C.H. MOHAMMED KOYA
KMEA ENGINEERING COLLEGE
Approved by AICTE Affiliated to MG University & KTU
ESTD - 1997

KRCC
KMEA
RESEARCH AND CONSULTANCY COUNCIL

"Science may set limits to knowledge, but should not set limits to imagination"
- Bertrand Russell

TECHNO-VIBES: THE TECHNICAL ARTICLES

Volume 1
Issue 2
July 2022

Kerala Muslim Educational Association

College Management Committee

Members

Mr. Riaz Ahmed Sait
Chairman

Adv. K. A. Jaleel
Secretary

Syed Bashir Ali Shihab Thangal
Mr. H. E. Mohammed Babu Sait
Adv. T. H. Abdul Azeez
Adv. P. A. Abdul Majeed Parakkadan
Mr. N. K. Nassar
Mr. V. S. Abdul Rahiman
Mr. N. M. Sharafudheen
Mr. M. P. Abdul Kader
Mr. P. K. Jaleel
Mr. A. Basheer
Adv. P. K. Aboobacker

Message from Director

It is a matter of great pride and utmost satisfaction for our college to bring out the online technical magazine: Techno-vibes under KMEA Research and Consultancy Council (KRCC). The college has crossed many milestones, targeting to become a centre of excellence in the field of technical education. Very recently, the college has been accredited by the National Assessment and Accreditation Council (NAAC).

I am confident that this technical magazine will provide a platform for both the staff and students of the college to showcase their academic and research activities and help them to develop and enrich the writing skills of students in particular and teaching faculty in general.

I express my sincere gratitude to Dr Sangeetha C P, Coordinator-KRCC for her sincere effort to take the lead role and accomplish the task of releasing the first issue of this biannual technical magazine within the stipulated time. I appreciate the efforts put in by the editorial board to bring out this technical magazine in record time. Also, I render my heartfelt congratulations to the faculty members for their contribution to the first issue of the magazine.
Best wishes!

Dr. Amar Nishad T M
Principal & Director

Message from Vice Principal

It is a pleasure for me to see the initiative taken by KRCC to present the first issue of the online technical magazine, "Techno-vibes". This magazine will definitely provide a platform for staff to share their technical knowledge, thereby creating a technically trained community. The college has been simply unstoppable in its progress as it has been actively involved in providing quality education.

My appreciation to the team who took the responsibility for the arduous task most effectively. Reading this magazine would definitely be an inspiration and motivation for all students and staff to contribute even more to the forthcoming issues. I hope that everyone will continue to work hard to keep the momentum going and to raise the magazine's standards.

Dr. Rekha Lakshmanan
Vice Principal

CONTENTS

Interventions among Energy - Water – Food Nexus in Rural Livelihoods and the Resilience Efficiency of Livelihoods Assets as a Socio-Economic Progress Indicator

Dr. Sanju John Thomas
Associate Professor and Head
Department of Mechanical Engineering

Renewable energy interventions in rural India have taken a top down approach. The importance to make the grid with clean energy sources within the shortest time to meet global commitments on climate change was the utmost importance.The extension of grid is an expensive program considering the isolated rural communities, with large residential loads. Insufficient anchor loads, lack of business models and instability of renewable energy mix are hurdles to provide decentralized quality power in rural areas. However, the rural community whose livelihood activities are dependent on geographical location, demographical mix, proximity to natural resources and nearness to supply chain require a closer analysis, to identify possible interventions of renewable energy.

Climate change, urbanisation and globalisation have affected the socio-economics of the livelihood activities in rural regions across the world. These are considered as stresses and shocks on a livelihood system which exposes its vulnerabilities, if any. A rural livelihood activity when considered as a closed system is sensitive to such stresses and shocks with probable impacts within the system and its surroundings [3]. There is a synergy that exists between energy, water and food in almost all rural livelihood activity, that sensitivity due to stress or shock on one of the three can affect the other with a change in state of the livelihood system [3]. Renewable energy integration is a globally accepted method to fast track and meets the impacts of climate change [1]. Sustainability in livelihood requires economic and environmental balance perspective, with respect to stresses and shocks. This identity of rural livelihoods calls for a bottom-up approach than a top-down approach for renewable energy intervention considerations. The relations between the factors that influence the efficiency of a livelihood asset to perform are modelled and relations for economic and environmental sustainability are derived considering the importance of interventions in energy, water and food through renewable energy [3]. A Renewable Energy Assessment Model (REAM) can assess socio-economic benefits of renewable energy projects for interventions in rural isolated communities. This will be useful for islands like Lakshadweep and Andaman Nicobar, which are critical with respect to ecology and environmental diversity, considering these islands run on diesel as the primary source of power. The importance of solar thermal energy technologies which can produce electricity and heat is explored for multiple benefits in rural isolated communities are studied with respect to polygeneration can reduce the dependency power produced in the island for rural livelihood activities.

The study conducted has shown that rural areas should have careful selection of renewable energy technologies with focus on energy-water-food from a bottom-up approach. Solar thermal based polygeneration was identified as a mechanism with multiple benefits in the context of energy, water and food. Thus the importance of addressing water, energy and food as a nexus component will optimize the use of natural resources and infrastructure investments towards the socio-economic development of small isolated communities.

References:

1. UNDP (2015), *Scale-up of access to clean energy for rural productive uses -India ACE project,* UNDP.
2. UN (2015) SDG Goal-7 Ensure Access to Affordable, Reliable, Sustainable and Modern Energy. [Online]. Available:

   https://www.un.org/sustainabledevelopment/energy/. (Accessed on 23/08/2019).
3. Scoones, I (2009) Livelihoods perspectives and rural development, *Journal of Peasant Studies* 36: 171-296, DOI: 10.1080/03066150902820503

Machining of Micro Features on Difficult-to-Machine Materials using Electro Discharge Machining Process

Dr Leera Raju
Associate Professor
Department of Mechanical Engineering

Machining is an important manufacturing process in which material is removed from the workpiece in the form of chips to realize the final shape of the product. Compared to non-material removal processes like casting and forming, machining is a more versatile process which can make customized products at lower costs. Machining processes are classified into conventional and non-conventional based on the nature by which material is removed from the workpiece. In conventional machining, pure mechanical forces serve as the mechanism behind the material removal process. Conventional machining methods such as turning, drilling, milling and grinding are solid tool machining in which physical contact between the tool and the workpiece is required for the material removal process. They use mechanical energy for material removal which primarily relies on the shearing action at the tool-chip interface. The shortcomings of this process are the residual stresses induced in the workpiece and tool wear due to heat generated while machining. Due to the above mentioned side-effects, dimensional accuracy and surface finish of the finished parts also gets affected. Soft materials like mild steel, aluminum, copper etc can be machined using high speed steel or high carbon steels whereas, some hard alloys require tools with higher hardness like tungsten carbide tools, cemented carbides, cermets, Cubic Boron Nitride etc. Newer engineering materials are developed to match various customer requirements, have extraordinary properties. Most of them are either hard and brittle or soft and ductile, which makes it difficult to process using the conventional machining methods. Here arises the need for advanced machining processes that use non-conventional forms of energy such as thermal, electrical and chemical energy.

The increased demand in difficult-to-machine, high-strength, temperature-resistant materials and necessity of miniaturization has made the machining of miniature parts and features a challenging task. miniaturization drives the attention of many researchers, industrialists and scientists to explore more on mechanical micromachining techniques. According to the College International pour la Recherche En Productique (CIRP) Scientific Technical Committee paper, the term micromachining defines the processes that have machine dimensions in the range of 1μm to 999 μm (Masuzawa and Tonshoff, 1997). The use of conventional machining process for machining these miniature parts and features is unfavourable due to large cutting force involved, heat affected zones, chatter, inaccessibility of the tool, etc. In such situations, the non-conventional machining processes play an important role in machining different engineering materials and are capable of machining micro-sized features on hard and soft materials. The non-conventional machining processes such as AJM, LBM, ECM etc are widely used in the machining industry. Out of these, the EDM process is most popular due to its non contact nature, low thermal stresses and ability to machine any conducting material.

Micro-holes and micro-channels are the important features and building blocks to

fabricate any micro-parts or devices. So a study on investigation of micro-holes and micro-channels machined using a developed Micro-Electro Discharge Machine is aimed. The Micro-Electro Discharge Machining (μ-EDM) process used for machining of holes, channels and their application in micro-devices are studied. Many products like Diesel engine nozzles (Tong et al., 2013), Turbine impeller (Liu et al., 2010) etc as application of this non-conventional process in miniature devices has proved their efficiency in the current industrial scenario. Recently, miniaturization of products and processes is no longer fashionable; rather, it is the need of time from which one can drive multifarious benefits - simple, less material, less power consumption, flexibility etc. In addition, miniaturization drives the attention of many researchers, industrialists and scientists to explore more on mechanical micromachining techniques.

References

1. Tong, H., Y. Li, L. Zhang, and B. Li (2013) Mechanism design and process control of micro EDM for drilling spray holes of diesel injector nozzles. *Precision Engineering*. *Elsevier Inc.*, 37(1), 213–221.
2. Liu, K., B. Lauwers, and D. Reynaerts (2010) Process capabilities of Micro-EDM and its applications. *International Journal of Advanced Manufacturing Technology*, 47(1–4), 11–19.
3. Masuzawa, T. and H. K. Toenshoff (1997) Three-Dimensional Micromachining by Machine Tools. *Annals of the CIRP*, 46(2), 621–628.

Deep Learning Network Based Speech Separation

Dr. Shahin M. Abdulla
Associate Professor and Head
Department of Electronics and Communication Engineering

Voice communication plays an important role in our lives and it is the most important means of transferring information in humans. In recent years a lot of research has been focused on separating acoustic sources from their mixtures. Speech separation, also called cocktail party problem, deals with decomposing input mixed audio signal into its corresponding sources. It finds a wide range of applications, including speaker recognition, mobile communication, song separation, hearing aid design, wireless communication etc. Speech separation strategies are becoming increasingly important in our lives as more and more gadgets that have been developed recently needs to do speech separation tasks. Speech separation has been implemented by several signal processing algorithms like Principal Component Analysis(PCA),Singular Value Decomposition(SVD),Independent Component Analysis(ICA),Non-negative matrix Factorization(NMF),Beam forming, Sparse Component Analysis(SCA). While, many of these algorithms try to mimic the extraordinary ability of humans to separate individual sources from their mixtures, intelligent algorithms for speech separation are attracting a lot of interest in this field. Before the advent of deep learning strategies most speech separation task concentrated on multiple microphone scenarios. Deep Learning strategies combine acoustic modelling and feature extraction which have resulted in drastic improvement in speech separation tasks (Wang & Chen, 2018).

Deep learning neural network based algorithms(Sose et al., 2019) is usually inspired by the hierarchical structure of the brain. The architecture consists of hierarchical layer wise arrangement of nonlinear activation functions fed by inputs and scaled by its linear weights. DNN based speech separation algorithms as depicted in Figure 1 are usually based on obtaining Time-Frequency Representation(TFR) or spectrograms of sound sources before and after mixing process using Short Time Fourier Transform(STFT) .

The features Ideal binary Mask (IBM) represented by Equation (1),Target Binary Mask(TBM) and Ideal Ratio Mask(IRM) (Hummersone et al.,2014) represented by Equation (2) were extracted from spectrograms and used for separation of signals.

IBM = 1 if SNR(t,f) > T; 0 otherwise (1)

where f: denote time and frequency

T: Threshold

$$IRM = \left(\frac{S(t,f)^2}{S(t,f)^2 + N(t,f)^2}\right)^{\gamma} \quad (2)$$

where $S(t,f)$ and $N(t,f)$ are speech and noise energy within the TF bin and γ is tunable parameter whose value is usually 0.5.

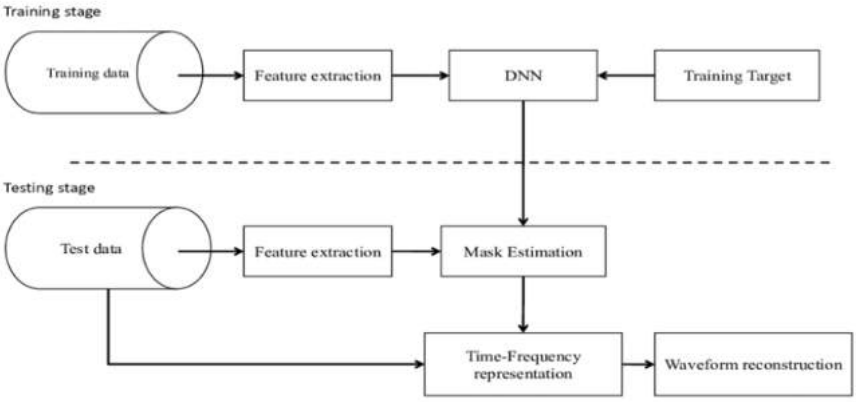

Fig1 DNN based speech separation system

The magnitude only mixture spectrogram and the respective mask were used for training the data. Original speech mixtures were used for the testing stage. A feed forward DNN of size 1300x1300x1300 is currently used. DNN employs biased sigmoid activation function throughout with zero bias output layer. The input layer of DNN is the mixture spectrogram. The Optimization of feature selection was done using stochastic gradient descent algorithm. The separated signals are further classified using the minimum distance between features and original speech signals.

This mask based DNN are far superior than NMF based DNN. The DNN based speech separation task has a brought a lot of insight into the mechanism of neural signal processing that is employed in human auditory system during a cocktail party scenario.DNN based separation algorithm usually outperform other speech separation algorithm by 2.44%.It is not far when DNN based speech separation system becomes a breakthrough technique that can separate speech sources with utmost clarity and speed as humans.

References

1. Wang, D., & Chen, J. (2018). Supervised speech separation based on deep learning: An overview. *IEEE/ACM Transactions on Audio Speech and Language Processing*, 26(10), 1702–1726.
2. Sose, S., Mali, S., N Mahajan, S. P. (2019). Sound Source Separation Using Neural Network. *2019 10th International Conference on Computing, Communication and Networking Technologies*, ICCCNT 2019, IIT-Kanpur, India.1–5.
3. Hummersone, C., Stokes, T., & Brookes, T. (2014). On the Ideal Ratio Mask as the Goal of Computational Auditory Scene Analysis. In Naik (Ed.), *Blind Source Separation: Advances in Theory, Algorithms and Applications* (pp. 349–368). Springer.

CUDA – The architecture for High Performance Computing

Binish M. C.
Assistant Professor
Department of Electronics and Communication Engineering

The CUDA (Compute Unified Device architecture) Toolkit is a development platform that allows you to develop high-performance GPU performance accelerated applications. You can use the CUDA Toolkit to create, optimize, and deploy applications for GPU-accelerated embedded systems, desktop workstations, corporate data centres, cloud-based platforms, and HPC supercomputers. GPU-powered libraries, troubleshooting and debugging tools, a C/C++ translator, and a dynamic library are included within the toolkit.

Research teams can create applications that scale from sole GPU workstations to cloud deployments with several GPUs by leveraging built-in features for distributing computations across multi-GPU configurations. Nvidia released the successful GPU GeForce 256, the first graphics card to be referred to as a GPU, in 1999. The primary purpose of having a GPU at the period was for video games but during early 2010 GPUs were employed for mathematics, research, image & video analysis, machine learning, engineering and technology. Recent advances in deep learning structures and algorithms necessitate extremely high computational demands for training image data and biomedical voxel information.

CUDA Architecture

For parallel execution, multiple streaming Multiprocessors (SM) are typically used. There are 8 Streaming Processors in each Streaming Multiprocessor (SP) Each Streaming processor includes a MAD (Multiplication and Addition Unit) as well as an extra MU (multiplication unit). The GT200 has 240 Streaming Processors with a processing capacity of more than 1 TFLOP.

Each Streaming Processor can execute thousands of threads per programme and is smoothly threaded. Each Streaming Multiprocessor on the G80 card can support 768 threads. After each Streaming Multiprocessor has 8 SPs, each SP can support up to 96 threads. Total number of threads that can execute - 8 * 96 = 768. As a result, these processors are referred to as highly parallel. The data rate of the G80 processor is 86.4GB/s. It also features an 8GB/s channel of communication with the CPU (4GB/s for each direction).

CUDA Programming Hierarchy

A thread is the lowest level of abstraction in the CUDA programming model for performing a computation or memory operation. Beginning with devices based on the

NVIDIA Geforce GPU architecture, the CUDA programming language uses the asynchronous programming approach to accelerate memory operations. The asynchronous computing model specifies how asynchronous operations behave with reference to CUDA cores.

The asynchronous programming model defines the behaviour of the Asynchronous Barrier for CUDA thread synchronisation. The model also discusses and defines how cuda::memcpy_async can be used to transport data from main memory asynchronously while processing in the GPU.

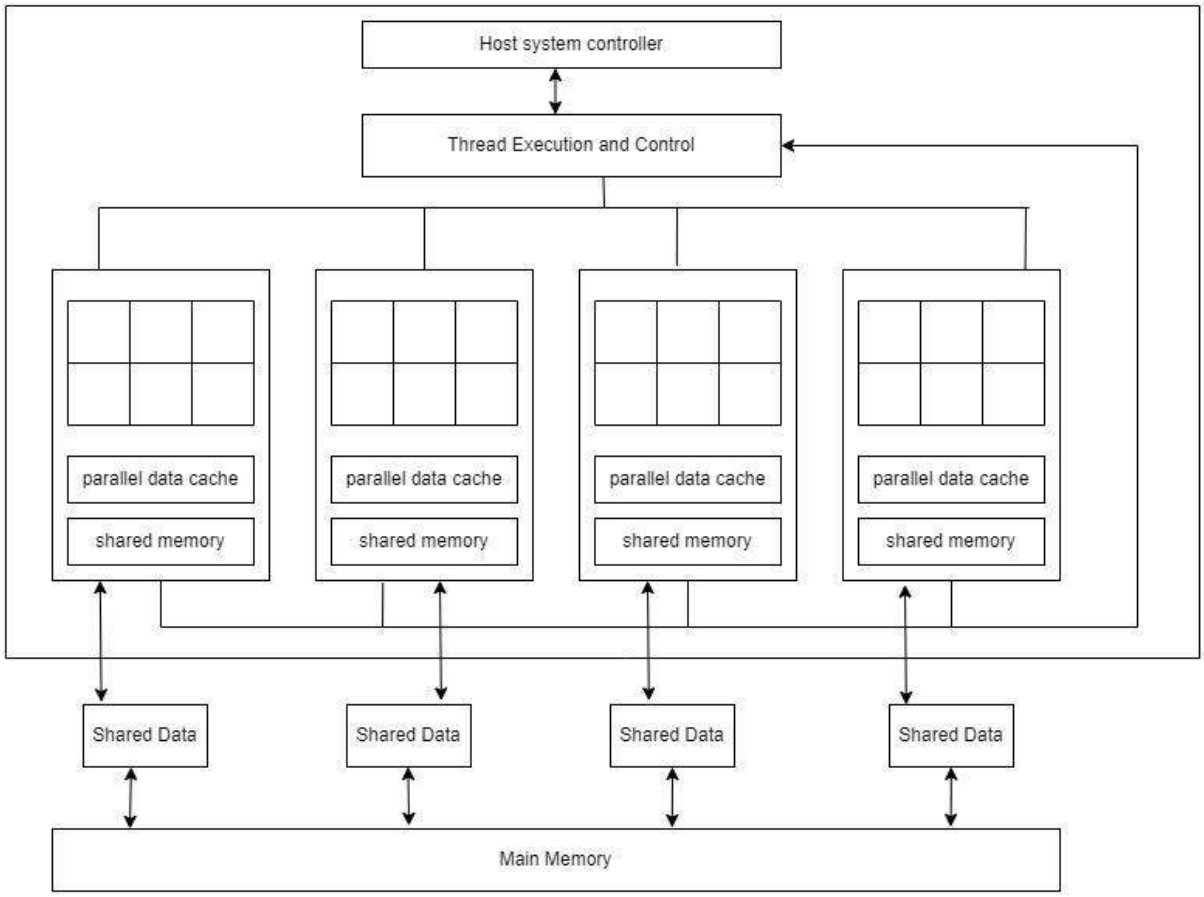

Fig 1. Compute Unified Device Architecture

Heterogeneous Programming

The CUDA programming approach assumes that the CUDA threads run on a physically distinct device that acts as a coprocessor to the host running the C++ programme. For example, when the kernel and corresponding parallel applications run on a GPU, then the remainder of the C++ application runs on a CPU. The CUDA programming model also implies that the host and device have their own DDR-4 DRAM memory areas, referred to as host memory and device memory, respectively. As a result, a programme manages the global,

constant, and texture memory areas visible to kernels via CUDA runtime calls. This involves memory allocation and deallocation on the device, as well as data transfer between the host and the device.

References

1. Bo Ma, Michaela Gaens, Liliana Caldeira, Julian Bert, Philipp Lohmann, Lutz Tellmann, Christoph Lerche, Member, IEEE, "Scatter Correction based on GPU-accelerated Full Monte Carlo Simulation for Brain PET/MRI ", *IEEE Transactions on Medical Imaging*, 2019.
2. Christos G. Xanthis, Member, IEEE, Ioannis E. Venetis, A. V. Chalkias, and Anthony H. Aletras."MRISIMUL: A GPU-Based Parallel Approach to MRI Simulations", *IEEE TRANSACTIONS ON MEDICAL IMAGING*, VOL. 33, NO. 3, MARCH 2014.
3. https://www.geeksforgeeks.org/introduction-to-cuda-programming/
4. https://docs.nvidia.com/cuda/cuda-c-programming-guide/index.html
5. https://www.run.ai/guides/nvidia-cuda-basics-and-best-practices/cuda-programming

Applications of Additive Manufacturing of Electrical Machines

Fareeda A. Kareem
Associate Professor
Department of Electrical &Electronics Engineering

Additive Manufacturing is a computerized method to industrial production that enables the creation of lighter, stronger components and systems. It has actually been around us for several decades. In the right applications, additive manufacturing delivers a perfect trifecta of improved performance, complex geometries and simplified fabrication. As a result, opportunities will be present in large quantities for those who actively embrace additive manufacturing.

Additive manufacturing (AM) is the industrial production name for 3 D printing.It is a computerized manufacturing process that creates three dimensional objects by adding materials, layer by layer. Using computer aided design (CAD), additive manufacturing allows the creation of objects with exact geometric shapes. This technique is in contrast to traditional manufacturing that often requires machining or other techniques to remove surplus material. AM allows the creation of customized parts with elaborate structures and little wastage .The design modifications can be done quickly and efficiently during the manufacturing process The lack of material wastage provides cost reduction for high value parts and also leads to reduced lead time. When these lighter structures are applied to aerospace or automotive applications, for example, they lead to fuel savings and the related environmental (and financial) benefits. AM also allows for the replacement of parts that may otherwise be impossible to replace, meaning that machines can be repaired rather than scrapped. From a manufacturing point of view, AM has also attracted interest in electrical machines.

The next generation electrical machines include designs with high efficiency and power density, including aspects such as minimal material waste and recyclability. Any electrical machine consists of coils/windings, magnetic cores, thermal management components and mechanical assemblies .The researches are progressing on all these components of electrical machines .But a complete AM-built and user-ready electrical machine, for large volume manufacturing and industrial applications, is a dream which is yet to be accomplished due to a few challenges regarding slow manufacturing speed, internal constructional defects, limited multi-material printing capability and the need for post-processing of printed parts.

Types of AM

There are 7 types of AM.Among all the AM processes, Selective laser melting (SLM),Fused deposition modeling (FDM),Binder jet printing (BJP) technology and Laser

Object Manufacturing (LOM) are the ones shown to be most promising for the manufacturing of electrical machines .

Materials for Additive Manufactured Machine Components

An electrical machine consists of a stator and a rotor separated by an airgap.AM puts its first step in electrical machine manufacturing,even when all components of electrical machine can be produced with AM.The recent states of AM in the manufacturing of electrical machines and their components that include magnetic materials and windings .The magnetic materials are essential in the construction of modern, high-specific-output electrical machines.Materials having best of electromagnetic properties are Soft magnetic composite (SMC) and intermetallic alloys. But when using these materials in conventional processes, it results in poor mechanical properties and limitations on the realization of complex geometries. But the use of AM gives a better control over electromagnetic and mechanical properties and a flexibility in geometrical shape utilization is obtained by employing AM.A magnetic core made using AM provides a magnetic permeability of up-to 31,000, low hysteresis losses i.e., low coercivity of minimum 16 A/m and up-to 50% weight reduction is observed . Also by using layered structures of different electrical resistivity, the eddy current loss due to non-laminated dense structure can be reduced. A difference in electromagnetic properties called anisotropy is introduced by the additive manufacturing technique being a layer based process. It is shown that the issue of macroscopic faults in the structure can be overcome by using pre heated print bed .For reducing macroscopic defects the intermetallic alloys like Fe-Si ,Fe-Co can be used in bulk form when employing AM technique.

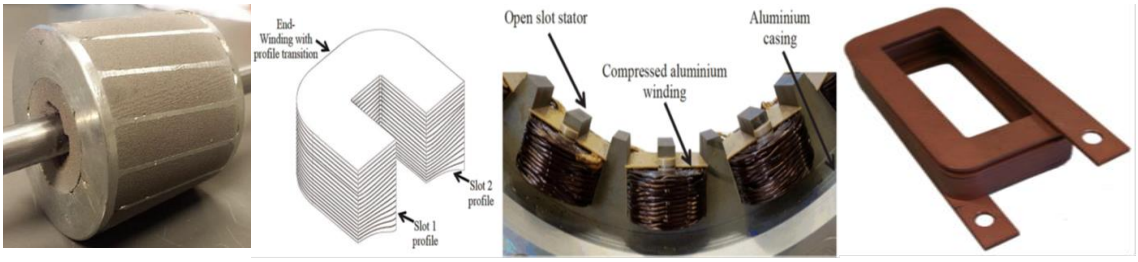

Fig 1. Examples of AM built core, AM shaped profile windings

The winding of an electrical machine consists of conductors ,insulating system and mechanical components .In order to have a low loss winding design ,a high conductor fill factor is necessary.The utilization of AM enables improved performance measures, effective material utilization and manufacturability in the manufacturing of machine windings. It has been shown that the specific profiling of winding of the conductors not only improved the slot area utilization (fill-factor) but also minimized the AC losses. The electrical properties of an AM built coil are varying with respect to different heat treatment methods.

AM can be utilized to build cooling structures with porosity, complex passages/channel/duct and extended surfaces. The cooling capability of electrical machines is

improved by the introduction of additive manufacturing in several ways, such as reducing the weight, optimizing the cooling system's shape and geometries, and reducing the cooling systems, AM to rethink the manner in which machines are thermally managed. AM makes possible design solutions with high thermal conductivity and minimal additional power loss.

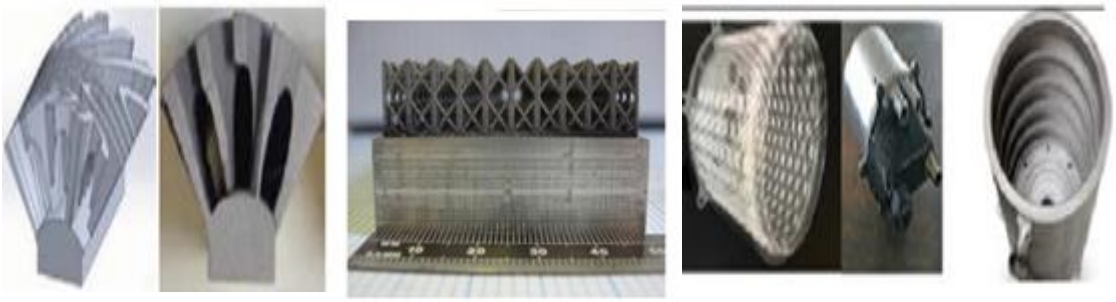

Fig 2. Examples of heat guides,heat pipes

The ongoing research into AM for electrical machines has been focused on tackling individual machine subassemblies/active materials in a decoupled manner to a large extent. Although, AM provides a virtually unrestricted way of designing and manufacturing new components, there is a need to understand how this translates to successful implementation when it comes to in-volume manufacturing of electrical machines.

References

1. Wrobel, R.; Mecrow, B.C.(2020), A Comprehensive Review of Additive Manufacturing in Construction of Electrical Machines. *IEEE Trans. Energy Convers*.35, 1054–1064.
2. Pham, T.; Kwon, P.; Foster, S.(2021) ,Additive Manufacturing and Topology Optimization of Magnetic Materials for Electrical Machines—A Review. *Energies* ,14, 283.
3. F.Wu and A. M. EL-Refaie,(2020), "Toward Additively Manufactured Electrical Machines: Opportunities and Challenges," in *IEEE Transactions on Industry Applications*, vol. 56, no. 2, pp. 1306-1320.
4. Trismus, H.; Kallaste, A.; Belahcen, A.; Rassolkin, A.; Vaimann, T.(2019), Challenges of Additive Manufacturing of Electrical Machines.In Proceedings of the 2019 IEEE 12th International Symposium on Diagnostics for Electrical Machines, Power Electronics and Drives (SDEMPED), Toulouse, France, 27–30 , pp. 44–48.

Fuel Cell Electric Vehicles

Femy P. H.
Associate Professor
Department of Electrical and Electronics Engineering

With the development of technologies in recent decades and the imposition of international standards to reduce greenhouse gas emissions, car manufacturers have turned their attention to new technologies related to electric/hybrid vehicles and electric fuel cell vehicles. This article focuses on electric fuel cell vehicles, which optimally combine the fuel cell system with hybrid energy storage systems, represented by batteries and ultracapacitors, to meet the dynamic power demand required by the electric motor and auxiliary systems. This paper compares the latest proposed topologies for fuel cell electric vehicles. In the last decade through research and development work in universities and laboratories of research institutes around the world shows that Hydrogen is an excellent source of energy with many unique properties. It is the cleanest and the most efficient fuel. The unique property of hydrogen in electrochemical processes is that it can be converted into electricity in the fuel cell system which makes it much more efficient than the conversion of conventional fuels into mechanical energy. This unique property of hydrogen has led to the manufacture of hydrogen fuel cells and makes them a very good choice for automotive companies. The alternative to fossil fuels found by car manufacturers for fueling vehicles is represented by other energy sources, such as: battery systems, ultracapacitors or fuel cells.

Electric Vehicles (EVs) and Fuel Cell Electric Vehicles (FCEVs) are the most viable solutions for reducing Greenhouse Gasses (GHG) and other harmful gasses for the environment. Although EVs and FCEVs can reduce emissions to a certain value, they do not reduce them to absolute zero. Thus, the renewable energy transport infrastructure allows FCEVs to become a preferable choice, because they attract great attention in the road and rail transport sector without using fossil fuels[1]. FCEVs and Fuel Cell Hybrid Electric Vehicles(FCHEVs) use a combination of Fuel Cells(FC), and batteries (B) or/and Ultracapacitors (UC). The research stages for FCHEVs include the development of vehicles and the improvement of their efficiency. Beside the fuel cell system, they use the battery and/or ultracapacitor pack as a complementary power source to provide the required power on the DC bus.

FCEVs use a full electric propulsion system, and the energy source is based on fuel cell stacks. A FCEV is hydrogen-fueled and the electrochemical process results in water and heat. Proton Exchange Membrane Fuel Cell is the ideal choice compared to other types of Fuel Cell System (FCS) because it operates at a low temperature of 60–80 ◦C, develops a high-power density and exhibits low corrosion [2]. FCEVs powertrain can be separated into three categories: fuel cell and battery (FC + B), Fuel Cell + Ultracapacitor (FC + UC) and

Fuel Cell + Battery + Ultracapacitor (FC + B + UC). Because FC + B + UC configuration is complex and due to the fact that ultracapacitors have low energy density, FC + B is the main design configuration and is applied in most FCEVs as shown in Figure 1.

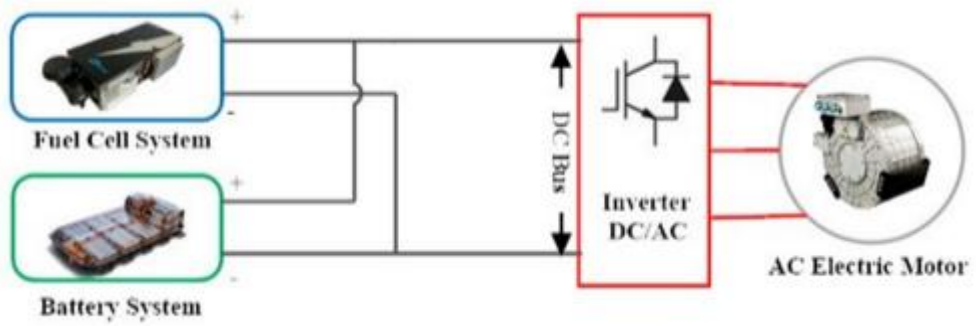

Fig 1. Topology of Fuel Cell Electric Vehicles: fuel cell + battery

Energy Management Strategy for Fuel Cell Electric Vehicle

In order to achieve a viable FCEV, with an opening to the market for marketing purposes by the manufacturers of the automotive industry, the main challenge is to develop a control strategy for energy management. These strategies lead to the improvement of the performances both from an energy point of view and of the reliability of the components, the most essential thing when we speak of the maintenance of a vehicle after commercialization. Reducing hydrogen consumption by optimizing energy consumption is the subject of much research. In addition to assessing fuel consumption, control strategies also play a role in preventing the degradation of energy storage systems, represented by batteries and the ultracapacitor[3].

The main challenges in adopting FC technologies as automotive propulsion systems are the following[4]:

1. Infrastructure for hydrogen (H2) stations and their refueling
2. High cost of hydrogen production
3. The low power density of the batteries increases the size of its system and implicitly
the mass of the vehicle
4. The use of FC + B topology facilitates the power split control over fuel cell and battery
but present low flexibility in controlling the power flow
5. FC + B + UC control configuration is more complex to achieve

The evolution of the technology in the automotive field and the worldwide imposing of the pollution norms, by reducing the greenhouse gasses emissions, has caused more and more researchers to focus on the design aspects of the propulsion systems and at the same

time on the development of software and new technologies that are able to manage the demand of power from the systems that make up EV and FCEV.

References

1. M. Muthukumar, N. Rengarajan, B. Velliyangiri, "The development of fuel cell electric vehicles – A review", Materials Today, Elsevier 2021.
2. S. Sorlei, N. Bizon, P. Thounthong, "Fuel Cell Electric Vehicles—A Brief Review of Current Topologies and Energy Management Strategies", Energies, 2021, MDPI.
3. B. Tanc, H. T. Arat, E. Baltacioglu, K. Aydin, "Overview of the next quarter century vision of hydrogen fuel cell electric vehicles", International Journal of Hydrogen Energy, Elsevier 2019.
4. C. E. Thomas, "Fuel cell and battery electric vehicles compared", International Journal of Hydrogen Energy, Elsevier 2009.

Pre-Trained Models for Natural Language Processing

Sheena Kurian K.
Associate Professor
Department of Computer Science and Engineering

Natural language processing (NLP) is one of the major fields in artificial intelligence. It is mainly concerned in making computers intelligent and capable of understanding and generating natural languages like humans. NLP applications include machine translators, chatbots, spam filters, voice assistant softwares, grammar correction softwares, etc. NLP uses both linguistic and domain knowledge to interpret the input. The main challenge in developing NLP applications is because of the way in which we use different words in different contexts. NLP systems use both linguistic and domain knowledge to interpret input. Also, a large volume of data is needed to train deep learning models in NLP to overcome the curse of overfitting and get a generalized high performing model.

NLP applications have gained more popularity now with the development of pre-trained models, which are available for free. The pre-trained models are trained on large corpus and they have high accuracy. NLP developers can use these models easily by fine-tuning on a small application specific dataset. This saves developers from the requirement of having a huge labelled dataset to work with. Pre-trained models are commonly used for tasks like named entity recognition, text classification, question answering, machine translation, sentiment analysis, text summarization, etc.

Pre-trained models are deep learning models based on transformer architecture. Transformers are the current state-of-the-art model for dealing with sequence to sequence tasks (seq2seq) in NLP. An example for a seq2seq task is machine translation where a sentence in English is converted into a French sentence. Transformers are efficient in handling long range dependencies in text. Transformer architecture has stacked encoder and decoder units which uses self-attention mechanism to learn long-term dependency.

Popular open-source pre-trained models

- Google's Bidirectional Encoder Representations from Transformers (BERT) pre-trained 2,500 million words of Wikipedia and 800 million words of Book Corpus. BERT showcased its performance on 11 NLP tasks. BERT pre-trains on two tasks: masked language modelling (MLM) and next sentence prediction (NSP). MLM masks some of the tokens randomly and the objective is to predict the original vocabulary id of the masked word based on the context. For NSP tasks, BERT uses pairs of sentences in training. For 50% of the pairs, the second sentence is actually the next

sentence to the first sentence. For the remaining 50% of pairs, the second sentence is a random sentence from the corpus. The objective is to predict whether the second sentence is actually the next sentence of the first sentence in the pair.

- Microsoft's CodeBERT supports tasks like code search, code documentation generation etc. It is trained on the large dataset from Github code repositories in 6 programming languages.
- OpenNMT for neural machine translation and neural sequence learning developed by Harvard NLP group and SYSTRAN.
- Facebook RoBERTa is built upon BERT's language masking strategy. The model is trained to predict hidden sections of text.
- Embeddings from Language Models (ELMo) developed by Allen AI research center is a deep contextualized word representation modelling syntax and semantics of words as well as their linguistic contexts.
- OpenAI's GPT-3 model is trained on 175 billion parameters and achieves strong performance on tasks like translation, question answering etc.
- Google's XLNet is an extension of the Transformer-XL model. It is pre-trained using an autoregressive method to learn the functions from bidirectional contexts. It has surpassed BERT in 20 tasks such as SQuAD, GLUE, and RACE.
- Google's ALBERT is an upgrade of BERT on 12 NLP tasks including SQuAD benchmark. This model uses only 12M parameters with less loss of accuracy while evaluating. Factorization of embedding layer and parameter sharing across hidden layers are used to reduce model size.
- Universal Language Model Fine-tuning (ULMFit) performs significantly on 6 text classification tasks. The model is trained on only 100 labelled examples and it matches the performance of model trained from scratch on 100x more data.

References

1. XiPeng Qiu and TianXiang Sun and YiGe Xu and YunFan Shao and Ning Dai and XuanJing Huang (2021). Pre-trained models for natural language processing: A survey. *Science China Technological Sciences*, 63 (10), 1872—1897.
2. https://neptune.ai/blog/hugging-face-pre-trained-models-find-the-best
3. https://huggingface.co/models
4. Xiao, Y. and Jin, Z.Z. (2021) Summary of Research Methods on Pre-Training Models of Natural Language Processing. *Open Access Library Journal*, 8, 1-7.

Non-Invasive Fetal ECG Monitoring Techniques

Sheeja D. S.
Assistant Professor
Department of Electronics & Instrumentation Engineering

During pregnancy, a Foetal Electrocardiogram (FECG) is performed to analyse the fetus's Foetal Heart Rate (FHR) to indicate the fetus's growth and health, to detect any abnormalities, and to prevent disease The fetal electrocardiogram monitoring can be carried out either invasively by placing the electrodes on the scalp of the fetus, involving the skin penetration and the risk of infection, or non-invasively by recording the fetal heart rate signal from the mother's abdomen through a placement of electrodes deploying portable, wearable devices. Non-Invasive Fetal Electrocardiogram (NIFECG) is an evolving technology in fetal surveillance because of the comfort to the pregnant women and being achieved remotely, specifically in the unprecedented circumstances such as pandemic or COVID-19. Textiles have been at the heart of human technological progress for thousands of years, with textile developments closely tied to key inventions that have shaped societies. The relatively recent invention of smart textiles is set to push boundaries again and has already opened the potential for garments relevant to medicine, and health monitoring. This paper aims to discuss the different technologies and methods used in non-invasive fetal electrocardiogram (NIFECG) monitoring as well as the potential and future research directions of NIFECG in the smart textiles area.

Electrocardiogram (ECG) can be defined as a graphical representation of bioelectrical signals helpful in determining the functionality of the heart through the analysis of graphic representation obtained during the measurement of cardiac cycle of the person or human body. The aim of the biomedical research is to continuously improve the diagnostic devices and develop non-invasive methods of health monitoring, in addition to upgrading already existing devices, thus reducing the cost involved. The on-going research predicts that the main cause of prenatal death is heart defects, as congenital heart defects easily occur during the formation of the heart at the initial stage of pregnancy.

During the pregnancy, the monitoring of fetal heart rate is essential to identify the proper supply of oxygen, nutrients, and growth of the fetus. Monitoring of the fetus during pregnancy may help in recognizing the pathological conditions, such as fetal hypoxia, allowing prompt medical interventions before irreversible changes take place. The abnormality in the fetal heart rate of the fetus indicates that there is insufficient oxygen supplied or other problems to the fetus.

FHR during pregnancy or labour can be monitored through invasive and non-invasive fetal methods so that the heart functionality of the fetus can be predicted to reflect the growth and wellbeing of the fetus. Electrocardiography (ECG) was used by researchers in 1906 to invasively determine the FHR through the abdomen during the pregnancy. In 1958, Edward

H. Hon used the successive R waves method from ECG for the calculation and estimation of FHR non-invasively. With the advancement in technology, Callagan in 1964 monitored an ultrasound beam is using through the abdo- sound monitoring procedure, in which the FHR non-invasively sent the doppler sound monitoring procedure, in which an ultrasound beam was sent through the abdomen of the men of the mother and the reflected signal was measured, thus helping to analyze FHR mother and the reflected signal was measured, thus helping to analyze FHR.

Unlike invasive electrocardiography (FECG), which involves surgery to insert the electrodes into the scalp of the fetus through the abdomen of pregnant women, non- invasive fetal electrocardiography (NIFECG) deploys electrodes placed on the abdomen of the pregnant mother to extract the fetus' health information. The electrical signal of the electrical signal of the fetal heart rate helps identify the development of the fetus in addition to the presence of development of the fetus in addition to the fetal heart rate helps any congenital heart disease within the fetus.

Fetal Electrocardiography (FECG)

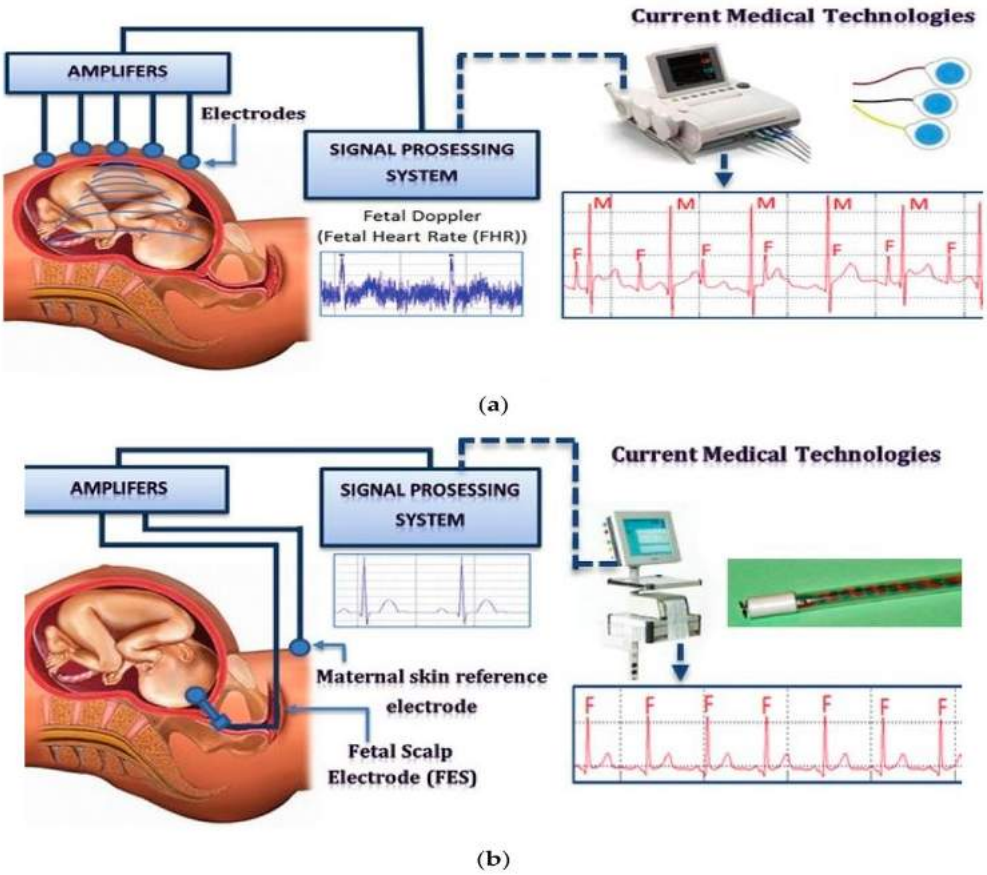

Fig 1. (a) Non-invasive FECG measurement. (b) Invasive FECG measurement

For the fetus, fetal electrocardiography (FECG) helps to analyze FHR and health conditions because the heart of the fetus is the first organ to develop during the first 3–4 weeks of pregnancy. To determine FHR of the fetus, several fetal monitoring techniques, both invasive and non-invasive, are used. However, considering the comfort of the patient, a non-invasive process for FECG is usually preferred. Clifford et al. analyzed and evaluated the FECG device's accuracy in the context of fetal scalp electrodes (FSE) by comparing the results from the experiment. Thirty-two pregnant women were involved for data recording and the electrode placement was achieved following the configuration shown in Figure 1. The signal quality varied according to fetal positioning. However, the results of the study depicted that an average correlation of 0.96 was achieved in comparison to results obtained using invasive Fetal Scalp Electrodes (FSE).

To understand the importance of electrode placement, a study was non-invasively conducted using the Monica AN24 Monitor with five electrodes. It was observed that the non-invasive FECG was a preferred method to provide comfort to pregnant women in comparison to invasive FECG. However, the results indicated that the signal quality of the FECG data obtained was affected by maternal cardiograph (MECG) artefacts and noise, but the FECG signal can be extracted after applying a set of filters.

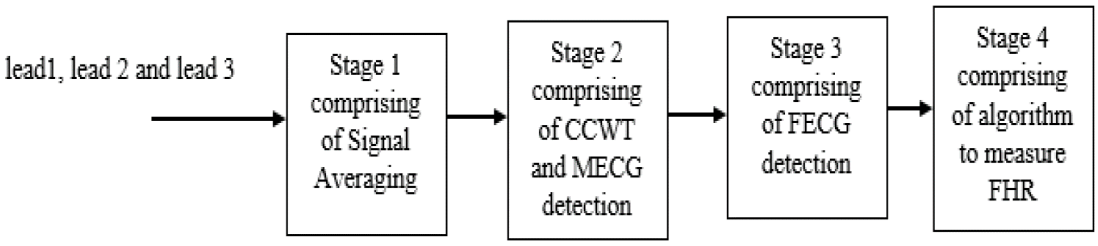

Fig 2. Fetal Heart Rate extraction method

A study was conducted using three pairs of electrodes which were placed on the abdomen of pregnant women. Complex continuous wavelet transform (CCWT) was deployed for the extraction of the FECG signal, using a four-stage procedure, as shown in Figure 2. In the first stage, the signals coming from the three pairs of electrodes were averaged, followed by stage two consisting of CCWT and MECG detection. The detection and extraction of FECG was carried out in stage three, while stage four focused on analyzing the fetal heart rate (FHR). Furthermore, a method to extract FECG from the MECG using a multivariate singular spectrum analysis (MSSA) was used, comprising two stages known as decomposition and reconstruction. This technique helped the researchers in detecting the FHR and separating the unwanted noise both in stationary and non-stationary signals. The main advantage of FECG monitoring is that it can be used remotely, in a non-clinical environment with high simplicity.

References

1. Ungureanu, G.; Gussi, I.; Wolf, W.; T¸ ¸tarălungă, D.; Pasca, S.; Strungaru, R. Prenatal Telemedicine Advances in Fetal Monitoring. *INTECH Open Access Publisher* 2011.
2. Hasan, M.A.; Reaz, M.B.I.; Ibrahimy, M.I.; Hussain, M.S.; Uddin, J. Detection and processing techniques of FECG signal for fetal monitoring. *Biol. Proceed. Online* **2009**, *11*, 263–295.
3. Chez, B.F.; Baird, S.M. Electronic Fetal Heart Rate Monitoring: Where Are We Now? *J. Perinat. Neonatal Nurs.* **2011**, *25*, 180–192.
4. Neilson, J.P. Fetal electrocardiogram (ECG) for fetal monitoring during labour. *Cochrane Database Syst. Rev.* **2006**, *3*.
5. Freeman, R.K.; Garite, T.J.; Nageotte, M.P.; Miller, L.A. *Fetal Heart Rate Monitoring*; Lippincott Williams & Wilkins: Philadelphia, PA, USA, 2012.

Swarm Robotics

Divya P. V.
Assistant Professor
Department of Electronics and Instrumentation Engineering

Swarm robotics is a field of multi-robotics in which a large number of robots are coordinated in a distributed and decentralised way. It is based on the use of local rules, and simple robots compared to the complexity of the task to achieve, and inspired by social insects. Large number of simple robots can perform complex tasks in a more efficient way than a single robot, giving robustness and flexibility to the group. In this article, an overview of swarm robotics is given, describing its main properties and characteristics and comparing it to general multi-robotic systems. Swarm robotics is the study of how to coordinate large groups of relatively simple robots through the use of local rules. It takes its inspiration from societies of insects that can perform tasks that are beyond the capabilities of the individuals. Beni [1] describes this kind of robots' coordination as follows: The group of robots is not just a group. It has some special characteristics, which are found in swarms of insects, that is, decentralised control, lack of synchronisation, simple and (quasi) identical members.

The motivation and inspiration of swarm robotics taken from social insects.The collective behaviours of social insects, such as the honey-bee's dance, the wasp's nest-building, the construction of the termite mound, or the trail following of ants, were considered for a long time strange and mysterious aspects of biology. Researchers have demonstrated in recent decades that individuals do not need any representation or sophisticated knowledge to produce such complex behaviours [2]. In social insects, the individuals are not informed about the global status of the colony. There exists no leader that guides all the other individuals in order to accomplish their goals. The knowledge of the swarm is distributed throughout all the agents, where an individual is not able to accomplish its task without the rest of the swarm.

Social insects are able to exchange information, and for instance, communicate the location of a food source, a favourable foraging zone or the presence of danger to their mates. This interaction between the individuals is based on the concept of locality, where there is no knowledge about the overall situation. The implicit communication through changes made in the environment is called stigmergy [3, 4]. Insects modify their behaviours because of the previous changes made by their mates in the environment. This can be seen in the nest construction of termites, where the changes in the behaviours of the workers are determined by the structure of the nest [5].

Organisation emerges from the interactions between the individuals and between individuals and the environment. These interactions are propagated throughout the colony

and therefore the colony can solve tasks that could not be solved by a sole individual. These collective behaviours are defined as self-organising behaviours. Self-organisation theories, borrowed from physics and chemistry domains, can be used to explain how social insects exhibit complex collective behaviour that emerges from interactions of individuals behaving simply [5]. Self-organisation relies on the combination of the following four basic rules: *positive feedback*, *negative feedback*, *randomness*, and *multiple interactions* [5].

Şahin [7] lists some properties seen in social insects as desirable in multi-robotic systems: robustness, the robot swarm must be able to work even if some of the individuals fail, or there are disturbances in the environment; flexibility, the swarm must be able to create different solutions for different tasks, and be able to change each robot role depending on the needs of the moment; scalability, the robot swarm should be able to work in different group sizes, from few individuals to thousands of them.

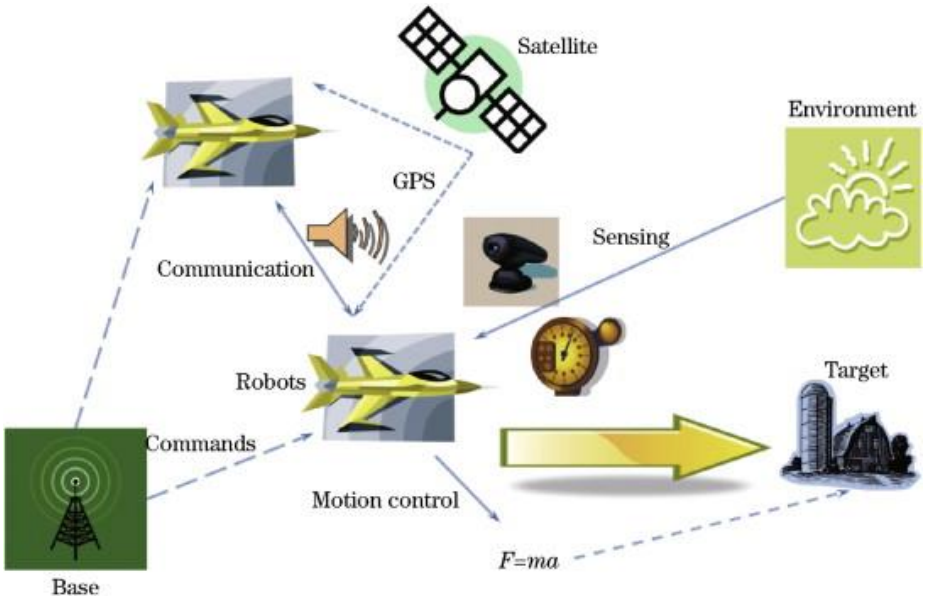

Fig 1. General model of swarm Robotics

In order to understand what swarm robotics is, a definition taken from sahin [7] is given: Swarm robotics is the study of how a large number of relatively simple physically embodied agents can be designed such that a desired collective behaviour emerges from the local interactions among agents and between the agents and the environment.

This definition is complemented with a set of criteria in order to have a better understanding and be able to differentiate it from other multi-robot types of systems [7].

(i) The robots of the swarm must be autonomous robots, able to sense and actuate in a real environment.

(ii) The number of robots in the swarm must be large or at least the control rules allow it.

(iii) Robots must be homogeneous. There can exist different types of robots in the swarm, but these groups must not be too many.

(iv) The robots must be incapable or inefficient with respect to the main task they have to solve, this is, they need to collaborate in order to succeed or to improve the performance.

(v) Robots have only local communication and sensing capabilities. It ensures the coordination is distributed, so scalability becomes one of the properties of the system.

Miniaturization and cost are key factors in swarm robotics. These are the constraints in building large groups of robots; therefore the simplicity of the individual team member should be emphasized. This should motivate a swarm-intelligent approach to achieve meaningful behaviour at swarm-level, instead of the individual level. Compared with individual robots, a swarm can commonly decompose it's given missions to their subtasks; a swarm is more robust to partial swarm failure and is more flexible with regard to different missions. Swarms of robots of different sizes could be sent to places that rescue-workers can't reach safely, to explore the unknown environment and solve complex mazes via on-board sensors. On the other hand, swarm robotics can be suited to tasks that demand cheap designs, for instance or agricultural shepherding tasks. More controversially, swarms of can form an autonomous army. U.S. Naval forces have tested a swarm of autonomous boats that can steer and take offensive actions by themselves. The boats are unmanned and can be fitted with any kind of kit to deter and destroy enemy vessels.

References

1. G. Beni, "From swarm intelligence to swarm robotics," in *Swarm Robotics Workshop: State-of-the-Art Survey*, E. Şahin and W. Spears, Eds., no. 3342, pp. 1–9, Springer, Berlin, Germany, 2005. View at: Google Scholar
2. S. Garnier, J. Gautrais, and G. Theraulaz, "The biological principles of swarm intelligence," *Swarm Intelligence*, vol. 1, no. 1, pp. 3–31, 2007. View at: Google Scholar
3. O. Holland and C. Melhuish, "Stigmergy, self-organization, and sorting in collective robotics," *Artificial Life*, vol. 5, no. 2, pp. 173–202, 1999. View at: Google Scholar
4. S. Franklin, "Coordination without communication," 2010, http://www.msci.memphis.edu/~franklin/coord.html. View at: Google Scholar
5. E. Bonabeau, M. Dorigo, and G. Theraulaz, *Swarm Intelligence: From Natural to Artificial Systems*, Oxford University Press, New York, NY, USA, 1999.
6. L. Iocchi, D. Nardi, and M. Salerno, "Reactivity and deliberation: a survey on multi-robot systems," in *Balancing Reactivity and Social Deliberation in Multi-Agent*

Systems. From RoboCup to Real-World Applications, pp. 9–32, Springer, Berlin, Germany, 2001. View at: Google Scholar

7. E. Şahin, "Swarm robotics: from sources of inspiration to domains of application," in *Swarm Robotics Workshop: State-of-the-Art Survey*, E Şahin and W. Spears, Eds., Lecture Notes in Computer Science, no. 3342, pp. 10–20, Berlin, Germany, 2005. View at: Google Scholar

Introduction to Queueing Theory

Shimna A
Assistant Professor
Department of Basic Science and Humanities

Queueing theory is a branch of Operations Research. It is originated in 1909 followed by the publication related to the study of congestion in telephone traffic. Over the years, this branch has grown tremendously and there are so many research papers on the different applications queueing theory.

A basic queueing system is a service system where customers arrive to a bank of servers and require some service from one of them.A queue or a waiting line is formed when some units need some kind of service at a service centre that offers such a service facility. A queueing system can be described by the flow of units for service, joining the queue, if the service is not immediately available. Otherwise leave the system after getting service and sometimes without being served.

The basic features that characterise a system are;
a) Input
b) Service mechanism
c) Queue discipline and
d) Number of service channels.
The description of each of them is given as follows;

Input: By units, we mean those demanding service, for example, customers at a bank counter, calls arriving at a telephone exchange etc.The input describes the manner in which units arrive and join the system.The interval between two consecutive arrivals is called interarrival time.The source from which the units come may be finite or infinite.

Service Mechanism: It describes the manner in which service is rendered. A unit may be served either singly or in a batch. The time required for servicing a unit is called service time.

Queue Discipline: Indicates the way in which the units form a queue and are served. The usual discipline is First Come First Served (FCFS) or First In First Out (FIFO).Other rules, such as, Random ordering before service is also adopted in many cases.

Number of Service Channels: The system may have a single channel or a number of parallel channels for service.

Queueing Theory is the most powerful and practical tool because these require relatively little data and are simple to use. Because of this simplicity and speed, they can be used to quickly evaluate and compare various alternatives for providing service. Queueing

analysis is one of the most practical and effective tools for understanding and aiding decision-making in managing critical resources and should become as widely used in the healthcare community as it is the major service sector.

References:

1. Allen, A.O., 1978, Probability, statistics and queueing theory, with computer science applications. New York, Academic Press.
2. Hillier, F. S., and Lieberman, G. J. Introduction to Operations Research,. Irwin/McGraw-Hill, 2010.
3. Karlin, S., and Taylor, H. Stochastic process (in Hungarian). GondolatKiadó, Budapest, 1985.
4. Gautam, N. Analysis of queues: methods and applications. CRC Press, 2012.

How Life skills help?

Remitha K P
Assistant Professor
Department of Basic Science and Humanities

We are all gifted and blessed in many ways, but this life is something that is one day going to end. How do we lead this life? Even though we have many skills, such as cycling, dancing, singing, and even cooking etc, still we lack the life skills that are very essential for our entire life. Likewise there are many skills that dominate our world, but the one set of skills that would predominantly decide whether we are happy or not are life skills.

Life skills are the skills that are useful and can be used effectively to deal with the challenges in life. It plays a very important role beyond academic learning of Mathematics, Science and Arts etc. By life skills, we mean those competencies that enable a person to sail smoothly through his journey of life. Put in simple terms, life skills are all about taking good care for oneself, interacting positively with other, and how to handle situations that you come across the most important life skill is the ability and willingness to learn, and remember that, learning new skills can help us understand more about the world and people around us, but it should not be limited to formal education. Students need life skills such as the ability to deal with stress and frustrations and for increasing pace and change of modern life and making them able to meet the challenges of everyday life.

The World Health Organization has defined life skills as, "the abilities for adaptive and positive behaviour that enable individuals to deal effectively with the demands and challenges of everyday life". Life skills are essentially those abilities that help promote mental well-being and competence in young people as they face the realities of life. Most development professionals agree that life skills are generally applied in the context of health and social event. They can be utilised in many content areas : prevention of drug use, sexual violence, teenage pregnancy, HIV/AIDS prevention and suicide prevention. The definition extends into consumer education, environmental education, peace education or education for development livelihood and income generation, among others. In short, life skills empower young people to take positive action to protect themselves and promote health and positive social relationships. UNESCO and WHO list the ten core life skills strategies and techniques as: problem solving, critical thinking, effective communication skills, decision-making, interpersonal relationship skills, self-awareness, empathy, and coping with stress and emotions. Self-awareness, self-esteem and self-confidence are essential tools for understanding one's strengths and weaknesses. Consequently, the individual is able to discern available opportunities and prepare to face possible threats. This leads to the development of social awareness of the concerns of one's family and society. Subsequently, it is possible to identify problems that arise within both family and society. With life skills one is able to explore alternatives, weigh pros and cons and make rational decisions in solving each

problem or issue as it arises. It also entails being able to establish productive interpersonal relationships with others.

How do life skills help?

Programs aimed at developing life skills have produced the following effects: lessened violent behaviour; increased prosocial behaviour and decreased negative, self-destructive behaviour; increased the ability to plan ahead and choose effective solutions to problems; improved self-image, self-awareness, social and emotional adjustment; improved classroom behaviour etc. It makes us emotionally balanced, socially adaptable and makes us an independent thinker too. It helps the individual for their problem solving and understanding the business environment. It builds confidence in taking responsibilities and confidence both in spoken skills and for group activities. Life skills develop a greater sense of self awareness, time and people management and cultural awareness. It allows creativity and imagination to flourish, developing a more tolerant and harmonious society.

References

1. Remesh .S, Vishnu R.G, (2016), Life Skills for Engineers
2. Larry James, (2016),The First Book of Life Skills

New Technologies in Civil Engineering

Dr Daniel Paul Thanaraj
Assistant Professor
Department of civil engineering

To understand the behaviour of building or structure, civil engineers necessitate advanced tools and technologies to evaluate structural performance. In recent years, advanced electronic tools have emerged for inspecting the performance of structure. The primary method to evaluate the performance of structure is by visual observation of cracks or defects on the surface of structure. Visual inspection is one the oldest and most trusted ways to evaluate the cracks or delamination on the structural element to assess the failure condition as a part of the maintenance process.

Visual inspection has been done often so that the structure's safety is maintained [2, 11]. But the reliability of the visual inspection is affected as it depends upon the engineer's decision and experience [3, 12 and 4]. Surface cracks in structure are difficult to detect visually [10], For instance, any defects or changes in bridge structure are hard to monitor due to inability of the engineer to capture the photographs of the entire structure [1]. Furthermore, in some structure where access is difficult to inspect [12], usage of machinery or scaffolding causes hazardous to health, higher expenses of auxiliary materials and traffic disruption [11, 13]. However, implementation of aerial robotic technologies, Unmanned Aerial Vehicle (UAV) technology and thermal camera technology in structural inspection helps in solving these issues.

Aerial robotic technology will help in providing the engineers a better clarity towards comparing the photographic records of the surface of structures or landforms [7] by identifying and monitoring the defects [10]. A Computer vision approach using photographs was established by [9] to identify the cracks in concrete structural elements. Robotic technologies are evolving as a replacement to visual inspections [6, 9].

Also, unmanned aerial vehicle (UAV) technology (Figure 1) offers a quantitative measurement by examining the structure in terms of damage detection or cracks, etc. [15]. Geotechnical structure conditions, stability assessment of slope, bank erosion monitoring and lateral scour conditions are identified with the use of UAV's [7]. While inspecting highway bridge structures, UAVs helps in not interfering with traffic due to the absence of scaffolding or land closures [11].

Thermal imaging is widely used in the field of civil engineering [14]. Detection of subsurface issues in concrete bridge decks and concrete building structures is done by thermal camera technology [11]. Subsurface delamination or defects or cracks interrupts the flow of heat (Figure 2) through the concrete which can be detected in this thermal imaging

technique as it creates an variance in the thermal image [5].

Fig1. UAV Technology in Construction site

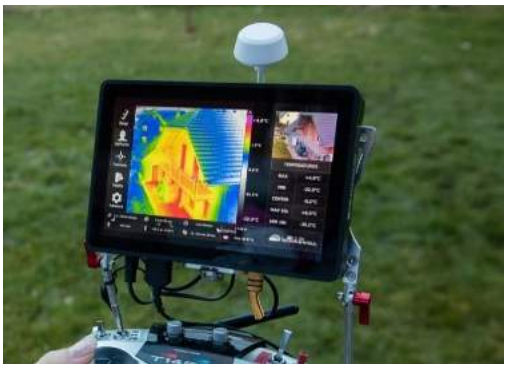

Fig 2. Thermal Imaging Technology

References

1. Bennetts, J., Denton, S. R., Webb, G. T., Nepomuceno, D. T., & Vardanega, P. J. (2021). Looking to the future of bridge inspection and management in the UK. Bridge Maintenance, Safety, Management, Life-Cycle Sustainability and Innovations, 3858-3866.
2. Bennetts, J., Vardanega, P. J., Taylor, C. A., & Denton, S. R. (2020, December). Survey of the use of data in UK bridge asset management. In Proceedings of the Institution of Civil Engineers-Bridge Engineering (Vol. 173, No. 4, pp. 211-222). Thomas Telford Ltd.
3. Bennetts, J., Webb, G., Denton, S., Vardanega, P. J., & Loudon, N. (2018). Quantifying uncertainty in visual inspection data. Maintenance, Safety, Risk, Management and Life-Cycle Performance of Bridges, 2252-2259.
4. Bolourian, N., & Hammad, A. (2020). LiDAR-equipped UAV path planning considering potential locations of defects for bridge inspection. *Automation in Construction*, 117, 103250.
5. Clark, D. G., & Cummings, J. L. (2003). Aphasia. In Neurological disorders (pp. 265-275). Academic Press.
6. Ham, Y., Han, K. K., Lin, J. J., &Golparvar-Fard, M. (2016). Visual monitoring of civil infrastructure systems via camera-equipped Unmanned Aerial Vehicles (UAVs): a review of related works. *Visualization in Engineering*, 4(1), 1-8.

7. Hellmuth, J., Hunter, A., & Barclay, A. (2018). Unmanned aerial vehicles (UAV) and their continuing application to geotechnical slope risk assessment and design. *Australian Geomechanics Journal*, 53(3), 41-49.
8. Lattanzi, D., & Miller, G. (2017). Review of robotic infrastructure inspection systems. *Journal of Infrastructure Systems*, 23(3), 04017004.
9. Lattanzi, D., Miller, G. R., Eberhard, M. O., &Haraldsson, O. S. (2016). Bridge column maximum drift estimation via computer vision. *Journal of Computing in Civil Engineering*, 30(4), 04015051.
10. McRobbie, S. G., Wright, M. A., & Chan, A. (2015, September). Can technology improve routine visual bridge inspections? In Proceedings of the Institution of Civil Engineers-Bridge Engineering (Vol. 168, No. 3, pp. 197-207). Thomas Telford Ltd.
11. Omar, T., &Nehdi, M. L. (2017). Remote sensing of concrete bridge decks using unmanned aerial vehicle infrared thermography. *Automation in Construction*, 83, 360-371.
12. Popescu, C., Täljsten, B., Blanksvärd, T., &Elfgren, L. (2019). 3D reconstruction of existing concrete bridges using optical methods. *Structure and Infrastructure Engineering*, 15(7), 912-924.
13. Snook, V. (2018, May). Using drone surveys of infrastructure and plant to improve safety and productivity. In Proceedings of the Institution of Civil Engineers-Civil Engineering (Vol. 171, No. 2, pp. 53-53). Thomas Telford Ltd.
14. Thusyanthan, I., Blower, T., & Cleverly, W. (2016, November). Innovative uses of thermal imaging in civil engineering. In Proceedings of the Institution of Civil Engineers-Civil Engineering (Vol. 170, No. 2, pp. 81-87). Thomas Telford Ltd.
15. Webb, G. T., Vardanega, P. J., & Middleton, C. (2015). Categories of SHM deployments: technologies and capabilities.

Editorial Board

TECHNO-VIBES: THE TECHNICAL ARTICLES – Vol 1, Issue 2, July 2022
KMEA Research and Consultancy Council, KMEA Engineering College

Techno-vibes is a biannual online publication under KMEA Research and Consultancy Council (KRCC) with an initiative to inspire students and faculty with current trends in technology. This will help them to steer towards academics and industry research. The objective of the magazine is to focus on high quality research articles and current affairs in the field of Science, Engineering and Technology. This enables everyone to immerse themselves in innovation and innovation-based transformations in the education system.

In order to strengthen and expand the research and consultancy activities in KMEA Engineering College, KRCC has been formed. The objective of the research council is to develop good infrastructural facilities and conducive environment to inculcate research and innovation culture among faculty and students. The consultancy wing puts an emphasis on socially relevant works which includes both industrial and infrastructural projects. The objectives of KRCC are to:

- Develop research infrastructure and framework for enhancing research
- Establish a research ecosystem to generate funding through sponsored projects
- Create novel products and solutions to existing problems through student projects
- Enhance the number of highly indexed publications in all departments
- Undertake socially committed projects and consultancies

KMEA ENGINEERING COLLEGE

kuzhivellipady , Edathala P.O . Ernakulam - 683561

ESTD - 1957

ADMISSION 2022 OPEN

20 Years of Excellence

B .TECH

- Civil Engg
- Mechanical Engg
- Computer Science and Engg
- Electronics & Communication Engg.
- Electrical & Electronics Engg.

M.TECH

- Computer Aided Structural Engg
- Computer Science & Engg
- Communication Engg.
- Power Electronics

PHD

- Computer Science & Engg./
- Civil Engg./ Interdisciplinary

B Tech : Honours | Option for Minor
Credentials in Emerging Areas

NAAC | MoE GOVT OF INDIA | ATAL RANKING 64 MoE, Govt. of India | MURDOCH UNIVERSITY | UNIVERSITI TEKNOLOGI MARA | N·S·D·C National Skill Development Corporation

COLLEGE CODE **KME**

KMEA ESTD - 1957

www.kmeacollege.ac.in

FOR ADMISSION

+91 790 292929 4/5/6

admission@kmeacollege.ac.in