure as per his application by varying the linker and metal cluster accordingly.

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