SPECIAL FEATURE

A Novel Approach to Social Network Mixed Comment Troll Detection Using Deep Learning Methods

Silicon University

The Science & Technology Magazine

Digest

Vol. 32 • July - September 2024

Our Vision: "To become a center of excellence in the fields of technical education & research and create responsible citizens"

Quantum Computing: Revolutionizing Problem-Solving in Computer Science

Problem-solving in computer science is on the brink of a significant transformation, with quantum computing emerging as a powerful tool that promises to redefine how we tackle complex problems. Unlike classical computers, which process information in binary bits (either 0 or 1), quantum computers use quantum bits or qubits. Qubits have the unique ability to exist in multiple states simultaneously, thanks to the principles of quantum mechanics, specifically, superposition and entanglement. This fundamental difference allows quantum computers to perform many calculations at once, potentially solving problems that classical computers would find intractable.

Quantum computing holds particular promise in fields that involve complex, large-scale computations. For instance, in cryptography, quantum computers could crack encryption methods that are currently considered secure, necessitating the development of new cryptographic standards. In materials science, quantum simulations could lead to the discovery of new materials with extraordinary properties, such as room-temperature superconductors or advanced catalysts for chemical reactions.

One of the most exciting potential applications of quantum computing is in solving optimization problems issues that require finding the best solution from an enormous set of possibilities. Such problems are common in logistics, financial modelling, and drug discovery. Classical algorithms often struggle with the sheer complexity of these tasks, but quantum algorithms could find solutions much more efficiently.

Despite its potential, quantum computing is still in the early stages of development. The quantum computers available today, often referred to as noisy intermediate-scale quantum (NISQ) devices, are limited by the number of qubits they can handle and are prone to errors. Achieving "quantum supremacy" – the point where a quantum computer can solve a problem faster than the best classical computer – remains a significant challenge.

Moreover, many of the quantum algorithms that have been proposed are still theoretical. Bridging the gap between theory and practical application will require significant advancements in both quantum hardware and software. Researchers are working tirelessly to develop more stable qubits, improve error correction methods, and create quantum algorithms that can take full advantage of quantum hardware.

The potential of quantum computing is driving significant investment from governments, corporations, and academic institutions around the world. These efforts are leading to rapid progress in the field, with breakthroughs occurring at an accelerating pace. For computer science students and professionals, gaining an understanding of quantum computing and learning how to work with quantum programming languages, such as Qiskit or Cirq, will be increasingly valuable as the technology matures.

Quantum computing is set to revolutionize the way we approach problem-solving in computer science and beyond. While the field is still in its early days, the advancements made so far suggest that quantum computers will eventually become a critical tool for solving some of the most complex problems facing humanity. As we continue to unlock the potential of quantum computing, its impact is likely to be profound and far-reaching, indicating a new era in computation and innovation.

Dr. Pamela Chaudhury
Dept. of CSE

A Novel Approach to Social Network Mixed Comment Troll Detection Using Deep Learning Methods

Abstract *– The excessive and inescapable presence of trolling on social media platforms necessitates an effective detection system to counter this malevolent practice. This research work aims to develop and deploy numerous deep learning algorithms for the detection and moderation of trolling behavior. This work makes use of the popular benchmark tweets dataset obtained from the Kaggle NLP Challenge repository. Furthermore, this work has tackled the challenges of uneven dataset distribution by employing an under-sampling technique. The proposed strategy contains an image text extraction segment using Tesseract OCR(Optical Character Recognition) and a text classification component employing various Recurrent Neural Network (RNN) architectures, including LSTM (Long Short-Term Memory), bidirectional LSTM, GRU (Gated Recurrent Unit) and BERT (Bidirectional Encoder Representations from Transformers). The accuracy, precision, recall, and F1-score evaluation metrics are used to find the efficiency of the proposed models. The experimental results reveal that the BERT model outperformed other models by achieving an average accuracy of 90.7%.*

Keywords *– GRU, Bi-LSTM, BERT, Deep Learning, Memes, Troll Detection.*

I. Introduction

Online social media trolls mean offensive remarks in reaction to posts intended to upset and create conflicts through text and images. On social media sites like Facebook, Instagram, Twitter, Discord, and others, trolling has spread like wildfire. It has been observed an increase in online abuse and toxicity as social media use grows. The comments generally range from veiled attacks like mocking, and sarcastic remarks to aggressive and rude opinions towards the subject or the person. Over time, people have become cunning and artful in this kind of behavior. The trolls include misleading information, targeting various cultures, religions, languages, genders, and appearances. The comments sometimes contain text and/or graphics, cartoons, and memes.

Therefore, there is an imperative requirement for effective troll detection systems capable of identifying and flagging such comments, images, and combinations of both with reasonable precision. If the trolls are severe and frequent, reports can be generated, which will facilitate the troll accounts to be seized or blocked based on the country's cyber laws. This work aims to develop and implement some prudent deep-learning approaches combined with natural language processing techniques to detect and mitigate trolling behavior on social media platforms. This will result in a safer and more propitious online social media environment for the netizens. For training the troll detection model, this work makes use of an openly accessible toxicity classification resource named Tweets Dataset for Detection of Cyber-Trolls from the renowned Kaggle machine-learning repository.

Initiatives to leverage online social media data analysis have escalated recently, with a notable increase in comments and memes shared across various online social media platforms. This trend presents a new forensic challenge, demanding the extraction and analysis of comments and text from the images. Existing strategies involve three methods: (1) Text extraction for analysis (2) Pattern recognition within images, and (3) A hybrid approach combining both techniques for improved prediction certainty. The majority of research is on text extraction using Tesseract OCR and other methods, with an emphasis on leveraging embedded text for picture categorization. Then, text interpretation is done using both machine learning and deep learning approaches. Models are able to achieve high accuracy in tasks like sentiment analysis and the categorization of harmful comments. Incorporating word embedding and addressing data imbalance become indispensable for enhancing model performance. Selecting relevant evaluation metrics is also critical to ensure robustness in classification tasks.

This work contains the following sections. Section 2, “Literature Review”, visits some pertinent research publications that performed advanced machine learning approaches, they have attempted to create effective tools for recognizing and filtering out offensive textual content. Section 3, “Proposed

Strategy", clearly demonstrates a deep learning model created for the purpose of identifying toxicity in the text contained in images is implemented by the text classification module. Section 4, "Experimental Studies" manifests the implementation of Deep Learning techniques in Python resulting in the classification of text. Section 5, "Conclusion" encapsulates the findings of our work.

II. Literature Review

Early research is actively tackling the issue of detecting harmful social media content, specifically focusing on mitigating hateful remarks & memes. Utilizing advanced machine learning approaches, they have attempted to create effective tools for recognizing and filtering out offensive textual content including the ones within the memes.

MacDermott, et al. [1] and Risch, et al. [2] proposed deep-learning approaches to identify resentful images with embedded text content. Employing GloVe (Global Vector) word embeddings for enhanced data augmentation, their project emphasized the implementation of LSTM, GRU models, and their Bidirectional variants, showcasing some accuracy improvements. Lai, et al. [3] implemented a robust and decoupled system, considering social media content as streaming data. Their system utilized a Publisher and Consumer model, along with Apache Kafka, to process large amounts of data with low latency. They deployed well-trained transfer learning models, including RNN, LSTM, and BERT for effective analysis.

Sadiq, et al. [4] applied dense layers of a Multilayer Perceptron, incorporating manually engineered features. They compared their approach with a combination of CNN-LSTM and CNN-BiLSTM (Bidirectional LSTM) in a deep neural network, conducting 10-fold cross-validation to predict model performance. Seah, et al. [5] used SVM (Support Vector Machine) rank for troll detection by using a sentiment analysis feature set derived from sentiment scores produced by the recursive neural tensor network (RNTN) sentiment analysis tool implemented in Stanford NLP.

Sahmoud, et al. [6] and Mitra, et al. [7] evaluated various machine learning classifiers such as LR, SVM, RF, etc. on a common dataset for Twitter troll labeling. Their findings highlighted the Random Forest algorithm (RF) as the most proficient in distinguishing normal comments from troll activity. Various other researchers [8-12] have experimented with different ML techniques like k-nearest neighbor (KNN), Classification and Regression tree (CART), Decision Trees, etc.

These studies have inspired this work along with our own innovations to produce more accurate results.

III. Proposed Strategy

The work proposed two modules—one for text classification and the other for picture text extraction—are being developed as part of our strategy. The Python-tesseract module is utilized to support OCR in extracting text from photos. It is the most widely used OCR engine. Tesseract enables extremely precise character extraction from photos.

This study focuses on communications written in pure English, even if Tesseract may be utilized for character detection in other languages. A deep learning model designed to identify toxicity in text contained in a picture is used by the text classification module.

A. Dataset

For our troll detection model training, we utilized a meticulously curated dataset of 1,50,000 items, obtained from a Kaggle NLP challenge focused on detecting cyber-trolls. Six classifications make up the dataset: identity hatred, obscene, threat, insult, toxic, and severely toxic. Although the original data was previously divided into train and test sets, both sets were combined for this research. The majority of the dataset consists of clean texts, with a total of 1,50,000 comments. The most prevalent label is "toxic," and many comments are solely assigned to this label.

B. Uneven Distribution of Dataset

In the context of this study, which focuses solely on binary classification for toxicity detection, the dataset's original binary labeling aligns perfectly with the research aim. It's a common occurrence in machine learning to encounter uneven distribution within datasets, particularly when dealing with thousands or millions of records. This irregularity can present a significant challenge, particularly in cases of severe class disproportion, often resulting in poor prediction outcomes. While several classifiers, such as logistic regression, SVM, and decision trees, can manage unbalanced data to some extent, they often falter when

the class disproportion is significant.

The two main techniques that may be used to solve the problem of unbalanced characteristics are under- and over-sampling. Over-sampling involves duplicating instances of the under-represented class while under-sampling entails removing instances of the major class. Generally, over-sampling is recommended for small datasets, while under-sampling is more suitable for larger datasets, as it minimizes the risk of negatively impacting the model by removing data. For the purposes of this study, under-sampling will be exclusively employed due to the majority representation of clean comments in the dataset. This method will effectively mitigate bias towards non-toxic comments, thereby enhancing the model's performance.

C. Text Processing

The earliest text-cleaning technique used was substituting shorter forms of different words, like *as's,'re,'ll,'d*, etc. All of the comments were then changed to lowercase in order to maintain consistency when handling capitalized terms and prevent any inconsistencies in the model's predictions. Following this, all stop words, hyperlinks, special characters, white spaces, and digits from the text are removed. The Tensorflow library's Text Vectorisation was then used. Breaking up sentences into individual words or subwords and assigning them to numerical indices, it made the tokenization of text data easier. Various configurations were explored, with the most effective results achieved using a maximum of 10,000 features. Additionally, based on both external research and our own experiments, we opted to filter out comments exceeding 150 characters. This decision was made to mitigate processing and training time, as longer comments were observed to adversely impact algorithm efficiency without significantly enhancing model performance.

D. Model Selection

The proposed approach entails contrasting the utilization of Recurrent Neural Networks (RNN) with a straightforward dense model. In the first model, instead of employing an RNN layer, a Dense layer along with a Global Max Pooling layer is utilized to transform multidimensional input into a singular-dimensional object. Subsequently, the resulting tensor passes through a dense output layer, which utilizes the sigmoid activation function to generate a solitary value representing the estimated toxicity level of the processed text.

The LSTM is the first one taken into consideration for this assignment. It is commonly used because of its superior handling of sequential data. Developed to address vanishing and exploding gradient issues in RNNs, LSTM integrates an extra output cell featuring four gates. The forget gate filters irrelevant data from memory, the input gate admits relevant information, the update gate refreshes memory, and the output gate retrieves the updated long-term memory. This design ensures LSTM's effectiveness in sequential tasks, setting high-performance standards.

Traditional RNNs typically learn sequentially from left to right. However, advancements in neural networks now enable training in both directions. In this type of network, two sequences are processed: one forward and one backward. Consequently, two models are trained simultaneously. This approach often enhances contextual understanding by incorporating information from both directions. Bidirectional RNNs demonstrate superiority in speech recognition and NLP tasks, making them a preferable choice for certain tasks. In this scenario, Bidirectional RNN is integrated with the LSTM network.

The GRU is another RNN that is used in this work. It only has two gates: reset and update. The update gate chooses how much of the previous memory to keep, whereas the reset gate merges inputs with the previous data. GRU's simpler architecture leads to quicker training times. Both models excel in time series and NLP tasks, thus similar accuracy scores are anticipated from both.

We utilized BERT's bidirectional transformer architecture to extract contextualized embeddings from preprocessed text data. These embeddings capture linguistic context, enabling the classification of comments as troll and non-troll. Through fine-tuning labeled data, BERT adapts its representations to our troll detection task, enhancing classification accuracy. By setting a threshold on the model's output probability scores, the proposed iterative approach can optimize the model's performance.

The model is trained first. The input layer receives text data and is represented as a string. This data is then passed through a text vectorization layer, which transforms the textual input into a numerical format suitable for processing. Subsequently, the embeddings

obtained from the vectorization step are fed into an embedding layer, facilitating the creation of word embeddings. The embedded representations are then inputted into to the RNN layer comprising 64 units, leveraging the hyperbolic tangent activation function for effective learning. The tensor is then passed through the Global Max Pooling layer. It translates multidimensional string into a one-dimensional object. Finally, the resulting tensor is directed through a dense output layer, employing the sigmoid activation function to produce a single value indicative of the estimated toxicity level of the processed text.

A 5-fold cross-validation is performed in which the dataset is partitioned into 5 parts with 4 parts used as training dataset and the remaining part as test dataset. This is repeated five times following the principles of 5-fold cross-validation.

E. Loss and Accuracy Metrics

The loss function is employed using binary cross-entropy function in all models and written in Equation-1. It is a binary classification task between predicted and actual binary labels. By calculating the logarithmic loss for each prediction, it penalizes notable deviations from the true labels. This evaluation against ground truth provides insight into the model's performance in distinguishing between two classes.

$$Loss_{BCE} = -\frac{1}{N}\sum_{i=1}^{N}(y_i \cdot \log(p_i) + (1 - y_i) \cdot \log(1 - p_i)) \quad (1)$$

Where y_i is the truth value for taking a value 0/1 for N data points

p_i is the softmax probability for the i^{th} data point

In all models, we utilized the Adam optimizer, which combines the benefits of both Adaptive Gradient (AdaGrad) and Root Mean Squared Propagation (RMSProp) algorithms by incorporating adaptive learning rates for each parameter along with momentum. It dynamically adjusts the learning rate for each parameter based on past gradients, allowing for faster convergence and improved model performance. Equation 2 is for updating each parameter θ at each iteration t.

$$\theta_{t+1} = \theta_t - \frac{\eta}{\sqrt{\hat{v}_t} + \epsilon} \cdot \widehat{m_t} \quad (2)$$

Where h is the learning rate

$\hat{v}_t$ is the Root Mean Squared Propagation

$\widehat{m_t}$ is the momentum, ϵ is a small constant

F. Evaluation Metrics

The performance of each classifier is evaluated using the following four metrics: accuracy, precision, recall, and F1-score. The proportion of correct predictions is used to determine accuracy. Although accuracy gives a broad indication of the model's performance, significant class imbalances have a detrimental impact on accuracy score, hence alternative measures should be utilized instead. The accuracy formula is shown in Equation 3. A True Positive (TP) is the outcome when the model correctly predicts the positive class. On the other hand, a True Negative (TN) is an outcome in which the model correctly predicts the negative class. A False Positive (FP) occurs when the model predicts the positive class incorrectly. A False Negative (FN) is an outcome that occurs when the model forecasts the negative class incorrectly.

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN} \quad (3)$$

Precision is a key concept in binary detection, where it is used to identify harmful signals without mistakenly detecting benign ones. Precision evaluates the accuracy of positive predictions. This metric ensures that the model's positive identifications are reliable and minimize false alarms in critical applications. It is calculated as per Equation 4:

$$Precision = \frac{TP}{TP + FP} \quad (4)$$

Recall quantifies the number of positive values that the model correctly predicted. It is defined in Equation 5.

$$Recall = \frac{TP}{TP + FN} \quad (5)$$

The F1 score is a metric that depends on recall and precision. The computed balance is defined in Equation 6 as the harmonic mean of the precision and recall of the model.

$$F1\ score = \frac{2 * Precision * Recall}{Precision + Recall} \quad (6)$$

The performance of the model was assessed based on training accuracy and loss. The over fitting of the training is avoided by stopping function and loss metric. Fig. 1 shows the process flow of the proposed approach for effective troll detection of mixed comments in social networks.

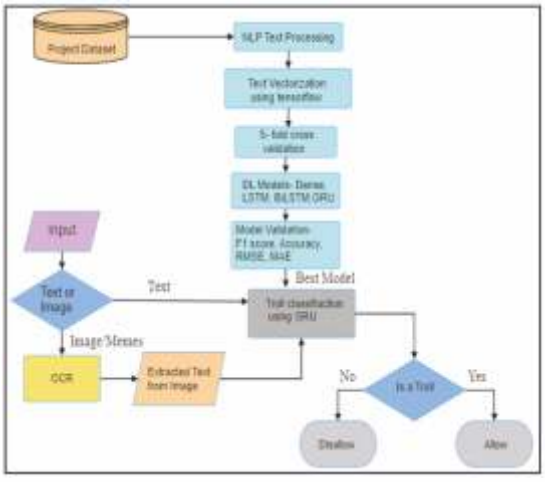


Fig.1 Proposed model for troll detection

IV. Experimental Studies

All of the predictive deep learning models have been written in Python 3.12.1 and implemented with the help of numpy, pandas, nltk, tensorflow, sklearn, and matplotlib packages with default parameters. All the independent features are taken into consideration for modeling the prediction. The models are trained for a total of 9 epochs. The data split between the train and test data in an 80:20 ratio. Validation loss was used to ensure that training is stopped as soon as there is no improvement shown on a validation set.

	Dense	LSTM	BiLSTM	GRU	BERT
Accuracy	0.864784	0.895776	0.900775	0.903024	0.907354
Precision	0.864939	0.901110	0.908869	0.907150	0.833333
Recall	0.864784	0.895776	0.900775	0.903024	0.966666
F1-score	0.864857	0.896667	0.896667	0.896667	0.895061

Table 1. Performance Observed

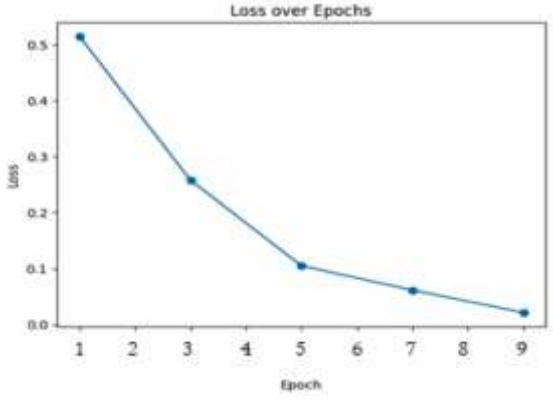


Fig.2 BERT Training Loss over Epochs

The final results of our predictive learning models are illustrated in Table 1. From the results it is clearly evident that BERT is the most accurate predictive deep learning model. The GRU model delivered the best estimation prediction when compared with the actual efforts. It produced an accuracy of 0.907354 and an F1 score of 0.895061. The Fig. 2 displays the training loss over 9 epochs for BERT indicating its prediction accuracy.

V. Conclusion

In this evaluation, we propose to provide a correct detection system that allows the detection of cyber trolls using deep learning models. We test with specific architectures, including Dense, LSTM, BiLSTM, GRU, and BERT. We examine the performance of these models through the use of metrics inclusive of accuracy, precision, and F1 score. Our experimental results show that the BERT model plays first-rate, reaching an accuracy of 90.7% and an F1-score of 89.5. The GRU model also performs well, attaining an accuracy of 90.3% and F1-score of 90.37. At the end, we conclude that the BERT model is more effective in detecting cyber trolls. This model may be utilized in real-world applications to monitor and moderate online groups, ensuring that they continue to be safe and respectful spaces for all users. In the coming time, we can explore other architectures and techniques to further improve the overall performance of our models.

Acknowledgment

We extend our heartfelt appreciation to Dr. Pulak Sahoo, Silicon University, Bhubaneswar for his continuous support and invaluable assistance throughout the project. His guidance has been instrumental in the development of our model.

References

[1] A. MacDermott, M. Motylinski, F. Iqbal, K. Stamp, M. Hussain, and A. Marrington, "Using deep learning to detect social media trolls", Forensic Science International: Digital Investigation, vol. 43, pp. 301-446, Elsevier, 2022.

[2] J. Risch and R. Krestel, "Toxic comment detection in online discussions", Deep learning based approaches for sentiment analysis, pp. 85-109, Springer, 2020.

[3] Chun-Ming Lai, Ting-Wei Chang and Chao-Tung Yang, "An online and highly-scalable streaming

platform for filtering trolls with transfer learning", The Journal of Supercomputing, pp. 1-24, Springer, 2023.
[4] S. Sadiq, A. Mehmood, S. Ullah, M. Ahmad, Gyu Sang Choi and Byung-Won On, "Aggression detection through deep neural model on twitter", Future Generation Computer Systems, vol. 114, pp. 120-129, Elsevier, 2021.
[5] Chun Wei Seah, Hai Leong Chieu, Kian Ming A. Chai, Loo-Nin Teow and Lee Wei Yeong, "Troll detection by domain-adapting sentiment analysis", 18th International Conference on Information Fusion, IEEE, pp. 792-799, 2015.
[6] S. Sahmoud, A. Abdellatif and Y. Ragheb, "A Fast Algorithm for Hunting State-Backed Twitter Trolls", Pervasive Computing and Social Networking: Proceedings of ICPCSN, pp. 643--657, Springer, 2022.
[7] S. Mitra, T. Tasnim, M. A. R. Islam, N. I. Khan, and M. S. Majib, "A Framework to Detect and Prevent Cyberbullying from Social Media by Exploring Machine Learning Algorithms", International Conference on Computer, Communication, Chemical, Materials and Electronic Engineering, pp. 1-4, IEEE, 2021.
[8] B. Mutlu, M. Mutlu, K. Oztoprak and E. Dogdu, "Identifying trolls and determining terror awareness level in social networks using a scalable framework", IEEE International Conference On Big Data, pp. 1792-1798, IEEE, 2016.
[9] F. Benrouba and R. Boudour, "Emotional sentiment analysis of social media content for mental health safety", Social Network Analysis and Mining, vol. 13, no. 1, pp. 1-7, Springer, 2023.
[10] A. Ghosh, B. C. Dhara, C. Pero, and S. Umer, "A multimodal sentiment analysis system for recognizing person aggressiveness in pain based on textual and visual information", Journal of Ambient Intelligence and Humanized Computing, vol. 14, no. 4, pp. 4489-4501, Springer, 2023.
[11] P. Fornacciari, M. Mordonini, A. Poggi, L. Sani and M. Tomaiuolo, "A holistic system for troll detection on Twitter", Computers in Human Behavior, vol. 89, pp. 258-268, Elsevier, 2018.
[12] Ana-Sabina Uban and Liviu P Dinu, "On transfer learning for detecting abusive language online", Advances in Computational Intelligence: 15th International Work-Conference on Artificial Neural Networks, IWANN 2019, Gran Canaria, Spain, June 12-14, 2019, Proceedings, Part I 15, pp. 688-700, Springer, 2019.

Aishwarya Upadhyay, Bhabana Pradhani
Eevani Bhargavi, Siddharth Mohanty
Dept. of CSE

AI tweaks to photos and videos can alter our memories

The use of artificial intelligence to edit images or generate video to remove unwanted objects or beautify scenes has become trivially simple. However, this practice results in individuals misremembering what they have seen. The potential for human memories to be distorted by artificial intelligence (AI)-edited photos and videos has prompted concerns regarding the potential consequences of such manipulation becoming an automatic feature of smartphones. *Souce: newscientist.com*

A pair of images used to assess people's memory, the right-hand one altered to change who was in the race.

Anushka, A Humanoid Robot Built from a Dump Yard

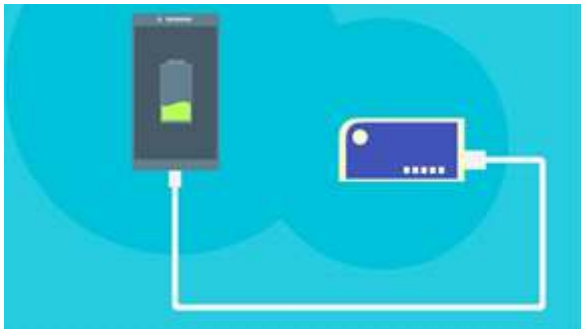
Humanoid robots have long fascinated science fiction enthusiasts, often evoking images of creations from Isaac Asimov's novels or the eerily lifelike Dolores from "West World." The advancements in generative AI, alongside existing social robots like Hanson Robotics' Sophia, make the concept of fully realized humanoid robots more tangible than ever. Recently, a humanoid robot named Anushka was developed by students and professors at the Krishna Institute of Engineering and Technology (KIET) in Ghaziabad, India. Despite its modest lab origins and a budget of just Rs. 2 lakh, Anushka boasts advanced features like autonomous movement and a 3D-printed face. The flexible silicone skin on Anushka's face was crafted by Madame Tussauds in India and modeled after a late French princess. Anushka's master-slave architecture utilizes an i7 processor as its brain, controlling various microcontrollers and servo-motors to enable lifelike movements. Currently designed to greet visitors, Anushka's creators envision her expanding into roles within healthcare and consultancy.

In a related development, Elon Musk recently revealed that two Optimus robots are already working autonomously at a Tesla factory, with plans for broader commercial use by 2026. This further underscores the rapid advancements in humanoid robotics and their growing potential for industrial and everyday applications.

(Source: The North Lines)

Pass-Through Charging

Pass-through charging is a convenient technology that allows users to charge multiple devices simultaneously from a single power source. It is commonly found in devices like power banks, docking stations, laptops, and some tablets. In power banks, pass-through charging allows both the power bank and connected devices to charge at the same time. However, some Universal Serial Bus Type-C (USB-C) hubs may allocate power to their own operations first, leaving less for the connected peripherals. The technology relies on power-regulating circuits that direct power where it's needed, with USB Power Delivery (PD) being crucial for docking stations and USB-C hubs. While pass-through charging offers convenience, it also has drawbacks, such as slower charging times since power is divided between devices. Additionally, it is less power-efficient compared to direct charging, and the heat generated can reduce the lifespan of power banks, particularly those with Lithium-ion batteries. Therefore, it's best to use pass-through charging when other options are unavailable, despite its convenience.



(Source: The Indian Express)

Five Free AI-Powered Transcriptions

Recent advancements in generative AI have streamlined many routine tasks, including the transcription of audio recordings like interviews and meetings. Despite the cost-intensive nature of AI development, several free transcription services are available. Google Recorder, for instance, is an Android app offering real-time transcriptions with AI-generated summaries, but it is limited to live audio and Google Pixel devices. Whisper, developed by OpenAI, allows users to transcribe and translate audio, accessible via a web app or local installation. Otter provides 300 minutes of free transcription monthly, along with features like speaker identification and integration with third-party apps. Happy Scribe offers ten minutes of free transcription but requires a paid plan for exporting files. Lastly, MeetGeek provides five hours of free transcription per month, with limited storage for transcripts and audio files. These services

offer various features catering to different needs, making transcription more accessible without a financial burden.

(Source: The Indian Express)

CrowdStrike, Microsoft Global IT Outage

On July 18, 2024, Windows PC systems crashed worldwide, disrupting operations across various sectors, including banks, hospitals, and restaurants. This global outage of Microsoft Windows PCs, caused by a faulty update from cyber security firm CrowdStrike, continues to create significant fallout. However, airlines, especially Delta, experienced the most severe impact, with numerous flights delayed or canceled, stranding thousands of passengers. CrowdStrike itself was able to identify and deploy a fix for the issue in 79 minutes. While CrowdStrike quickly identified and deployed a fix for the issue, the recovery process for businesses is complex and time-consuming. Among the issues is that, once the problematic update was installed, the underlying Windows OS would trigger Blue Screen of Death (BSOD), rendering the system inoperative using the normal boot process. The CrowdStrike Windows outage highlighted the vulnerabilities of modern society's heavy reliance on technology.

(Source: TechTarget)

Mayonnaise and Nuclear Fusion

Scientists at Lehigh University are using mayonnaise in an innovative approach to study nuclear fusion, a process that could revolutionize energy production by providing limitless and clean energy. The unique behavior of mayonnaise, which acts like a solid but flows under pressure, makes it an ideal analog for studying plasma, the state of matter crucial in nuclear fusion. This property of mayonnaise helps mimic the behavior of plasma under the extreme conditions required for fusion. One method of achieving nuclear fusion on Earth is inertial confinement fusion (ICF), which involves compressing hydrogen-filled capsules to create plasma. However, ICF faces significant challenges, such as the formation of Rayleigh-Taylor instabilities when materials of different densities interact under opposing pressure gradients. These findings contribute valuable insights into managing plasma behavior, bringing scientists closer to overcoming the challenges of nuclear fusion.

(Source: Firstpost)

Chittaranjan Mohapatra
Dept. of CSE

Plan to Refreeze Arctic Sea Ice Shows Promise in First Tests

Field trials suggest that the thickening of Arctic sea ice may be achieved by pouring seawater onto the snow on top of the ice. This technique could potentially preserve the sea ice throughout the summer. A daring proposal to pump seawater over the frigid Arctic Ocean to preserve the region's rapidly disappearing sea ice by real ice, a UK-based start-up, along with field trials have been successful.

Source: newscientist.com

Helmet Detection for Motorcycle Riders Using CNN

Abstract *– In today's fast-paced world, the importance of road safety cannot be overstated. Automated detection of traffic rule violators is a critical aspect of any smart traffic system. In countries like India, where the population density is high in major cities, motorcycles play a significant role in transportation. One common safety violation observed among motorcyclists is the neglect of wearing helmets, both within cities and on highways. Wearing a helmet significantly reduces the risk of head and severe brain injuries in the event of a motorcycle accident. Convolutional Neural Network (CNN) based architecture is employed to detect helmets on motorcycle riders. This approach enables the system to identify instances where riders are not adhering to safety regulations by not wearing helmets. The proposed CNN model has shown promising results when tested on traffic videos, outperforming other CNN-based methods in terms of accuracy and efficiency.*

Keywords *– Convolutional Neural Network (CNN), Object Detection, Helmet Detection.*

I. Introduction

In recent years, the alarming increase in the number of motorcyclist deaths due to road accidents in metro cities and highways has become a pressing issue. The primary reason behind such tragedies is the failure to wear helmets while riding. To address this critical issue and enhance road safety measures, the detection of helmetless motorcyclists through automated means is imperative. Utilizing advanced technology to analyze traffic surveillance videos plays a pivotal role in ensuring the safety of all road users. In real-time surveillance videos, high-speed motorcycles may not appear clearly in frames, making their detection difficult. Traditionally, researchers have utilized image processing methods for feature extraction to detect objects. By leveraging cutting-edge technology like CNN with innovative methodologies, we strive to enhance road safety and reduce the number of tragic accidents caused by helmetless riding.

II. Literature Survey

Various methodologies ranging from machine vision techniques to deep learning approaches have been explored to enhance safety measures for motorcycle riders. In this blog post, we will delve into the different research works aimed at identifying safety helmet presence among motorcycle riders, highlighting the evolution from traditional methods to cutting-edge technologies like Convolutional Neural Networks (CNN). Rattapoom et al. [1] utilized the K-Nearest Neighbor (KNN) algorithm for detecting motorcycle safety helmets through machine vision techniques. This approach involved analyzing surveillance videos to identify motorcyclists wearing safety helmets, emphasizing the importance of accurate classification for enhanced safety measures, by implementing the KNN classifier. He demonstrated the effectiveness of machine learning algorithms in helmet detection tasks. Chiverton et al. [2] classified Support Vector Machine (SVM) and Background Subtraction. He proposed a methodology that combines background subtraction for rider segmentation in traffic videos with classification using a Support Vector Machine (SVM). This innovative approach aimed to improve the accuracy of safety helmet detection by precisely identifying motorcycle riders and distinguishing between helmeted and helmet-less individuals. Li et al. [3] implemented a Histogram of Oriented Gradients (HOG) and SVM. He leveraged Histogram of Oriented Gradients (HOG) based feature extraction followed by SVM for safety helmet detection. This feature extraction method enhanced the ability to capture unique characteristics of safety helmets, enabling accurate classification through SVM. Silva et al. [4, 5] worked on Local Binary Patterns and Circular Hough Transform. She introduced a hybrid descriptor based on the Local Binary Pattern for feature extraction in helmet detection tasks. Additionally, they explored Circular Hough Transform in conjunction with a Histogram of Oriented Gradients (HOG) for automated identification of helmet-less motorcyclists. The utilization of multiple descriptors and classifiers showcased the versatility of different techniques in addressing complex challenges like automated helmet detection. In recent years, Convolutional Neural Networks (CNN) have revolutionized computer vision applications, including object detection tasks. Alex et al. [6] demonstrated the power of CNN by training a large network to classify 1000 different

classes using a vast number of images, establishing CNN as a state-of-the-art method in object recognition. The exceptional performance of CNNs surpassed traditional models like HOG, Scale-invariant feature transform (SIFT), and Local Binary Pattern(LBP) paving the way for advanced applications in various domains, including motorcycle safety. CNN-based approaches by Visnu et al. [7] and Mistry et al. [8] have showcased effective methods for detecting motorcyclists without helmets, emphasizing the critical role of advanced technologies in enhancing safety protocols.

III. Proposed Framework

The utilization of CNN in processing video frames enables detailed analysis of each rider. Not only does this system detect the presence of riders, but it also distinguishes riders wearing helmets from those who are not. This dual functionality enhances safety measures on the roads, promoting compliance with helmet regulations. In conjunction with the multiple rider detection system, a specialized deep neural network has been developed for motorcycle rider's helmet detection. This additional layer of security focuses on ensuring that all riders are adhering to safety protocols by wearing helmets. With a more targeted approach, this system significantly improves accuracy in identifying non-compliant riders, thereby reducing the risk of head injuries in potential accidents.

IV. Results & Discussions

In Fig. 1, the x-axis represents the number of training epochs. The y-axis represents the accuracy of the helmet detection model. Accuracy is a measure of how many predictions made by the model are correct compared to the total number of predictions. Each data point on the graph corresponds to the accuracy achieved by the model at a particular epoch during training. These data points are plotted based on the accuracy values calculated at the end of each epoch. In some cases, you might see a trendline or curve that connects the data points. This trendline helps to visualize the model's accuracy if it's increasing, decreasing, or stabilizing over time. Initially, during the early epochs, the model's accuracy may be relatively low as it is still learning from the training data. Remember, the accuracy graph is not just a visual representation; it is a powerful tool that guides you toward building a robust and reliable machine-learning model.

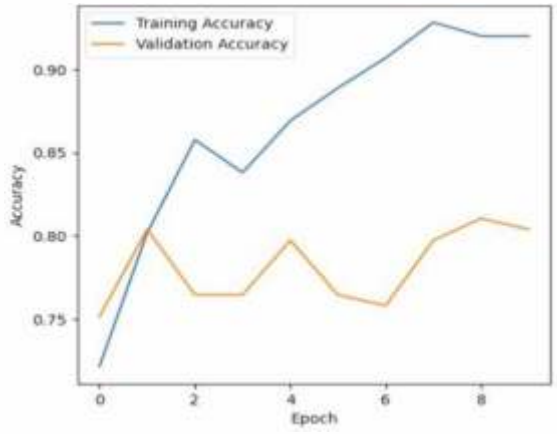


Fig. 1. Accuracy vs Epoch graph for Helmet Detection

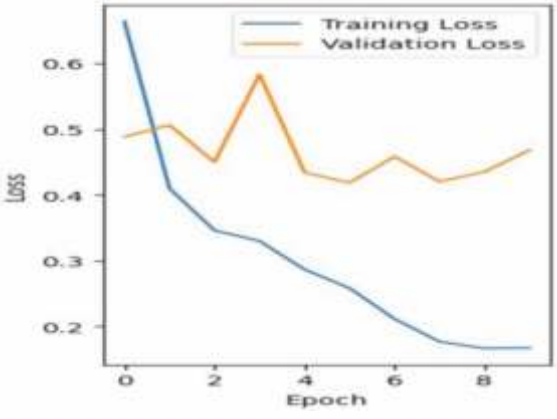


Fig. 2. Loss vs Epoch graph for Helmet Detection

In Fig. 2, The x-axis of the loss vs epoch graph represents the number of training epochs. On the y-axis of the graph, we have the loss incurred by the model during training. Loss is a crucial metric as it quantifies how well the model is performing on the training data. Lower values of loss indicate better performance. By monitoring the loss on both the training and validation sets, we can detect overfitting or underfitting of the model. If the loss continues to decrease on the training set but starts to increase or plateau on the validation set, it may indicate overfitting. Overfitting occurs when the model memorizes the training data too well, leading to poor generalization of new data. By analyzing the trends in loss over epochs, we can optimize the model's performance and ensure that it generalizes well to unseen data.

Predicting "With Helmet" for Fig. 3 suggests that the system analyzing the image believes the person riding the motorcycle is wearing a helmet. The confidence score of 0.9683 indicates the level of certainty associated with this prediction, with higher scores indicating higher confidence.

Fig. 3. Prediction "With Helmet"

Fig. 4. Prediction "Without Helmet"

The prediction in Fig. 4 indicates that a person is without a helmet, and the model has very low confidence in this prediction, with a confidence score of 0.0049. It's important to note that the model's confidence level is quite low, so there might be uncertainty in the prediction. This could be due to various factors such as image quality, angle, lighting conditions, or the presence of objects that may resemble a helmet.

V. Conclusion

In conclusion, the innovative approach outlined in this study represents a significant stride toward enhancing road safety for motorcycle riders. By leveraging cutting-edge technologies and a lightweight CNN, we can identify helmetless motorcyclists with precision, paving the way for effective enforcement of safety regulations. As we continue to refine and expand upon this framework, the vision of a safer road environment for all riders draws closer. Let us harness the power of technology to prioritize safety and well-being on our roads. Remember, safety on the road begins with each individual's commitment to responsible riding practices. Let's stay vigilant, wear our helmets, and strive towards creating a secure environment for all road users. Together, we can make a difference in shaping a safer future for motorcyclists everywhere.

References

[1] W. Rattapoom, B. Nannaphat, T. Vasan, T. Chainarong, and P. Pattanawadee, 'Machine vision techniques for motorcycle safety helmet detection,' in Proceedings of International Conference on Image and Vision Computing, pp. 35–40, 2013.

[2] J. Chiverton, 'Helmet presence classification with motorcycle detection and tracking,' IET Intelligent Transport Systems (ITS), vol. 6, no. 3, pp. 259–269, 2012.

[3] J. Li, H. Liu, T. Wang, M. Jiang, S. Wang, K. Li, and X. Zhao, 'Safety helmet wearing detection based on image processing and maca hine learning' In Proceedings of IEEE International Conference on Advanced Computational Intelligence (ICACI), pp. 201-205, 2017.

[4] R. Silva, K. Aires, T. Santos, K. Abdala, R. Veras, and A. Soares, 'Automatic detection of motorcyclists without a helmet,' in Proceedings of Latin American Computing Conference (CLEI), pp. 1–7, 2013.

[5] R. V. Silva, T. Aires, and V. Rodrigo, 'Helmet detection on motorcyclists using image descriptors and classifiers,' in Proceedings of Graphics, Patterns, and Images (SIBGRAPI), pp. 141–148, 2014.

[6] Alex Krizhevsky, I. Sutskever, and G. E. Hinton, 'Imagenet classification with deep convolutional neural networks,' in Advances in Neural Information Processing Systems, vol. 25(2), DOI: 10.1145/3065386, 2012.

[7] C. Vishnu, D. Singh, C. K. Mohan, and S. Babu, 'Detection of motorcyclists without a helmet in videos using convolutional neural network' In Proceedings of IEEE International Joint Conference on Neural Networks (IJCNN), pp. 3036-3041, 2017.

[8] J. Mistry, K. A. Misraa, M. Agarwal, A. Vyas, V. M. Chudasama, and K. P. Upla, 'An automatic detection of helmeted and non-helmeted motorcyclist with license plate extraction using convolutional neural network' In Proceedings of IEEE International Conference on Image Processing Theory, Tools and Applications (IPTA), pp. 1-6, 2017.

Aaleesa Pattnaik, Tanisha Satapathy, Anushka Maji, Himanshu Sekhar Behera, Sankalp Anand
Dept. of EE

Satyendra Nath Bose

Born on January 1, 1894, in Calcutta, India, Satyendra Nath Bose was a major physicist whose work influenced the field of quantum mechanics. Bose is best known for his collaboration with Albert Einstein, which led to the creation of Bose-Einstein statistics, a major development in theoretical physics. Bose completed his education at the University of Calcutta, receiving his bachelor's degree in 1913 and his master's degree in 1915. In 1924, Bose submitted a paper to the Philosophical Journal discussing the behavior of photons, or light. In this work, he introduced the method known today as Bose statistics, which describes the distribution of different particles that do not obey the Pauli separation principle, such as photons and helium-4 atoms. Einstein recognized the importance of Bose's work and, after creating the Bose-Einstein condensate, extended it to predict the new existence of matter. When a group of bosons are in the same quantum state, this happens at a certain temperature, leading to a special quantum effect. The experimental demonstration of the Bose-Einstein condensate in 1995 confirmed Bose's theoretical contributions and heralded a new era in physics problems. Bose's achievements were surpassed by his work in quantum statistics. He wrote many important books and worked for the spread of science in India. He was also a Jay Fellow of the Indian National Academy of Sciences and received many awards for his contributions to physics, including the Padma Shri Award in 1954. His legacy continues to inspire generations of physicists and scientists around the world, highlighting the importance of collaboration in advancing scientific knowledge. Satyendra Nath Bose died on 4 February 1974, but his influence on the field

of physics continues to endure. Through his pioneering work in quantum statistics and his dedication to scientific advancement, Bose has established himself as one of the most important figures in the history of physics, highlighting the contributions of Indian scientists to the world scientific community.

(Source: en.wikipedia.org)

Abhishikta Sahoo
Dept. of EE

Modeling of Internet of Things (IoT) & Architecting Services for Realizing Smart Cities

The Internet of Things is a conglomeration of sophisticated Information and Communication Technologies (ICTs) that enables the seamless integration of massive digital devices across sensors, actuators, and computers over the Internet. Such technologies hold promises to augment infrastructural and resources of smart cities towards better management by harnessing IoT services with big data and machine learning techniques. The rapid rate of urbanization has put city resources and services under tremendous pressure and IoT, with its wide variety of ICT technologies can address them, specifically for critical services including mobility, health care, energy, and civil infrastructure. In such a milieu, IoT services can provide sustainable solutions by gainfully coalescing broad ICT solutions. But for any service-based system, providing long-term sustainability is a major challenge and for IoT-based smart city services it is an even bigger challenge. There are two key factors that impact the sustainability of any service-based system, namely unreliable services and quality of service issues.

The prime motivation of this research work is to ensure the sustainability of IoT-based services for smart cities by focusing on the a fare mentioned said key factors. To provide reliable IoT services, modeling and assessing the reliability of IoT services in a system is of utmost importance. Hence, this thesis presents a reliability model for IoT that specifically emphasizes service-oriented aspects. Keeping this in mind, this research presents a Centralized Heterogeneous IoT Service System (CHISS) model and a generalized methodology to evaluate the service reliability of the CHISS system. The assessment of the proposed model was carried out by means of two case studies namely intelligent fire alarm system and smart health care system.

However, the quality of IoT service depends on many factors such as communication technologies, computing paradigms, and the underlying mechanism to enable cross-domain IoT services. Although cloud computing owing to its huge computing and storage facilities presents a promising solution, it is unable to provide services in real-time, particularly for delay-sensitive applications such as healthcare. Hence, Fog computing has been used in this research to mitigate the same, particularly in cross-domain platforms. However, Fog computing due to its limited resource capabilities cannot sustain the burden of a humongous amount of data generated at the edge by IoT devices and this burden will be doubled in terms of processing requirements in a cross-domain set-up. Hence, smart management and innovative solutions are needed at Fog to mitigate the same.

This thesis presents a smart context-sharing approach among independent vertical applications by enacting context-sharing among Fog nodes to address the delay requirements of cross-domain applications. To this end, this thesis also presents a detailed network model and presents required algorithms for context sharing and delay-tolerant load balancing. Further, this thesis presents a Smart Multi-Channel Queuing (SMCQ) model by considering the virtualization of fog nodes to further minimize service delay for cross-domain IoT services. Here, a distributed service management algorithm has been presented that serves the service requests at every fog node by either sharing contexts among context requests within a fog node, by bringing in unavailable contexts from other fog nodes, or by migrating service requests to remote fog nodes with available contexts in a deadline-aware fashion. These algorithms are simulated in a cloud simulator to test the efficacy of the proposed model.

Dr. Ranjit Kumar Behera
Dept. of CSE

Methods of Waste Disposal

Garbage accumulation has never been much of a concern in the past. Open dumping is a prevalent method of waste disposal but it can result in numerous health and environmental issues. Due to globalization and industrialization, there is a need for a more efficient waste disposal method. Some of the methods used today are -

1. Landfill: In this process, the waste that cannot be reused or recycled is separated out and spread as a thin layer in low-lying areas across a city. A layer of soil is added after each layer of garbage. However, once this process is complete, the area is declared unfit for construction of buildings for the next 20 years. Instead, it can only be used as a playground or a park.

2. Incineration: It is the process of controlled combustion of garbage to reduce it to incombustible matter such as ash and waste gas. The exhaust gases from this process may be toxic, hence it is treated before being released into the environment. This process reduces the volume of waste by 90% and is considered one of the most hygienic methods of waste disposal. In some cases, the heat generated is used to produce electricity. However, some consider this process, not quite environmentally friendly due to the generation of greenhouse gases such as carbon dioxide and carbon monoxide.

3. Waste Compaction: The waste materials such as cans and plastic bottles are compacted into blocks and sent for recycling. This process prevents the oxidation of metals and reduces airspace needs, thus making transportation and positioning easy.

4. Biogas Generation: Biodegradable waste, such as food items, animal waste, or organic industrial waste from food packaging industries is sent to bio-degradation plants. In bio-degradation plants, they are converted to biogas by degradation with the help of bacteria, fungi, or other microbes. Here, the organic matter serves as food for the micro-organisms. The degradation can happen aerobically (without oxygen). Biogas is generated as a result of this process, which is used as fuel, and the residue is used as manure.

5. Composting: All organic materials decompose with time. Food scraps, yard waste, etc., make up one of the major organic wastes which are thrown away every day. The process of composting starts with these organic wastes being buried under layers of soil and then, are left to decay under the action of microorganisms such as bacteria and fungi. This results in the formation of nutrient-rich manure. Also, this process ensures that the nutrients are replenished in the soil. Besides enriching the soil, composting also increases the water retention capacity. In agriculture, it is the best alternative to chemical fertilizers.

6. Vermicomposting: Vermicomposting is the process of using worms for the degradation of organic matter into nutrient-rich manure. Worms consume and digest the organic matter. The by-products of digestion which are excreted out by the worms make the soil nutrient-rich, thus enhancing the growth of bacteria and fungi. It is also far more effective than traditional composting.

(Source: https://byjus.com/biology/waste-disposal)

The Role of Dark Matter in Stabilizing Disc Galaxies

Introduction

Gravitational instabilities are fundamental processes that drive the evolution of galaxies. They provide essential insights into how gas in galaxies is converted into stars and how non-equilibrium dynamics contribute to galaxy formation and evolution. In this article, we explore the influence of dark matter on the stability of galactic discs, particularly focusing on a two-component system consisting of stars and gas in equilibrium with an external dark matter halo.

Theoretical Framework

To understand the role of dark matter [1] in stabilizing disc galaxies, we model the galaxy as a two-component system of stars and gas. The differential equations governing the growth rate of perturbations are derived by considering the equilibrium state of the system with the external force field of the dark matter halo. These equations resemble a wave equation with additional terms that account for the influence of the dark matter halo.

The key parameters in our model include the surface density of the disc, the velocity dispersion of stars and gas, and the rotation curve of the galaxy. The dark matter halo is characterized by its density profile, which is typically assumed to follow a Navarro-Frenk-White (NFW) profile. This profile describes the distribution of dark matter in a spherical halo and is parameterized by a scale radius and a characteristic density.

Key Findings

Susceptibility to Gravitational Instabilities

The two-component disc is more susceptible to the growth of gravitational instabilities than individual components. Increasing the gas fraction at a fixed value of external potential lowers the stability of the two-component disc, emphasizing the destabilizing role of cold gas. This increased susceptibility can lead to the formation of spiral arms, bars, and other non-axisymmetric structures in the disc.

Stabilizing Role of Dark Matter

The external field due to the dark matter halo acts as a stabilizing agent. In dark matter-dominated systems [2], the gravitational force exerted by the dark matter halo stabilizes the two-component system, even when the system is locally unstable. This stabilization occurs because the dark matter halo deepens the gravitational potential well, thereby increasing the overall binding energy of the system and suppressing the growth of perturbations.

Application to Milky Way and Low Surface Brightness Galaxies

The stability criterion was applied to models of the Milky Way and low surface brightness galaxies. It was found that these galaxies are locally unstable without the contribution of dark matter. However, the addition of dark matter significantly increases their net stability levels. In the case of the Milky Way, the dark matter halo plays a crucial role in maintaining the stability of the disc, particularly in the outer regions where the stellar density is low.

Baryon-Dominated Galaxies in the Early Universe

In rare cases, the two-component system can still be susceptible to gravitational instabilities despite the presence of a stabilizing dark matter halo. This is observed in baryon-dominated cold rotating disc galaxies in the early universe, where the influence of dark matter is insufficient to stabilize the system. These galaxies are characterized by high gas fractions and low dark matter densities, making them prone to instabilities that can drive rapid star formation and morphological transformations.

Implications for Galaxy Formation and Evolution

The results of this study have significant implications for our understanding of galaxy formation and evolution. The stabilizing effect of dark matter halos suggests that dark matter plays a crucial role in

regulating the dynamics of galactic discs and preventing the catastrophic collapse of gas into stars. This regulation is essential for the formation of stable, long-lived disc galaxies like the Milky Way.

The susceptibility of baryon-dominated galaxies in the early universe to gravitational instabilities provides a potential explanation for the high rates of star formation and the prevalence of irregular and clumpy morphologies observed in these systems. As these galaxies evolve and accumulate more dark matter, their stability increases, leading to the emergence of more regular and stable disc structures.

Future Directions

Further research is needed to explore the detailed interplay between dark matter and baryonic matter in different types of galaxies. High-resolution simulations that incorporate realistic models of star formation, feedback, and gas dynamics are essential for understanding the complex processes that drive the evolution of galaxies. Observational studies that probe the dark matter distribution and the stability of galactic discs across cosmic time will provide valuable constraints on theoretical models and help refine our understanding of the role of dark matter in galaxy formation.

Conclusion

The study highlights the critical role of dark matter in stabilizing disc galaxies. The potential due to the dark matter halo significantly contributes to the overall stability of nearby galaxies such as the Milky Way and low surface brightness galaxies. However, the effectiveness of dark matter in stabilizing galaxies diminishes in the early universe where baryon-dominated conditions prevail. Understanding the interplay between dark matter and baryonic matter is essential for a comprehensive picture of galaxy formation and evolution.

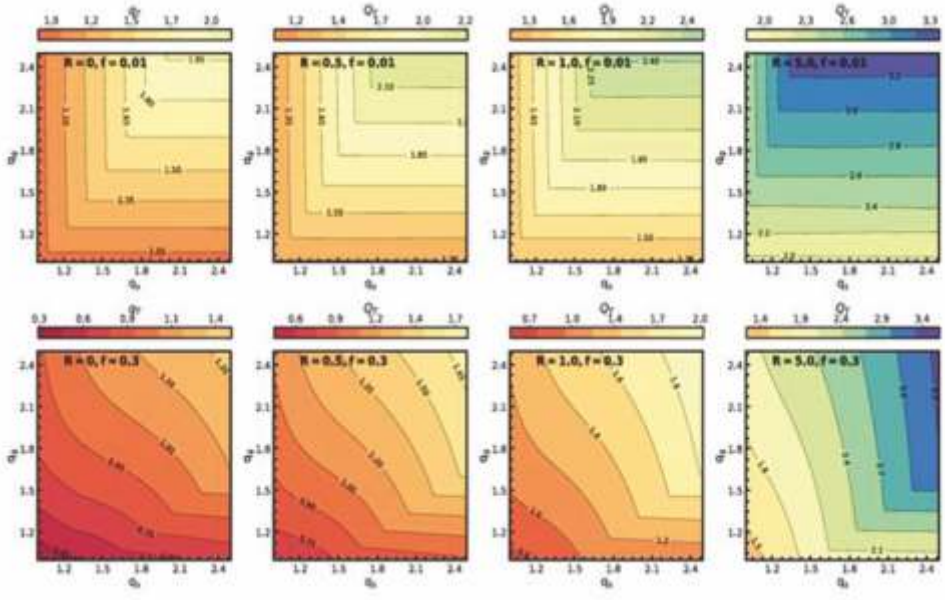
References

[1] K Aditya, How does dark matter stabilize disc galaxies?, Monthly Notices of the Royal Astronomical Society, Volume 532, Issue 4, August 2024, Pages 3839–3846, https://doi.org/10.1093/mnras/stae1737.

[2] Famaey, B., McGaugh, S.S. Modified Newtonian Dynamics (MOND): Observational Phenomenology and Relativistic Extensions. Living Rev. Relativ. 15, 10 (2012). https://doi.org/10.12942/lrr-2012-10.

Source: science.nasa.gov, academic.oup.com

Adarsh Amrit
Dept. of EE



The effect of varying the external force of dark matter halo on the stability of the two-component disc. In the top panel, the gas fraction is fixed at $f = 0.01$, and in the bottom panel, the gas fraction is fixed at $f = 0.3$. The colour bar indicates net stability levels given by Qr.

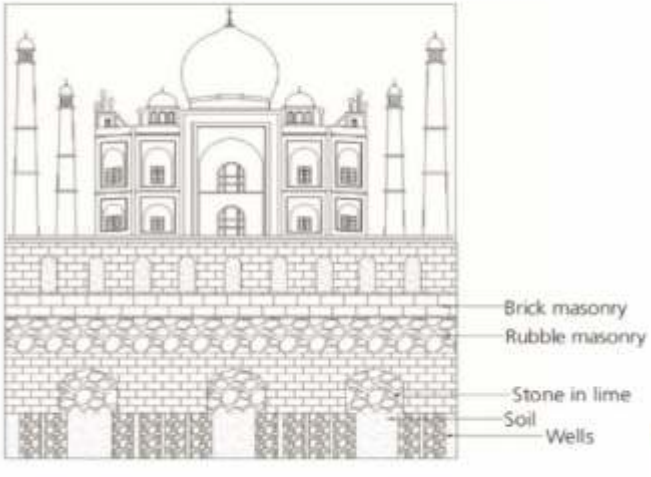
Historical Tidbits: The Foundation of the Taj Mahal

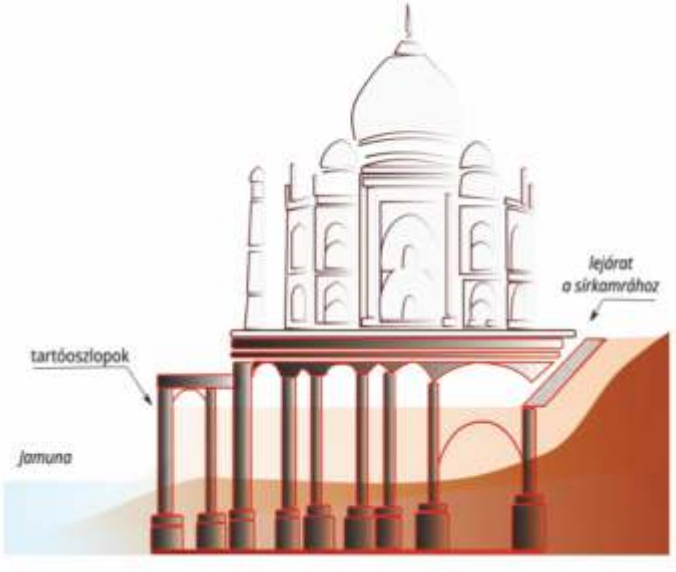
The moment one thinks of grandiose architecture, the Taj Mahal inevitably comes to mind. This white marble mausoleum built by the Mughal Emperor Shah Jahan in memory of his wife Mumtaz Mahal, is breathtakingly beautiful. The perfect symmetry in its construction epitomizes the skill and craftsmanship of the 20,000 workers who worked for over 20 years to erect this incredible edifice.

However, almost always overlooked but equally fascinating is the foundation of the Taj Mahal. Hidden from public view, the foundation is a masterclass by itself and a testament to the ingenuity of the architects and builders of the era. It is estimated that the building weighs 80,000 tons, with the dome alone tipping the scales at a staggering 12,000 tons. To stabilize this massive weight of the superstructure, an ingenious well foundation was constructed. Deep wells were dug, cased in wood, and filled with rubble and stone, to essentially make augered piles. On top of these wells brick and masonry work were set, which evenly distributed the weight of the building.

The Jamuna River, upon whose bank the Taj Mahal is built plays an important role in the structural integrity of the foundation. The groundwater infiltration from the river to the soil keeps the ebony wood in the casing of the wells wet, minimizing weathering and deterioration. The images below, taken from constructor.org and Wikipedia, depict pictorially the foundation of the Taj Mahal.

Dr. Jaideep Talukdar
Dept. of BSH





Solar MPPT Inverter with Dual Axis Tracker

Abstract *– The goal of this project was to develop a laboratory prototype of a solar tracking system with an Maximum Power Point Tracking (MPPT) charge controller and inverter which is able to enhance the performance of the photovoltaic modules in a solar energy system. The operating principle of the device is to keep the photovoltaic modules constantly aligned with the sunbeams, which maximizes the exposure of the solar panel to the Sun's radiation. As a result, more output power can be produced by the solar panel. The solar energy is converted to electrical energy by photo-voltaic cells. This energy is stored in batteries during the daytime for utilizing the same during nighttime. Our aim is to obtain maximum power on the load side from the solar panel. So a basic network theorem is applied called the maximum power point theorem. Solar energy obtained is in DC form and DC to DC converters are used to use the output of the solar voltage to load, it can be either stepped up or stepped down according to requirement. We have used an Arduino control board for the duty cycle control of the converter so that the required load voltage can be obtained. For this signal from the load side is given to the Arduino and the Maximum Power Point is obtained using the Perturb & Observe (P&O) technique.*

Keywords *– Solar Energy Harvesting, DC-DC Converters, Maximum Power Point Tracking (MPPT), Battery Charging, Wireless Sensor Nodes.*

I. Introduction

A developing country requires substantial energy. Nowadays, most of the energy supplied by fossil fuels such as diesel, coal, petrol, and gas is 80% of our current energy. On top of this energy demand is expected to grow by almost half over the next two decades. One third of the world green house gas emission come form the sources of power generation, coal, oil and natural gas. Providing cleaner and more constant electricity helps to increase quality of living. The economic development strategies those are currently being implemented in India resulting in an increasing demand for energy. Increasing demand for energy results in two main problems: climate change and energy crisis. As the global energy demand increases, energy related greenhouse gas production increases. It is a global challenge to reduce the CO_2 emissions and offer clean, sustainable and affordable energy [1].

The worldwide increasing energy demand Energy saving is one cost-effective solution, but does not tackle. Renewable energy is a good option because it gives a clean and green energy, with no CO_2 emission. Renewable energy is defined as energy that comes from resources which are naturally refilled on a human timescale such as sunlight, wind, rain, tides, waves and geothermal heat. The harvester system extracts the solar energy into the electrical form by using the Photovoltaic (PV) cells. Then, this electrical energy is used to charge the wireless sensor node battery. It reduces the human efforts to replace the battery of hundreds or thousands of sensor nodes by going out in remote areas. Therefore, the design problem of limited energy availability of wireless sensor nodes is resolved and the human efforts to replace the battery periodically have been reduced. In this paper, the simulation results show that by using efficient solar energy harvester circuits the sensor network lifetime can be increased from a few days to 20-30 years and higher.

II. Operation of an MPPT

The operation of an MPPT is explained as follows: The solar energy-harvesting system provides a DC power supply (3.6 volts) to the MPPT. This voltage is harvested from the ambient sunlight by using solar panels. The solar panel converts light energy directly

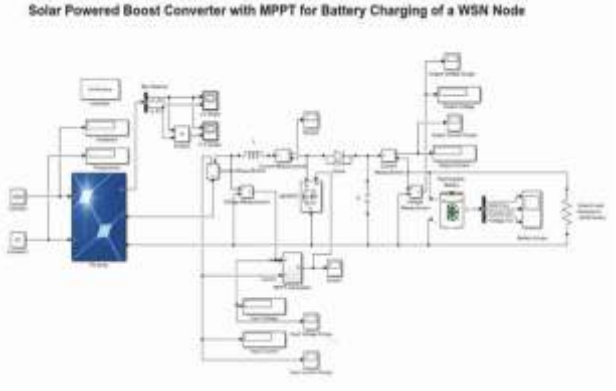


Fig - 1 Block Diagram of MPPT

into the electrical energy. The DC-DC converter regulates this DC voltage to charge the battery. The rechargeable battery powers the Wireless Sensor Node (WSN). The WSN measures the desired physical quantity (e.g. temp., light, humidity, and pressure) by using the sensor measurement unit. A microcontroller in the computation unit processes this sensed data. The measured or sensed data is sent to the nearby network node wirelessly, in the form of data packets using a transmitter unit. The information is sent to the USB gateway node via cluster head nodes [2]. Finally, the user can remotely monitor & control the application process e.g. temperature monitoring & control of an industrial boiler plant, Air conditioner cooling system control, and Traffic light management in a smart city. In this paper, we will focus on the modeling and optimization of solar energy harvesting systems.

III. Solar Energy System

Fig. 1 shows a block diagram of a maximum power point tracking (MPPT) controlled solar energy harvester (SEH) system. The SEH system consists of a solar panel, a DC-DC buck converter, a rechargeable battery, a Maximum Power Point Tracking controller, and a wireless sensor node connected as a DC load. The ambient solar light energy is harvested using the solar panel and converted into electrical energy. The DC-DC Buck converter steps down and regulates the magnitude of this harvested voltage, and is supplied to the rechargeable battery. The MPPT controller tracks the voltage and current from the solar panel and adjusts the duty cycle accordingly for the MOSFET of the DC-DC Buck converter. Finally, the battery voltage is utilized to operate the wireless sensor node [3]. The WSN performs the function of sensing, computation, and communication with other similar characteristics nodes. Thus, autonomous monitoring and control of any physical phenomenon like temperature, humidity, pressure, or acceleration can be achieved using SEH-WSN nodes. In this whole scenario, the efficiency of the solar energy harvester circuit plays a very important role. If the efficiency of the solar energy harvester system is poor, then the battery will not recharge properly and hence the wireless sensor network lifetime will be reduced.

Resistance of Light Dependent Register (LDR) depends on the intensity of the light and it varies according to it. The higher the intensity of light, the lower the LDR resistance, and due to this the output voltage lowers when the light intensity is low, higher will be the LDR resistance, and thus higher output voltage is obtained. A potential divider circuit is used to get the output voltage from the sensors (LDRs). The circuit is shown in Fig 2.

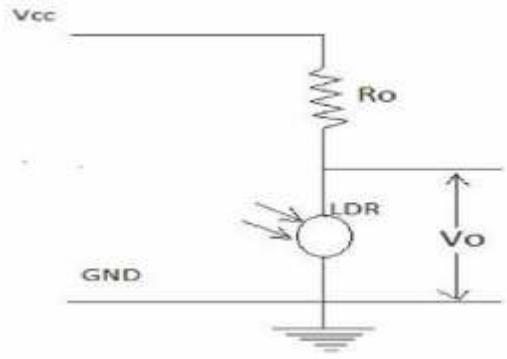


Fig. 2 Potential divider circuit

The LDR senses the analog input in voltages between 0 to 5 volts and provides a digital number at the output which generally ranges from 0 to 1023. Now this will give feedback to the microcontroller using the arduino software(IDE). The servo motor position can be controlled by this mechanism which is discussed later in the hardware model.

IV. Buck Converter Design

There are three basic types of DC-DC converter circuits, termed buck, boost and buck-boost. In all of these circuits, a power device is used as a switch [4]. This device earlier used was a thyristor, which is turned on by a pulse fed at its gate. In all these circuits, the thyristor is connected in series with load to a DC supply, or a positive (forward) voltage is applied between anode and cathode terminals. The thyristor turns off, when the current decreases below the holding current, or a reverse (negative) voltage is applied between the anode and cathode terminals. So, a thyristor is to be force-commutated, for which an additional circuit is to be used, where another thyristor is often used. Later, Gate Turn-Off Thyristor (GTO) came into the market, which can also be turned off by a negative current fed at its gate, unlike thyristors, requiring a proper control circuit. The turn-on and turn-off times of GTOs are lower than those of thyristors. So, the frequency used in GTO-based choppers can be increased, thus reducing the size of filters. Earlier, DC-DC converters were called

'choppers', where thyristors or GTOs were used. It may be noted here that a buck converter (DC-DC) is called a 'step-down chopper', where as a boost converter (DC-DC) is a 'step-up chopper'. In the case of choppers, no buck-boost type was used.

These converters are now being used for applications, one of the most important being Switched Mode Power Supply (SMPS). Similarly, when an application requires high voltage, Insulated Gate Bipolar Transistors (IGBT) are preferred over Bipolar Junction Transistors (BJT), as the turn-on and turn-off times of IGBTs are lower than those of power transistors (BJT), thus the frequency can be increased in the converters using them. So, mostly self-commutated devices of the transistor family as described are increasing.

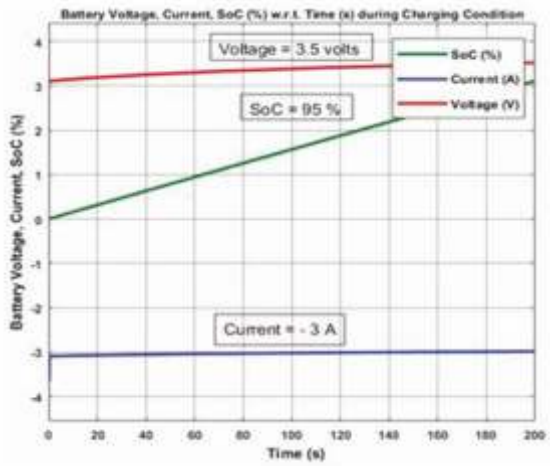


Fig. 3 Battery voltage, current, & SoC during charging

MPPT controlled solar energy harvesting battery charger (i.e. Battery State of Charge (SoC), battery Current and Voltage) are shown for a simulation time of 10 seconds [5]. Here, in Fig. 3 the battery SoC reaches 95 % in just 200 s simulation time. Thus, the battery charging time is dynamically increased by using MPPT-controlled solar energy harvesting systems for WSN nodes. The energy harvester system efficiency is calculated for MPPT control methods by using P&O.

VI. Results

Fig. 4 shows the hardware setup of an efficient solar energy harvesting system tailored for wireless sensor nodes. By leveraging ambient solar radiation, the system offers a sustainable and reliable power source, reducing the dependency on traditional batteries and enabling long-term deployment of sensor networks in remote or challenging environments. Future enhancements may include optimization of the harvesting system for specific environmental conditions, integration of advanced energy storage technologies, and scalability for larger sensor networks. This method presented here controls lead acid battery charging faster and more efficiently. The control algorithm executes the P&O method allows the module to operate at maximum power point according to solar irradiation, and matches load with the source impedance to provide maximum power.

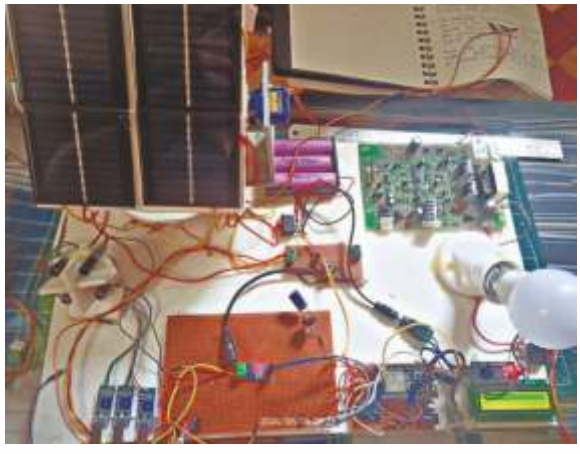


Fig. 4. Hardware setup

This MPPT model is more suitable because of its lower cost, and easier circuit design. And efficiency of the circuit is increased by 20-25% in the case of an MPPT solar charge controller compared to a circuit without MPPT. Also, the solar tracker is used to follow the maximum irradiance or intensity of the sun. And also saved the extra energy required in mechanical tracking. As Arduino-based controlling is used, it maintains a constant 12V at the output terminal i.e. at the battery terminal. Tracker, we've developed a demo model of a solar tracker to track the maximum intensity point of the light source so that the voltage given at that point by the solar panel is maximum. After a lot of trial and error, we've successfully completed our project and we are proud to invest some effort for our society.

References

[1] Himanshu Sharma, Ahteshamul Haque, and Zainul A. Jaffery "Solar energy harvesting wireless sensor network nodes: A survey", Journal of Renewable and Sustainable Energy, American Institute of Physics (AIP), USA, vol.10, no.2, pp 1 33, March 2018.

MPPT for internet of things smart nodes," IEEE Transections on VLSI System, vol. 23(12), pp. 3065–3075, 2015.

[4] S. Sivakumar et al., "An assessment on performance of DC DC converters for renewable energy applications," Renewable Sustainable Energy Reviews, Springer, Elsevier, vol. 58, pp. 1475–1485 , 2016.

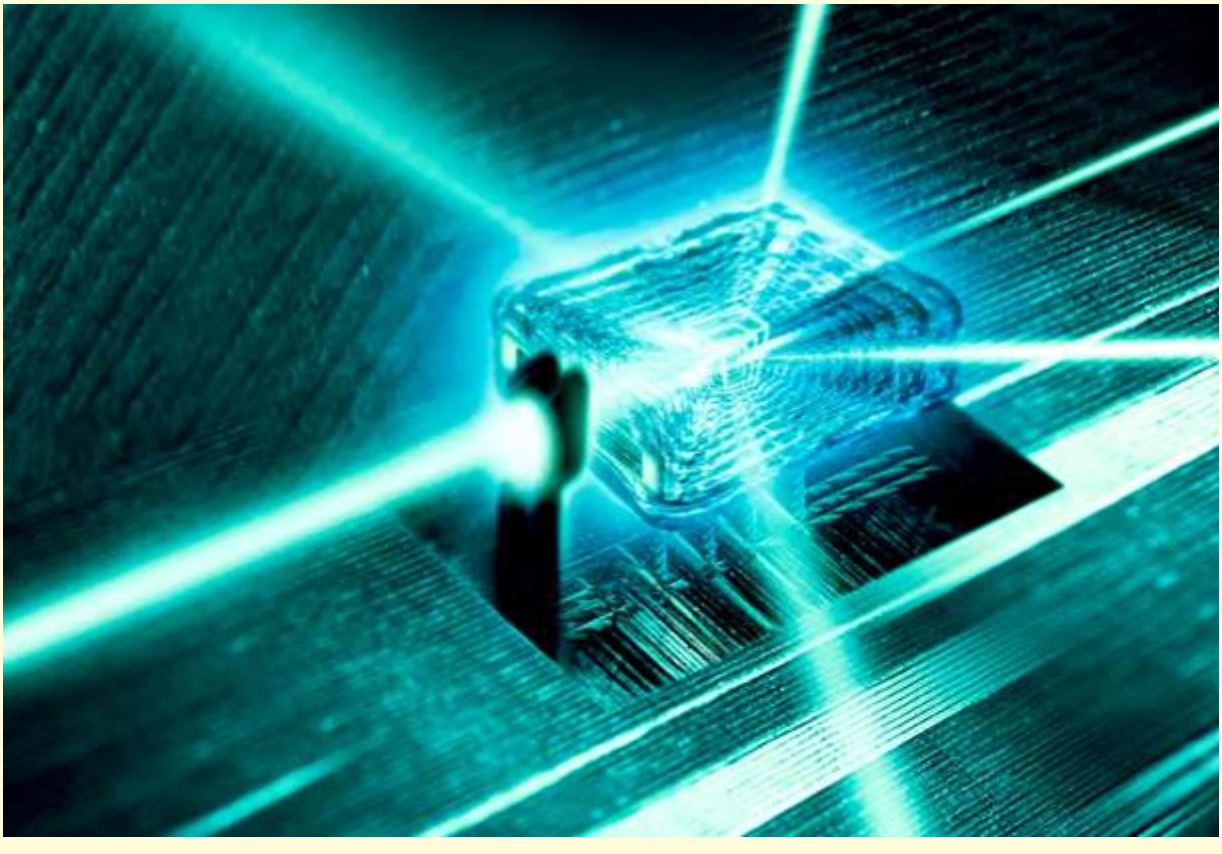
[5] Minchul Shin, Inwhee Joe, "Energy management algorithm for solar-powered energy harvesting wireless sensor node for Internet of Things" , IEEE-IET Communications Journal, , volume: 10, Issue: 12, pp.1508-1521, 2016.

Sanskruti Tanaya, Satya Prakash Pradhan
Dept. of EEE

Diamond could be the Super Semiconductor the Power Grid needs

The concealed semiconductor capabilities of diamonds have the potential to enhance the efficiency of the management of vast quantities of electricity by electric vehicles and power infrastructures. Diamond semiconductors have the potential to significantly enhance the energy efficiency of AI data centers, electric vehicles, and smaller consumer electronics, as the power infrastructure grapples with a historic increase in electricity demand. This is the reason why the many governments are investing a lot in the development of novel power electronics technologies that are based on diamonds.

Source: newscientist.com



Diamond has excellent semiconductor properties

Publication Cell
Tel: 9937289499/8260333609
Email: publication@silicon.ac.in

www.silicon.ac.in

The Science & Technology Magazine

Digital Digest

Silicon University, Odisha

Contents

Make your submissions to:
publication@silicon.ac.in