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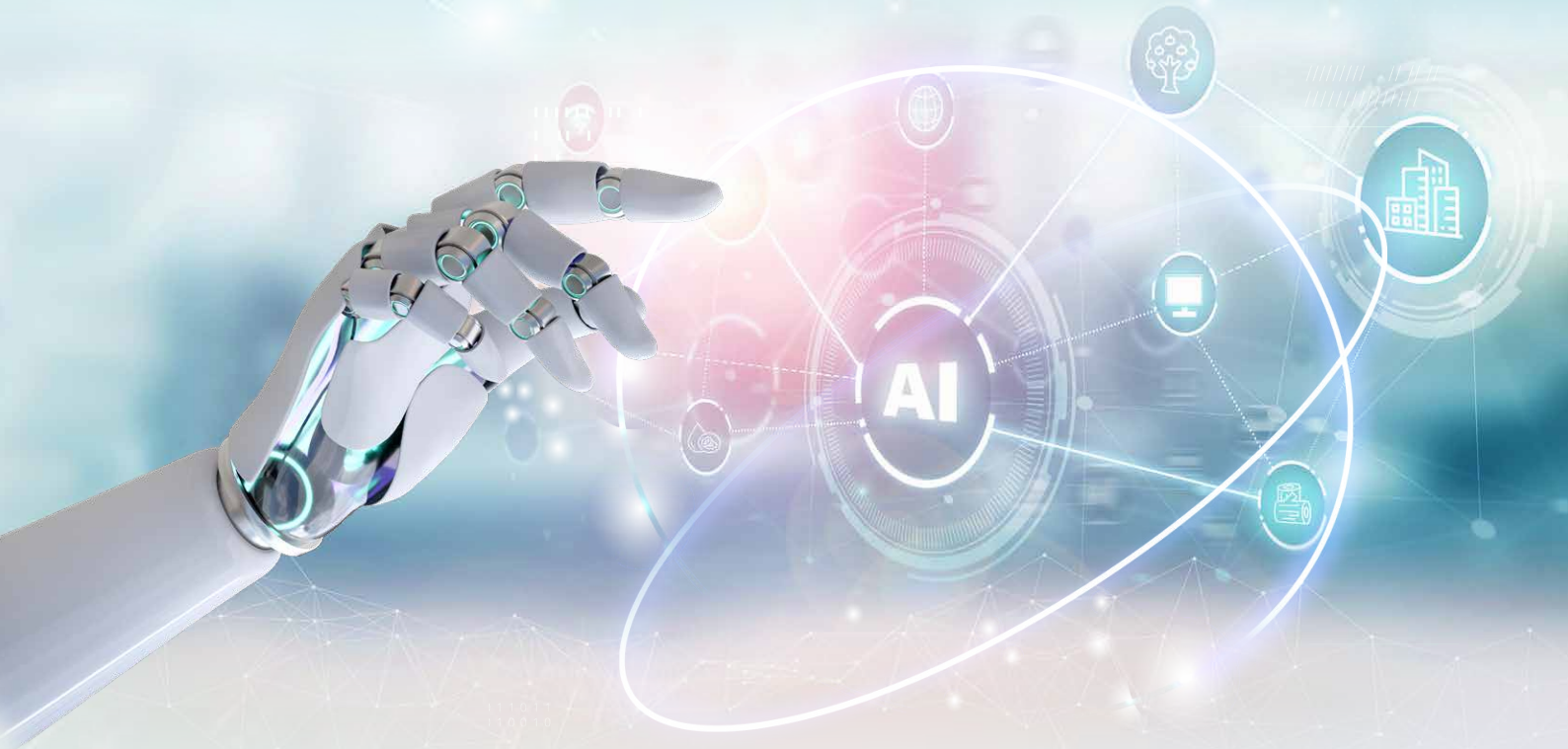
Artificial Intelligence: Promises & Challenges



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Editor's Note

Advanced technologies such as AI are now embedded in various facets of our lives such as; working, learning, communicating, and playing. Daily, whether we are aware of it or not we encounter advanced technologies which may be just scrolling through our social media or reviewing some industrial processes. AI has broad implications on individuals, communities, and industries. The impacts brought by AI need to be understood better, and it is this reason that in the recent years many institutions and stakeholders have come forward to share their interest through research and innovative programs in order to better understand the promises and challenges AI brings to the society.

Keeping this in perspective, we reached out to experts in academia and industry to share their experiences in incorporating AI in research and business processes. As you will read through this issue, you will find researchers who are actively working in applying AI-based systems in agriculture, medical technology, structural engineering, and traceability. Also, you will find perspective on how the full potential of AI can be tapped for businesses. This issue also includes a Q&A section with industry expert, specifically focusing on how AI is impacting their current business, and how they think that AI is going to impact the society, business, industry, and organizations in the coming decade.

I am thankful to all authors for sharing their views, knowledge and experience in development of AI technologies and their applications. I also appreciate the efforts of our editorial team in editing and designing this issue.

This magazine is a knowledge product of AIT Solutions and a professional communication platform for experts and researchers and a window to its readers to the technologies, events, and developments.

We welcome your valuable feedback and opinions.

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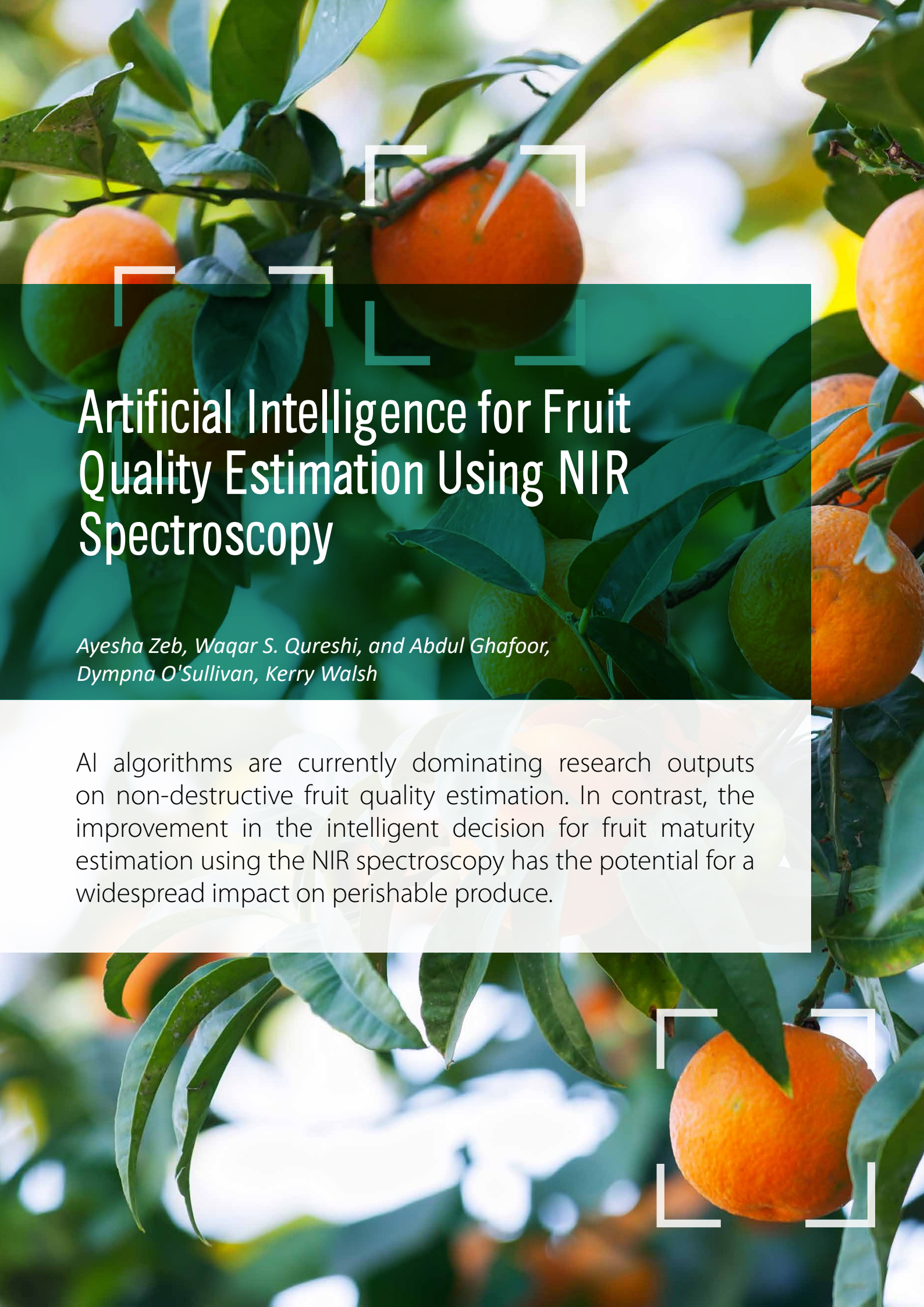

Artificial Intelligence for Fruit Quality Estimation Using NIR Spectroscopy

Ayesha Zeb, Waqar S. Qureshi, and Abdul Ghafoor, Dympna O'Sullivan, Kerry Walsh

AI algorithms are currently dominating research outputs on non-destructive fruit quality estimation. In contrast, the improvement in the intelligent decision for fruit maturity estimation using the NIR spectroscopy has the potential for a widespread impact on perishable produce.

Artificial Intelligence for Fruit Quality Estimation Using NIR Spectroscopy

Artificial Intelligence (AI) in precision agriculture is enabling an agriculture revolution. Automated decision support systems using AI can enable farmers to make smarter decisions that improve production and management. Such decision support systems have been applied in farm planning, crop management, soil and water conservation, pest and disease management, horticulture, and fertilizer management [1]. AI algorithms are currently dominating research outputs on non-destructive fruit quality estimation. In contrast, the improvement in the intelligent decision for fruit maturity estimation using the NIR spectroscopy has the potential for a widespread impact on perishable produce.

Fruit harvest maturity/quality is of great concern for growers and dealers. Early harvest of fruit results in the delivery of poor eating quality fruit to market with consequent loss of purchases, while late harvest of fruit results in the postharvest loss by delivery of overripe fruit to needs. The assessment of harvest time is generally based on time (number of days from flowering) and physical features (size, shape and surface characteristics, firmness, and pulp color). Chemical and biological methods determine quality indices such as solids soluble contents (SSC), dry matter (D.M.), and titratable acidity (T.A.). However, these methods are destructive and time-consuming procedures.

Quality specifications have been set for many fruit commodities relating to SSC of fruit and D.M. of fruit at the harvest stage [2] to meet consumer expectations for export markets. Non-destructive testing using near-infrared spectroscopy (NIRS) has gained much attention for fruit quality estimation in the last few years [3]. Near-infrared spectroscopy uses the near-infrared light region to excite the molecules of fruit samples. As a result, some energy is absorbed, and some get reflected. The reflected energy is then sensed and quantified by a spectrometer. The light absorbance data at particular wavelengths is then analyzed concerning standard destructive testing procedures. The goal of AI here is to develop computer models that exhibit intelligent behaviors and are trained to recognize specific patterns, e.g., prediction of fruit quality indices like SSC and D.M., etc. A model is prepared using training data and an AI algorithm for reasoning over and learning from the data. Once created, these prediction models can be used for fruit quality prediction of samples that the model has not seen before. NIRS has many advantages over traditional methods, i.e., easy handling, no sample preparation needed, fast and environment-friendly way, and easy to operate. The technology (estimating dry matter of samples during harvesting using non-destructive techniques) has been adopted in horticultural in some developed countries like Australia [3].

NIRS instruments were initially laboratory-bound, but portable instrumentation is now available, e.g., SCiO [4]. Some portable devices are designed for use with fruits, such as Sunforest H-100C [5] or Atago Hikari [6]; some are capable of operating outdoors with varying ambient temperature and light levels, e.g., Felix Instrument F-750 fruit quality meter [7].

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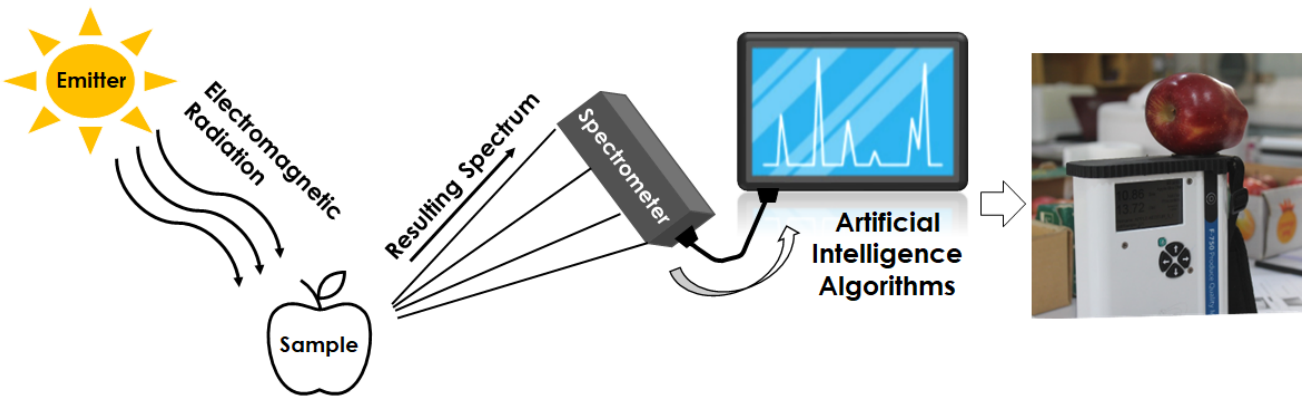

Figure 1: *Fruit quality estimation using artificial intelligence*

We have defined acceptance criteria for melons and oranges based on a direct classification method to predict the sweetness level using NIR spectroscopy.

There are many challenges still associated with the practical adoption of NIRS globally. One challenge is that for each fruit type, a new model is required with training samples of various cultivars, seasons, growing conditions, and temperatures. For example, Red-delicious apples cultivated in the USA have different growing conditions than the ones produced in Pakistan, which in turn may affect the prediction performance of a model developed with red-delicious apples in the USA. Researchers have developed prediction models for many fruits like apple, pear, mango, banana, melon, mandarin, strawberry, apricot, kiwifruit, persimmon, grape, loquat, and pineapple [3]. However, most of the models are developed for a single cultivar for a single season. They are not usually tested on independent test data having samples of different cultivars and growing conditions. We investigated the 'starter' models of apple, mango, and mandarin of the F-750 fruit quality meter with independent test data (local Pakistani cultivars of apple, mango, and mandarin). We observe that the models developed with a broad set of samples of various plant varieties having a wide maturity range at multiple temperatures appear to be robust in the prediction of representatives from different growing locations and conditions, and the lack of robustness to such factors of a model is based on a narrow set of samples.

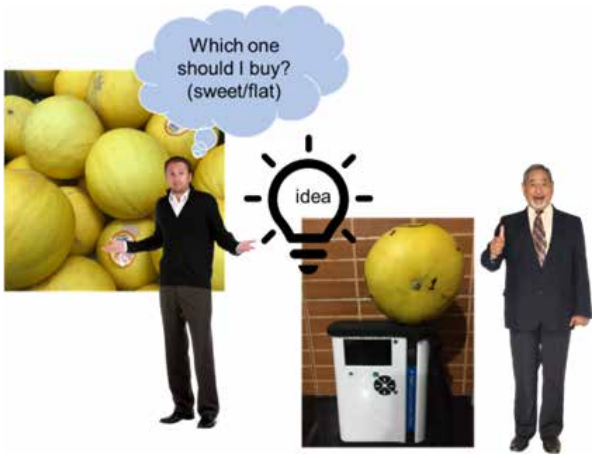

Figure 2: *Qualitative analysis using Artificial Intelligence*

We also observed that most non-destructive fruit quality estimation systems use an indirect approach to classify fruit samples, i.e., predict the quality index value using some machine learning regression algorithm based on the expected value and judge the sample quality (which requires prior knowledge about standards). For instance, the model will predict the sample's SSC value for melon acceptance criteria in the existing approach. Suppose the model's expected value of SSC is above a certain threshold (typical values of SSC that represent sweet samples, e.g., for the Australian market SSC threshold of a minimum acceptable quality standard is 10o Brix). In that case, the sample is considered to be of acceptable sweetness. Hence, the device's person needs to know these threshold values for the investigated cultivar. As opposed to this approach, we have developed a direct sweetness classification model for fruit sweetness classification. We have defined acceptance criteria for melons and oranges based on a direct classification method to predict the sweetness level using NIR spectroscopy. The proposed classifier has been tested for the sweetness classification of Pakistani melon ('honey melons') and orange ('Blood red,' 'Mosambi,' and 'Succari') fruits. Extensive evaluation validates our argument that modeling a direct sweetness classifier is better than estimating quality indices for sweetness classification using NIR spectroscopy [8][9].

Furthermore, knowledge in the domain of computer vision has been widely used to solve the fruit classification problem using many sensors, from black and white cameras to non-visual sensors like acoustic and tactile sensors. For non-destructive classification, the auditory and tactile sensors have limitations such as physical contact or fruit excitation requirements. Vision-based sensors also have limitations like high sensitivity to light conditions and the background environment, which introduce problems like reflection, refraction, translation, rotation, and scale dependence. Therefore, we have presented NIR spectral data-based classifier for fruit classification problems[10]. The research focuses on fruit's O-H and C-H overtone features and their correlation with short wave NIRS (725-975nm). It, therefore, opens a new dimension of fruit classification problems using short wave NIRS. Eleven fruits, which include apple, cherry, Hass, kiwi, grapes, mango, melon, orange, loquat, plum, and apricot, were used in this study to cover physical characteristics such as peel thinness, pulp, seed thickness, and size. Different shallow machine learning architectures were trained to classify fruits using spectral feature vectors. The QDA classifier achieved a cross-validation accuracy of 97.1% and test data accuracy of 90.38%. The results demonstrate that fruit classification is mainly a function of absorptivity of short wave NIR radiation primarily concerning O-H and C-H overtones features. An LED-based device with 770nm, 840nm, 910nm, and 960nm range LEDs can be used in applications where automation in fruit classification is required.

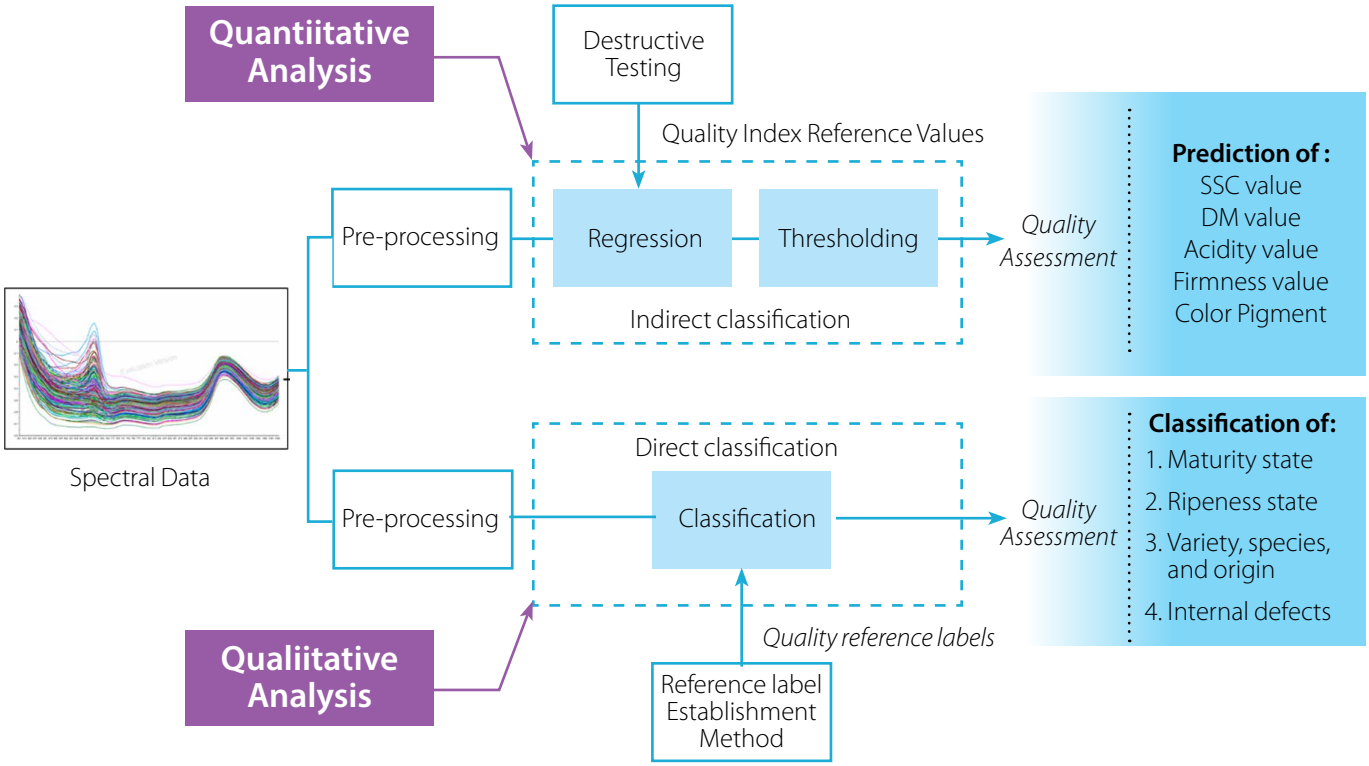

Figure 3: *Block diagram representing two different definitions of establishing quality standards for fruits*

AI-based systems challenge our traditional approach in the agricultural sector and are the key to a sustainable future. It is the need of the hour to shift to such automated decision support systems to manage food quality and quantity issues. Our research is only focused on fruit maturity/quality estimation; however, the presented system also has the scope to determine the quality of vegetables and crops (like sugar cane) by training the AI model with the relevant data. Moreover, most of the AI models are based on shallow machine learning algorithms with datasets having a limited number of samples. Deep learning via artificial neural networks and convolutional neural networks are the future in this area where extensive datasets may be available and comparative studies need to be done. It is to be noted here that in horticultural applications, collecting such a comprehensive dataset requires years of effort, time, and a huge amount of financial resources, as well as the loss of many fruits.

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Self-monitoring of Blood Glucose (SMBG)


Chaklam Silpasuwanchai and Akraradet Sinsamersuk

Self-monitoring of blood glucose (SMBG) is essential for diabetics. Knowing a person's blood glucose level can assist them in determining a suitable treatment (diet, exercise, and insulin) for oneself. Continuous self-monitoring will provide a better and more accurate assessment of the patient's status, as the glucose level in the blood fluctuates throughout the day. However, SMBG can only be performed by drawing blood from the patient, an intrusive procedure. In reality, continuous SMBG is deemed impracticable for this reason.

Researchers have fortunately been investigating the viability of utilizing Raman Spectroscopy to assess blood glucose levels. In conclusion, the Raman approach for SMBG is a non-invasive technique, allowing for continuous self-monitoring. This article will explain what Raman is and how it operates within the context of SMBG.

What exactly is Raman Spectroscopy?

Raman Spectroscopy is a technique for observing the scattering of a molecule following the application of energy. The electron in the molecule will absorb the energy, become excited, leap to a new energy level, recognize it is no longer stable, release the energy, and return to its original state. This occurrence is referred to as excitation and de-excitation. This energy is in the form of an electromagnetic wave indicated by the equation below.

Energy (E) = Planck's constant (h) x wave frequency (v)

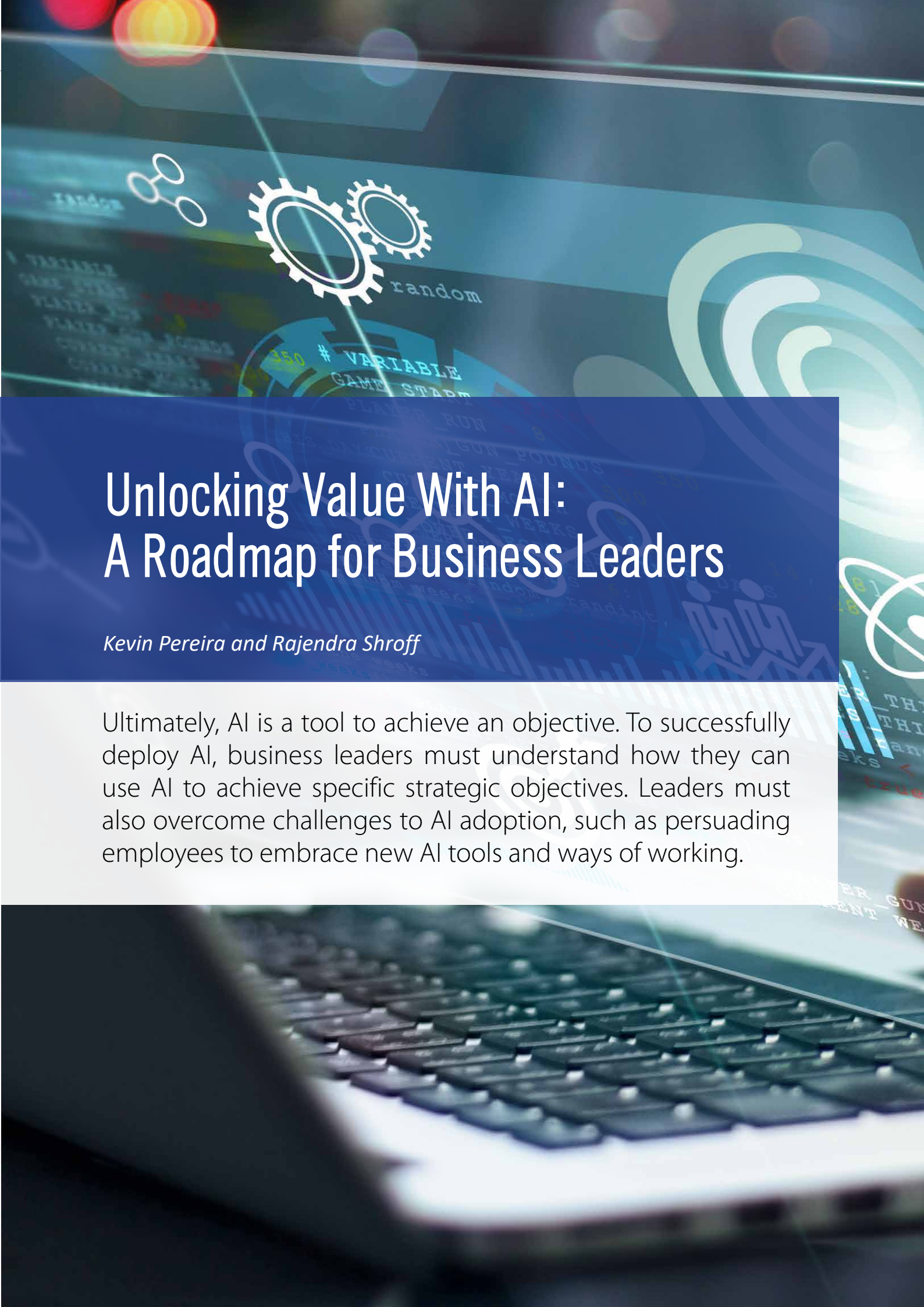
Since Plank's constant (h) is a constant, the amount of energy (E) varies as a result of the wave frequency (v). This is significant because, given an input energy E i, the output energy E o is not always equal to E i (Inelastic scattering). This indicates that the input and output frequencies diverge (Stoke and anti-stoke). This property is known as Raman scattering.

Raman scattering varies from molecule to molecule. Scattering is caused by excitation and de-excitation, but each chemical bond emits a unique scattering pattern. Due to the fact that each molecule has a distinct link and shape, its dispersion pattern is also distinct. Consequently, Raman Spectroscopy can be utilized to investigate the drug or substance mixture. Sometimes, we refer to Raman Scattering as the molecule's fingerprint. In conclusion, we shed light on the topic and measure its dispersal. The measurement allows us to determine the subject's composition.

In the context of Blood Glucose Self-Monitoring (SMBG)

The success of the Pulse Oximeter exemplifies our aim for non-invasive SMBG. The patient constantly wears a tiny device that monitors their condition in real-time. Pulse Oximeter employs the fundamental principle of utilizing known energy (laser) as input and measuring the output energy, but the measurement may vary since Oxygen Saturation does not utilize Raman Scattering. The difficulty lies in reducing the size of Raman equipment so that it may be worn on a regular basis. Multiple parameters must be identified and determined. Nonetheless, we are quite enthusiastic about what awaits us on this journey and how it will impact the well-being of humanity.

This research is a part of the bigger well-being project funded 14 million baht by NBTC. This project is collaborated by experts from AIT WellTech Center and Mahidol University. This 3-year collaboration started on June, 2 2022. This non-invasive SMBG is led by Mr. Akraradet Sinsamersuk, a doctoral student in the DSAI program, together with his advisor, Dr. Chaklam Silpasuwanchai.



Unlocking Value With AI: A Roadmap for Business Leaders

Kevin Pereira and Rajendra Shroff

Ultimately, AI is a tool to achieve an objective. To successfully deploy AI, business leaders must understand how they can use AI to achieve specific strategic objectives. Leaders must also overcome challenges to AI adoption, such as persuading employees to embrace new AI tools and ways of working.

Unlocking Value With AI: A Roadmap for Business Leaders

In 1995, a young and fresh-faced Bill Gates tried to explain the internet to the famous talk show host David Letterman ("Bill Gates Explains the Internet to Dave" on YouTube). As Gates describes the internet's potential to broadcast a baseball game, Letterman cuts in with his trademark wit, saying "Does 'radio' ring a bell?" The audience laughs on cue. Gates had the last laugh, however. The internet transformed the way we communicate, work, and live. Today, AI is on the verge of something equally monumental.

AI Today: Untapped Potential

Widespread AI adoption – in business and in our daily lives – is on the horizon. Firms that build and adopt AI tools to do business faster, better, and cheaper will secure long-term competitive advantages. Forward-thinking firms have already operationalized using AI tools to automate business processes, make operational decisions and predict evolving customer needs – at scale and with minimal human intervention.

The same goes for firms that create AI-powered consumer products that improve people's quality of life. At the time of writing, seven out of the top 10 public companies by market capitalization embed AI in many of their products and services. Most of the content we see online on Netflix, YouTube, and social media, are recommended to us by AI algorithms via recommendation engines.

Ultimately, AI is a tool to achieve an objective. To successfully deploy AI, business leaders must understand how they can use AI to achieve specific strategic objectives. Leaders must also overcome challenges to AI adoption, such as persuading employees to embrace new AI tools and ways of working.

Unlocking Business Value with AI

One of AI's most high potential value-adds is simulating human decision making. When trained with high-quality real-world data, AI can classify new data, find patterns in massive datasets, predict outcomes and make repeated decisions at scale

Automated decision-making at scale makes AI powerful because AI tools can parse through far more data than humans can. This also leads to exponential increases in speed and efficiency in terms of execution and implementation.

AI SUPPORTS BUSINESS PRIORITIES

Business Priorities

Efficiency | Risk Reduction | Customer Insights

Some AI Applications

Automated Defect Detection

AI-enabled cameras spot product defects on the assembly line

Automated Fraud Detection

AI flags potentially fraudulent transactions in real-time

Proactive Customer Retention

Using AI-enabled Enterprise Search

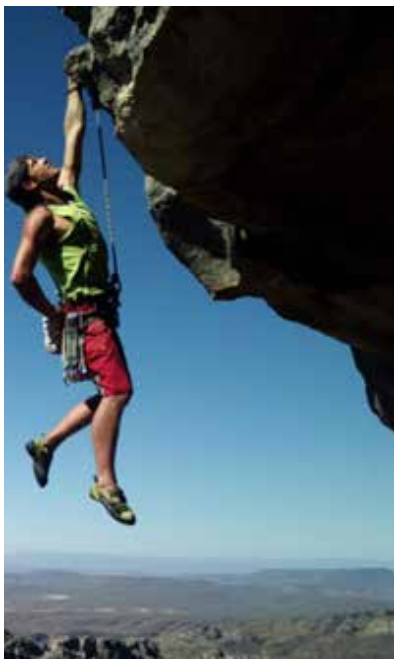


Figure 1: *AI supports and helps achieve business priorities*

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Businesses have three critical priorities: Becoming more efficient, reducing business risk, and improving customer insights. Efficiency and risk reduction keep expenses low. Better customer insights enable firms to grow current revenue streams and create products that customers value.

Manufacturers are cutting costs by using AI-enabled cameras to identify defective goods on the production line in real-time. For products with low profit margins (or high costs of production defects), detecting defective goods before they are shipped saves time and money. It also leads to lower customer returns which in turn enhances a brand's reputation.

Banks are using AI to reduce business risk by automating fraud detection. AI models are trained on past transaction data and learn to identify patterns that indicate fraud. When deployed, these models identify potential fraud in real-time by analyzing a continuous stream of transaction data that is too large for humans to study in a timely manner. The time saved and regulatory fines avoided have so far proved to be worth the investment.

Customer Analytics teams are turning to AI to pinpoint customers at risk of leaving and identify the type of customer outreach with the highest chance of convincing them to stay. Using AI to improve customer retention will enable businesses to survive and thrive as many are adopting subscription-based revenue models.

Formulating an AI Strategy

A strong AI strategy answers the question: 'How will our firm implement AI tools internally – or embed AI in our customer products – to achieve key business goals?'

AI strategy is part of the overall business strategy. As such, business leaders should formulate their AI strategy by first articulating current strategic goals and hurdles. Does the firm plan to double sales in an emerging market? Are there competitive or regulatory challenges that keep management up at night?

Next, leaders should understand specific business processes that are key for achieving the firm's strategic goals. For instance, if a bank's strategic focus is regulatory compliance, processes related to fraud detection and anti-money laundering (AML) are important.

At this stage, business leaders can have meaningful conversations with AI builders to identify AI solutions that enable critical processes to be done faster, cheaper, and more effectively.

AI builders are those who have the technical skills to create AI applications and are a key part of the implementation process. In addition to AI builders, there is also a need for business translators who while having a working knowledge of technology, are primarily there to ensure that the AI really does meet the business needs. Business leaders should therefore ensure that their organization has both AI builders and business translators, and that communication is happening constantly between all parties.

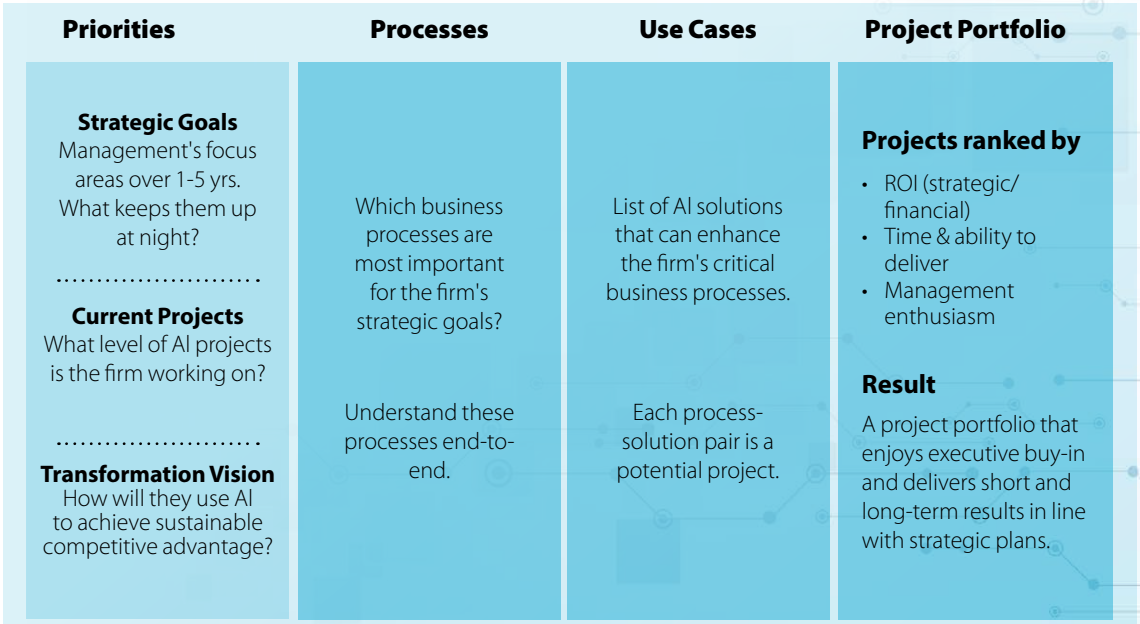

Figure 2: *A strategic framework for identifying high-value AI initiatives*

The result of the aforementioned steps should result in a structured project portfolio that delivers short-term and long-term benefits to support the firm's strategic goals. A balanced portfolio contains some projects that deliver quick wins and others that tackle higher-value use cases over time, thereby generating a consistent stream of benefits.

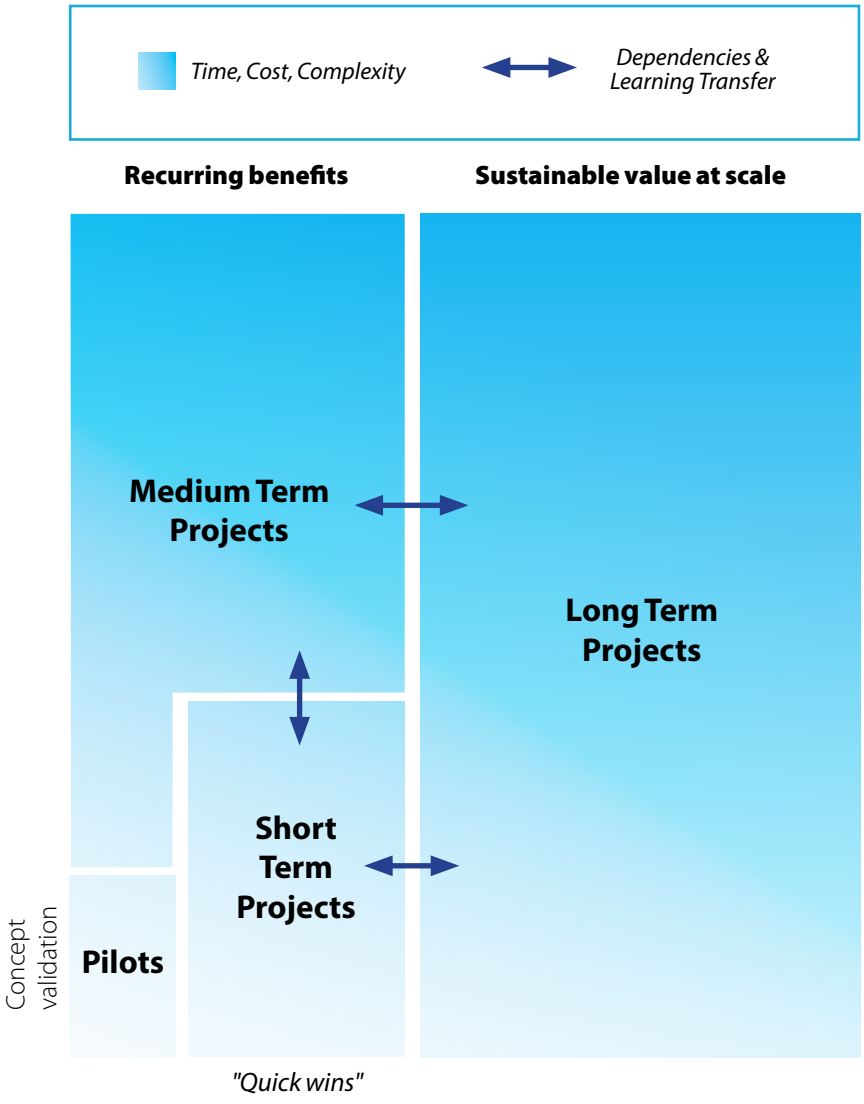

Figure 3: *A balanced AI project portfolio generates a consistent stream of benefits*

Overcoming Challenges to AI Adoption

AI awareness and employee buy-in are not enough to ensure smooth AI integration with business processes. Even if the tech works, human work habits are hard to change. Firms must budget time and resources for adoption and change management.

Integrating AI tools into daily operations involves process redesign, staff training, and change management. These supporting activities should start well before deploying the AI tool. These activities get people ready to use the AI tool effectively from day one. They also keep staff aware of, involved in, and supportive of the AI journey.

Starting change management activities early allows the firm to identify potential issues before implementation. Getting early feedback from end users might reveal that an AI tool requires process changes that create more issues than benefits. Realizing this early allows the technical team to modify the AI tool accordingly.

Takeaways for Business Leaders

Effective AI implementation makes business processes more efficient and effective, while predicting customer needs and actions. Ultimately, AI is a tool to achieve a business objective. By understanding what AI is capable of, formulating an AI strategy and effectively managing change, AI enables firms to achieve high-quality and sustainable business results.

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Services in a Glance

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STRUCTURAL SYSTEM DEVELOPMENT AND CODE-BASED DESIGN REVIEW

BUILDING INFORMATION MODELING (BIM)

WIND TUNNEL TESTING

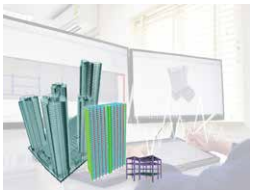
STRUCTURAL HEALTH MONITORING

COMPUTATIONAL MODELING AND ANALYSIS OF COMPLEX STRUCTURAL SYSTEMS

STRUCTURAL FAILURE INVESTIGATIONS AND RETROFIT DESIGN

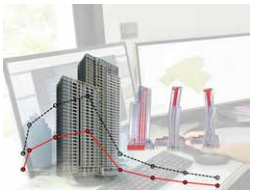
SOFTWARE DEVELOPMENT & IT

Performance-based Seismic Design



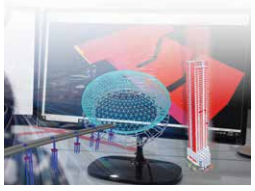
With its in-house team, AITS has conducted structural performance-based design of over 120 tall buildings located in high seismic zone. For our partners & clients in these projects, AITS conducts highly detailed earthquake simulations to check and improve the structural performance as well as cost-effectiveness. The scope that AITS carries out to evaluate the primary lateral load resisting system for specified performance objectives under different levels of earthquakes.

Structural System Development and Code-based Design Review



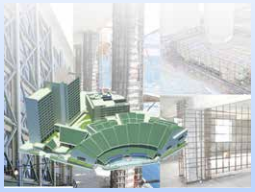
AITS team conducts the structural system development and code-based design review to check the structural design in terms of strength and serviceability requirements as well as conformance to the building codes. Firstly, AITS develops the structural system and provides it to the main structural consultant for detailed design. After substantial completion of structural detailed design by main structural consultant, structural design review is carried out using the information from the structural drawings and documents provided by the main architect and structural consultant.

Computational Modeling and Analysis of Complex Structural Systems



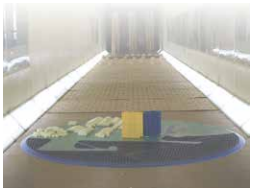
AITS team carries out the computational modeling and simulation of various types of structures with complex geometry and behavior under normal and extreme loading conditions.

Structural Failure Investigations and Retrofit Design



AITS team conducts site investigation as well as structural design review as part of the structural failure investigations.

Wind Tunnel Testing

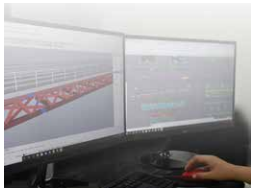


AITS in-house team works closely with project engineers and developers to enhance the reliability and cost effectiveness of the structural design thereby ensuring occupant comfort, façade design optimization, and improving pedestrian comfort. The wind tunnel test is carried out in the atmospheric boundary layer wind tunnel, in which the working section is 2.5 m wide and 2.5 m high with 23 m long.

Structural Health Monitoring

This advanced analysis technique, researched and developed by AITS in-house team, monitors the structural health of instrumented buildings/ structures. This analysis can be relayed to building managers, developers, engineers, and occupants to assess the safety and reliability of the structure as well as enabling damage detection, especially in a post-earthquake scenario.

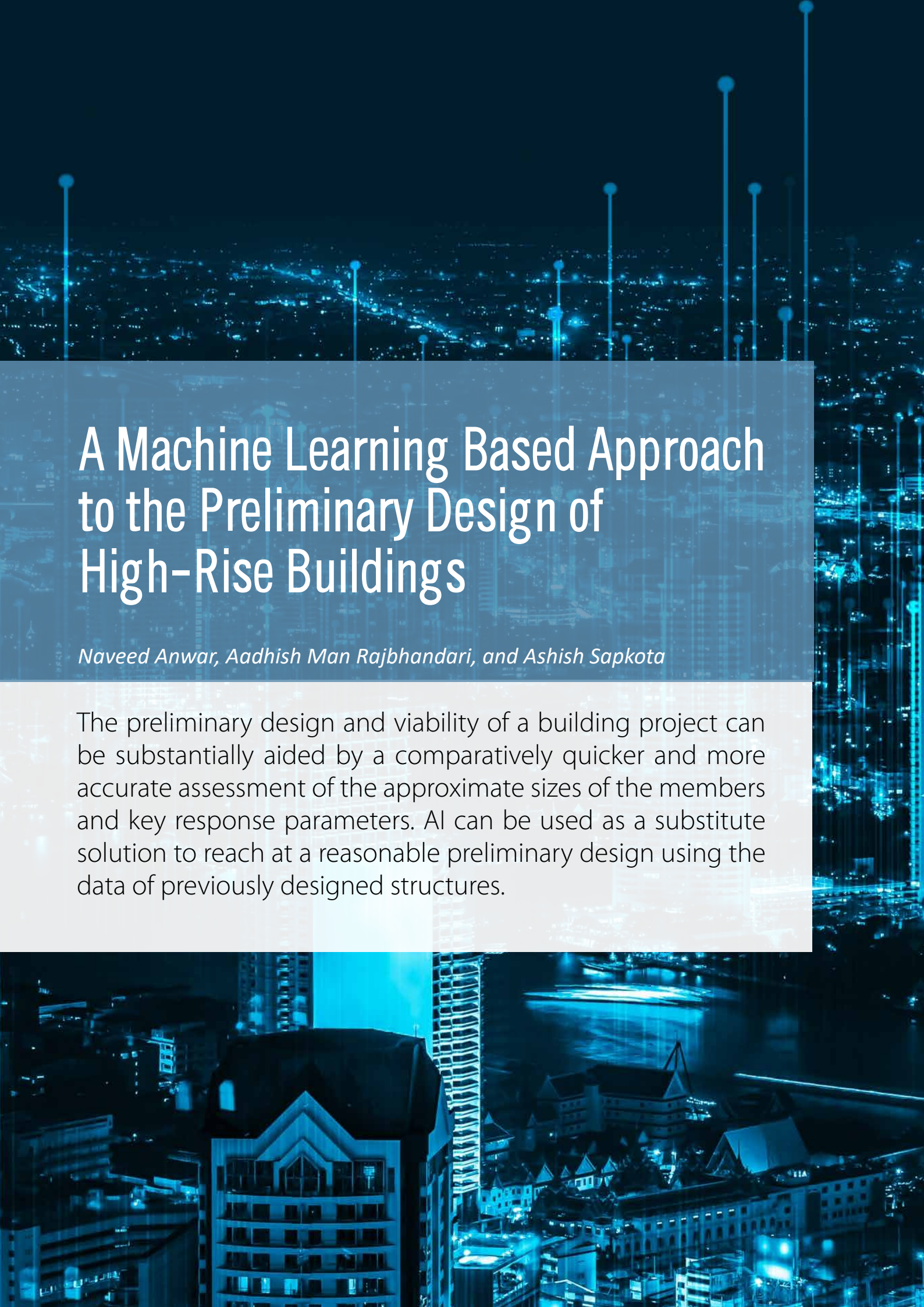
Building Information Modeling (BIM)



The Computers and Structures, Inc. (CSi), the pioneering leader in software tools for structural and earthquake engineering, partnered with AIT Solutions to establish CSi BIM Lab at AIT for the advancement of the application of BIM in various aspects of building design, construction, management and operation. BIM Lab team carries out the research and development of platform and tools to read and check the different data format of BIM models as well as development of BIM models from scanned data.

Software Development & IT

AITS in-house team has collaborated with several leading industry partners to research and develop software solutions in the field of structural engineering, mobile computing, knowledge products, construction monitoring & management, travel & leisure, and smart living. AITS develops customized desktop, web, mobile and cloud-based applications to fulfill the needs of partners and clients.



A Machine Learning Based Approach to the Preliminary Design of High-Rise Buildings

Naveed Anwar, Aadhish Man Rajbhandari, and Ashish Sapkota

The preliminary design and viability of a building project can be substantially aided by a comparatively quicker and more accurate assessment of the approximate sizes of the members and key response parameters. AI can be used as a substitute solution to reach at a reasonable preliminary design using the data of previously designed structures.

A Machine Learning Based Approach to the Preliminary Design of High-Rise Buildings

With innovations in structural forms and systems, exploring analytical processes, and increasing modelling complexities, there is a greater demand for quick and preceding knowledge about proportioning the basic geometry and configuration of structural systems and members. To complete the basic design of a structure and arrive at a decision, designers frequently need to carry out a variety of calculations and utilize their own judgement and discretion. It requires numerous trial-and-error analyses and different code-based calculations. It is a laborious process that takes a significant time and energy. At an early stage of a project, clients are always interested to learn the acceptable solutions to various design problems with associated cost. The more quickly an engineers can reach the right decision, the better it is for them in terms of their reputation and project outcome.

If I look at my own practice long time back, once I get the projects, I used to start making the drawings and start putting the reinforcement even before I did any calculations. After that, when the drafting is being finalized, I used to verify whether my assumed design details are correct or not via calculations. Most of the times, my estimation would be correct, and the reason is because of the design sense and intuition that comes with the continuous learning and experience. It is worth noting that the time we are talking here is before we started using CADs and computers. During that time, most of the designers would have to rely on thumb rule and handbooks whereas the experienced one would go little further based on their design intuition.

Talking about the computational development in the structural design, we can refer to suitable modeling of the structure, assumed analysis, and design. However, in most of the cases the design engineers are unaware of the assumptions being made and the output with too many details tends to lose the sense of design. This can be considered as the first level of computational system that we are relying upon. Similarly, the second level of system can be an expert system where the designer can reply upon the Artificial Intelligence (AI), Machine Learning (ML), Deep Learning (DL) and so on. This system operates based on the previous experience and use that experience to determine the new values. The system requires a lot of data to train the algorithm but once it has sufficient information, the same data could be useful in making a design decision.

Even the most experienced engineer might need to make a few attempts before arriving at an acceptable design estimation. Choosing the suitable structural design on the first attempt is challenging. Poor choices could result in an uneconomical or unsafe design. The preliminary design and viability of the project can be substantially aided by a comparatively quicker and more accurate assessment of the approximate sizes of the members and key response parameters. Artificial intelligence can therefore be employed as a substitute solution to reach at a reasonable preliminary design using the data of previously designed structures.

Artificial Neural Networks (ANN) is the basis for most of the AI in which we have hidden layer, the input, and the output (Figure 1). The hidden layers could be determined through a lot of known input and output data and train the network to get the reasonable values for the hidden layers. These data can be utilized further to solve the various problems where the output is unknown. This is how we could use AI for reasonable estimation of the parameters which are not easily obtained otherwise.

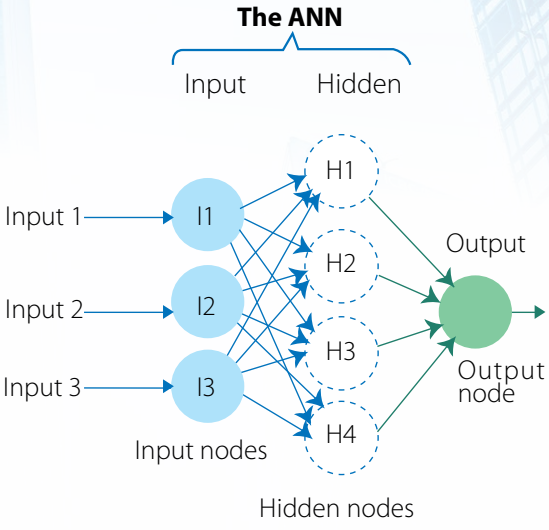


Figure 1: *The Artificial Neural Networks (ANNs)*

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The tool can also be used to compare code based and performance-based design quickly. With future access to new data, the system is also capable of incremental learning.

In this study, we explain the machine learning based approach to directly determine various key design parameters based on experience gained from previously designed buildings. The objective is to provide means of assisting the design team and clients to make key design decisions based on validating previous designs and collective experience rather than depending on judgment of individual designers or the need to do the detailed calculations for preliminary design. The approach is based on a heuristic tool employing ANN that can produce results quickly and with reasonable accuracy using two algorithms (Multi-layer Perceptron with Back Propagation – MLP BP, and PCA-Sparse- Extreme Learning Machine with online Sequential learning – OS ELM). The tool can also be used to compare code based and performance-based design quickly. With future access to new data, the system is also capable of incremental learning. The method is based on the sample networks that have been trained on numerous high-rise building case studies from the Philippines using their architectural and design reports.

The goal of the study carried out by Mr. Aadhis Man Rajbhandari is to design a model that can be further developed to create a software package that can be utilized in the preliminary design of a building based on the concept of machine learning or embedded in existing software for preliminary design. It features an ELM model that builds itself and is capable of sequential learning. A set of input and output data from architectural and structural drawings is used to train and evaluate the model.

Preliminary Design and Response

The conventional design process starts with the architectural design. Based on this design data, preliminary sizing, structural modeling, analysis, and design will be performed. This process is iterative, computationally intense and time consuming. However, if we apply the concept of AI based on our experience of the previous design details, the time of the overall design process can be reduced significantly as seen in the flowchart (Figure 3).

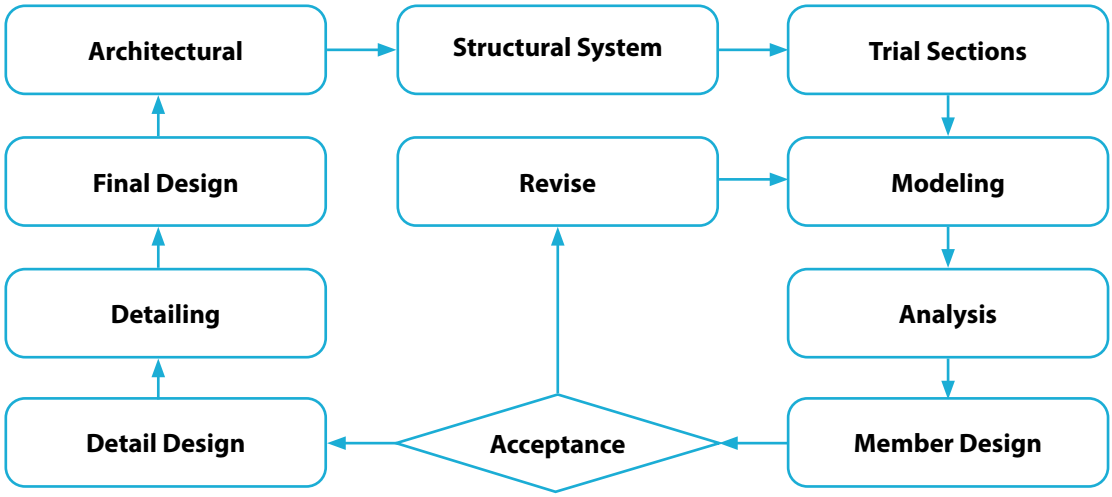


Figure 2: *Conventional structural design process*

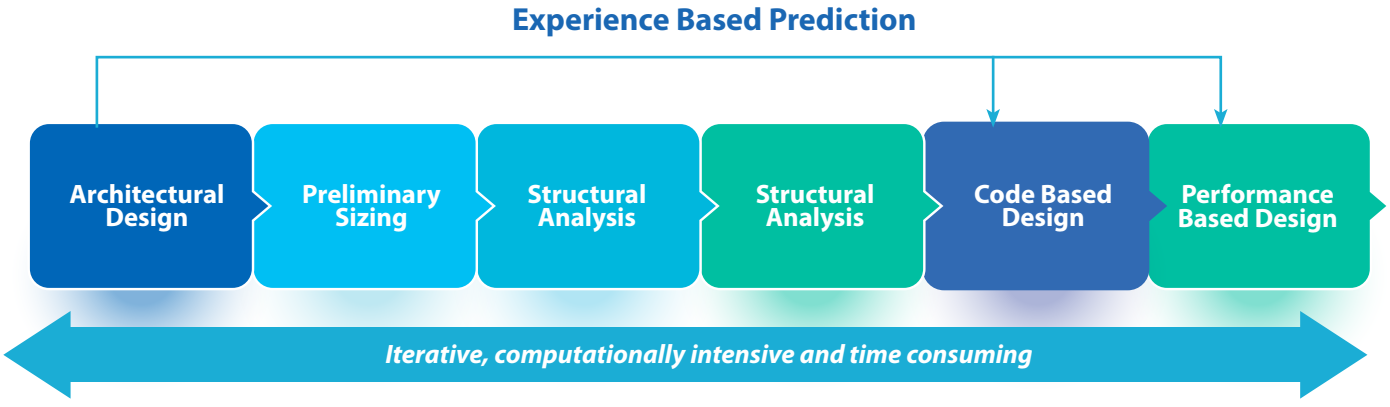


Figure 3: *Using AI for structural design process*

APPLICATION OF ANN

Unlike the conventional design method (Figure 2), this system is trained to determine structural design indicators from architectural parameters as shown in Figure 4. Information of the buildings are taken from AIT Solutions. Those architectural plans and data are categorized into two sets: set 1 with training data and set 2 with testing data sets. Two different models (MLP-BP and OS-ELM) were used to train and test the data sets. All input parameters were employed in the MLP-BP algorithm to predict each output parameter separately. Each model was designed with different architecture for prediction of different set of outputs. The generic ELM algorithm was evaluated on the OS-ELM models first, and the Online Sequential (OS) procedure was then added to the model. The OS refers to a sequential learning process in which data chunks are used to train the network one at a time. To map single output and multiple sets of outputs, various input parameters were used. The details regarding the crucial input parameters are shown in the Figure 4. Overall, the system will work in a way that it collects the necessary data, undergoes data pre-processing, subjected to the algorithm of the Neural Network, and receiving the desirable outputs after sufficient training, testing, and sensitivity analysis of the Neural Network (Figure 5).

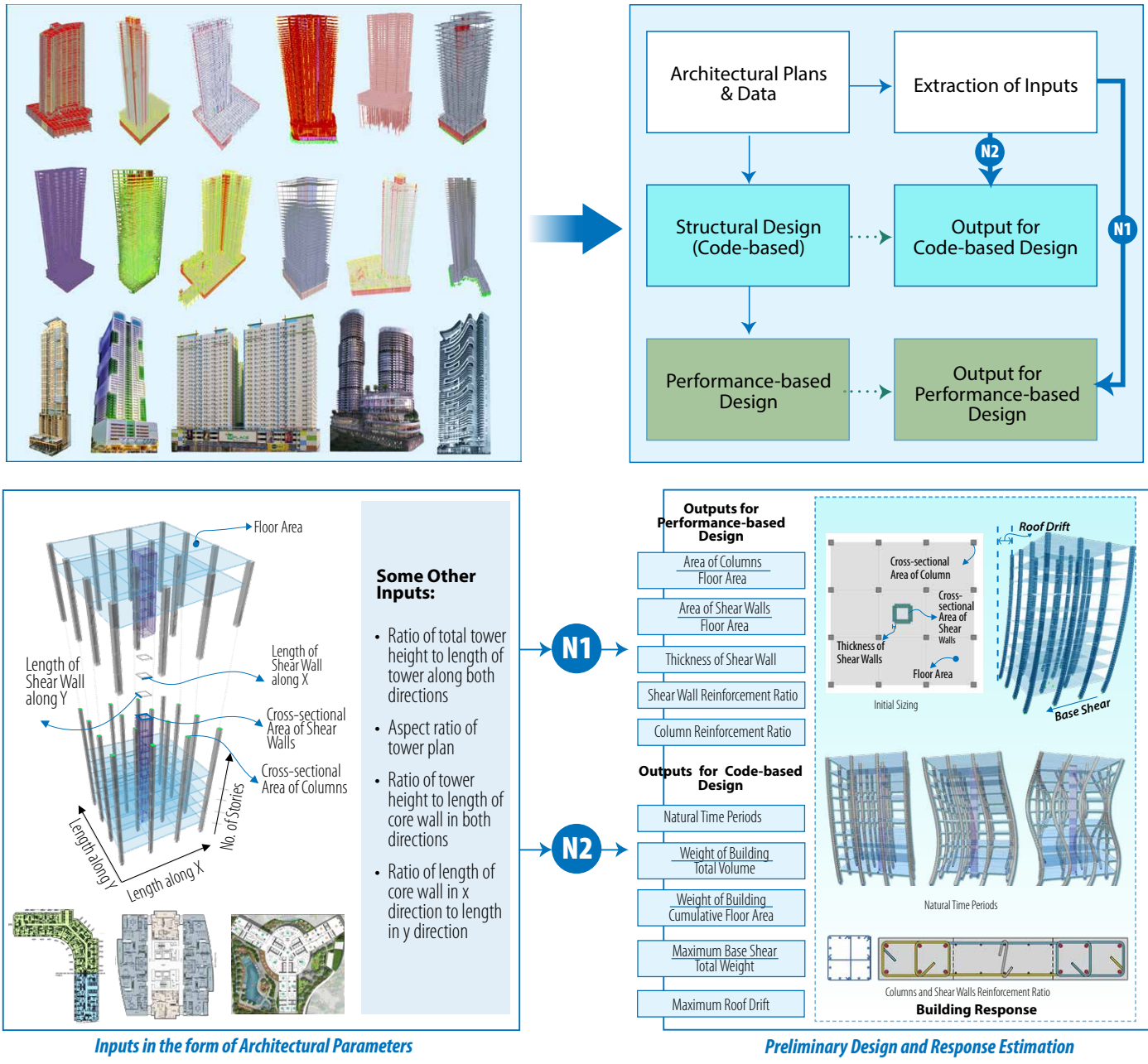


Figure 4: *An overview of the study*

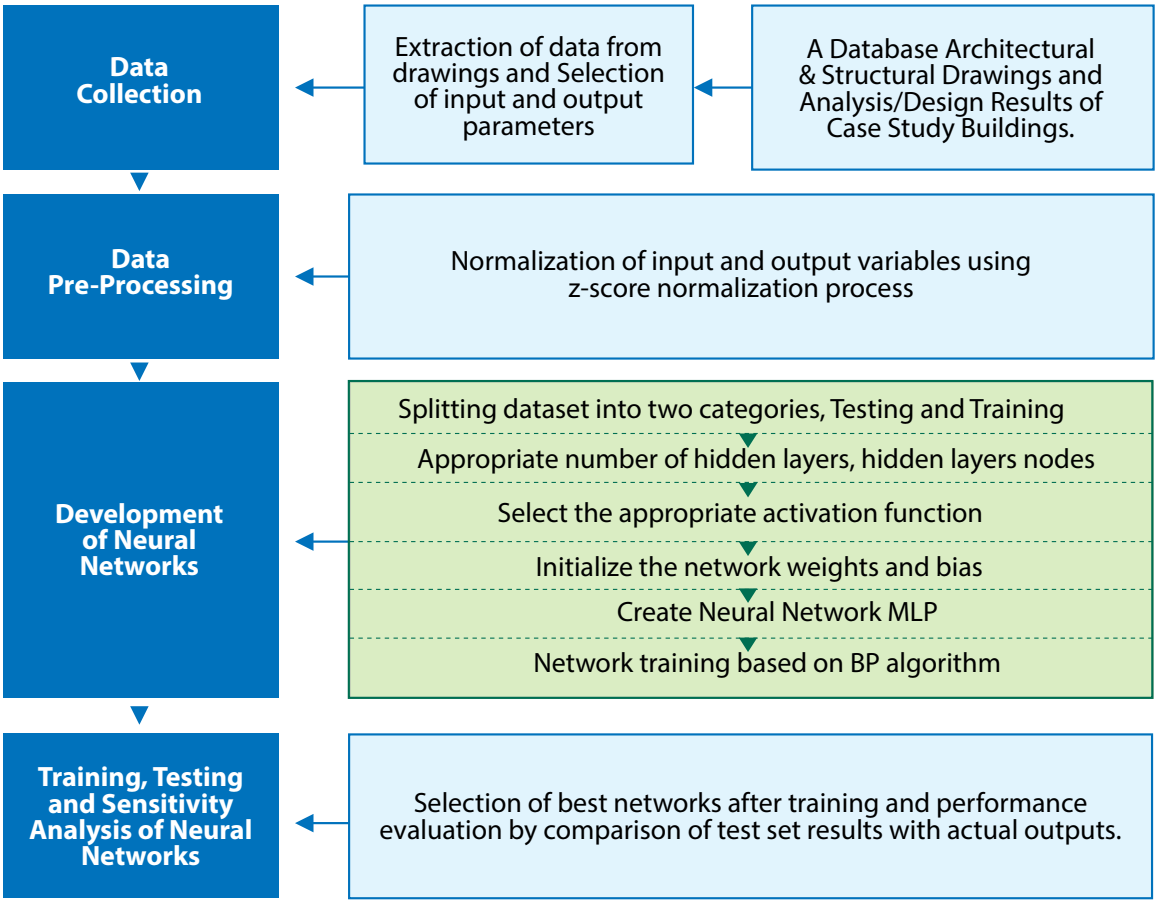


Figure 5: *The overall process for the preliminary design of the building*

OUTCOME

The presented method is demonstrated using sample networks that have been trained on a variety of case study high-rise structures for which the necessary architectural and structural design outcomes have already been established through detailed design. It is observed that well-trained ANN models can reliably predict the critical structural parameters from architectural drawings. These networks map the nonlinear relationship between input and output. Although the MLP's Back Propagation learning process has outstanding generalization properties, it takes a long time to train. The Pearson correlation coefficient for MLP-BP for the new building set was discovered to be greater than 80%. The ELM algorithm exhibits a quick learning curve and comparable generalization ability. Each model's network training and testing took less than a second. Online sequential learning in ELM enables the model to be used in online platform where additional training data can be used to fine tune the network.

CONCLUSIONS AND FUTURE RECOMMENDATIONS

It is demonstrated that the suggested approach can offer a quick and reasonably accurate estimate of design output for new structures. The method is also useful for quickly cross-checking the outcomes of code-based design and performance-based evaluation of existing structures. Future research can use regularization functions or bootstrapping to provide new data and enhance the performance of developed networks. Combining various optimization technologies, such as Genetic Algorithms (GA), can also help in improving the network performance of MLP-BP. For greater accuracy and broader applicability in future research, other design characteristics (such as wind design) might be introduced. Similarly, more study and research on machine learning should be encouraged in the civil and construction industries.

ARTIFICIAL INTELLIGENCE

Q&A with AI Expert

Shreeravi Kachinthaya
Global Head – AI Solutions Design & Presales, Wipro Limited, India

1 What will be AI in the next decade?

Business adoption of AI is expected to take wings and fly - exponentially! To understand the magnitude of this, we must look back in time. The 1950's saw the underlying theories of AI take shape. However, for businesses to achieve "results", there was a very high cost (e.g. lack of computing power, data etc.), leading to the "AI winter". It was around 2010 that the cloud services (e.g. aws, gcp, azure) came into prominence accompanied by an explosion of data due to faster broadband & mobile tech. Over the last decade, businesses have spent their monies towards "digital transformation" which has largely been "on-premises to cloud migration". As enterprises move their apps & data to cloud, they have increasingly started to realize more AI use cases at much lower computing costs but delivering phenomenal "results". For e.g.

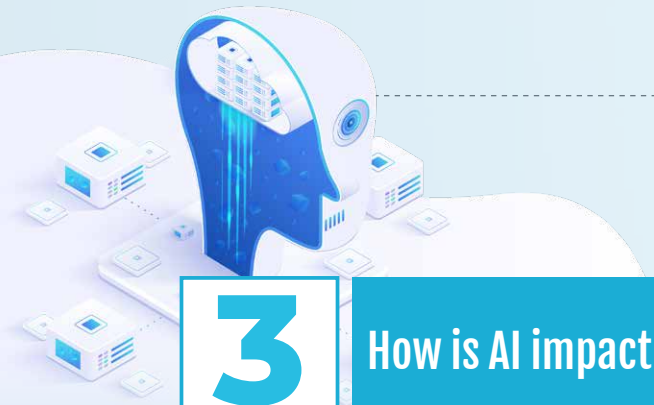
- AI for business - solving problems such as how to use AI for increasing revenues (e.g. better customer segmentations, cross-sell/up-sell recommendation models, identifying churning customers, building effective AI powered ad campaigns, engaging customers via AI etc.)
- AI for industry - solving domain specific problems e.g. how to improve patient outcomes & cure diseases faster, how to reduce wastage & keep expensive equipment running reliably while manufacturing, how to efficiently manage energy, how to predict loan default/fraud/anomalies etc.)
- AI for organizations - solving operational problems e.g. keep the IT on, how to better engage & retain my employees, how to find efficiencies in supply chain or contact centres or finance departments

The next decade will see enterprises "infuse AI" across all the above in a bid to make them smarter & more intelligent. Technologically, newer advances such as AI in metaverse, advances in NLP, computer vision & generative AI will accelerate this adoption. To put it a bit more vividly, while you have gotten used to interact with the alexas' & the siris' of the world (which at this point do break often) - the next decade will likely see them evolve into a smooth talking "Jarvis 1.0" of the Ironman fame!

2 How is AI affecting your organization now? And how can the skills of professionals be scaled up?

As a global company delivering innovation-led strategy, technology, and business consulting services, we see enormous AI opportunities across our diverse client base. We are helping them unlock AI potential across enterprise processes. Apart from assisting our customers in their AI journeys, we eat our own cake e.g. we save $25mn annually in our HR function via AI powered employee onboarding & engagement solution (recipient of The Hackett Group Digital Awards in 2021). Similarly, we have stepped up AI usage across our procurement, IT & demand management functions & we see a lot more possibility of AI adoption in every facet of the company.

To achieve this, we face an exciting challenge of educating both our customers & broader employee-base on the possibilities of AI, helping them pick the right use cases that can deliver multi-fold value. With over 5,000 data scientists & ML engineers on our rolls, we are easily one of the largest AI builders globally and have organically built internal AI academies to train/up-skill and educate both our customers and employees. We have also built evolved consulting frameworks which help pick the right AI use cases delivering value. Concepts such as "citizen data science" & low-code/no-code AI tools are helping us execute AI at scale & easily up-skill professionals.



3 How is AI impacting customer service?

Most of the AI interventions in customer service today are via contact centres. If you have watched the movie "The Intern", you would have heard of a dialogue that if a CEO wants to truly understand their customers, they should spend a day in their call center! Well, if the management is too busy to do this, today AI can understand millions of customer conversations not just in call centres, but also via other digital/online channels such as social or comments fields of your e-commerce product listings etc. Today, AI can distil various insights from these channels helping in understanding customers frustrations, complaints and also what do customers like about products - all these insights can go a long way to plan a company's product strategy, what they should make more of, what they shouldn't be doing and to whom they should be selling to.

AI is also helping customer service more proactive than reactive. If you look at it with a different lens, a contact center is a channel where customers are reaching out to you (for free!) vs. marketing - where you are paying to reach the customers. So, if you are able to delight customers via this channel - it can unlock a lot more up-sell/cross-sell opportunities. E.g. If a customer has visited your website and spent 10 minutes searching around for information, that data is available today for utilization by your marketing as well as call center teams. Via this knowledge, one can drive much smarter conversations and impress customers during customer service.

For expensive products, organizations can also "prevent" customer complaints to contact centres by utilizing IoT and predicting failures e.g. battery failure in an electric vehicle can cause big disappointment & vehicle downtime. We are helping vehicle makers predict failures of critical components & plan replacement/reverse logistics before the vehicles break-down, leading to improved customer service.

Conversational AI is another major technology adopted in customer service. However, this one is a double-edged sword. Simple chat bots aren't that helpful and can in fact increase customer frustrations. A well-designed bot implementation project is key to realize its true potential, with a good base of content training & implementation of smarter AI/NLP features.

4 How fast AI is moving and how is it impacting society?

AI is impacting every aspect of society. To name a few: Health care is one of the areas with significant societal benefits of AI usage - One of my favourite use cases implemented was for a government health body where we used AI to predict how much blood stock is required, by when and at which centres. This helped the blood banks to proactively arrange transfers from other centres where there are excess stock / plan donation campaigns as needed - so that no one has to struggle to get the required blood type that they desperately need during emergencies. AI is also assisting doctors/researchers diagnose diseases faster (e.g. tumours) and accelerate drug development. We all desperately waited for vaccines recently. AI is helping in identifying success/failures in vaccines/drug development by predicting outcomes based on early patterns detected during trials/experiments. All these equate to "AI saving lives", quite contrary to some of the apocalyptic narratives doing the rounds today.

AI also has a great play in sustainability. We are using AI to help factories produce more with less energy requirement and lesser pollution/wastage. We are using AI to help power companies produce more e.g. predict wind speed/irradiance and align wind mills & solar panels for power production maximization. We are helping banks become more conscious of who they do business with, by understanding ESG footprint. AI in agriculture is another burgeoning field to increase yield and avoid crop failures via AI led prediction of their health.

AI is making cities smarter e.g. predict mobility requirements in certain areas of the city every day and automatically issue instructions to transport providers to maintain a higher concentration of vehicles (e.g. cabs) in certain areas. Likewise, AI and its application possibilities to help humanity are endless & are only bound by our thinking & adoption of this wonderful technology!

Timber Traceability

Mongkol Ekpanyapong

This article reviews some of the many alternative and promising digital technologies including AI-based systems that could help in addressing timber traceability with a better efficiency than the traditional approaches.

Timber Traceability

Thailand has approximately 16.4 million hectares of forested land, covering almost one third of the country and is a major exporter of wooden furniture, sawn timber, and paper, among other timber-based products. Thailand's processing industry relies more on timber imported than those produced domestically. In 2019, Thailand imports logs and sawn timber to the processing industry about 2.9 million Cum. or around 7,094 million THB, mainly from Malaysia (2,970 million THB), New Zealand (905 million THB), the United States (685 million THB), and Myanmar (408 million THB) (RFD Information Technology and Communication Center, 2019). To ensure sound governance and implement robust timber legality assurance system and supply-chain controls, Thailand embarked in the process of negotiating a Voluntary Partnership Agreement (VPA) with the European Union (EU) in 2013. One important application for this assurance system is timber traceability. In this article, we have reviewed some new approaches including AI-based for Timber traceability. First, we reveal the background of a traditional timber traceability approach. Then, we reviewed the new approaches. Finally, we conclude the article.

In the traditional approach for timber verification, the comparison between stump and timber is verified by trained officers. From the data obtained from the field data collection and the desk review, it is found that the method based on the technical principle used is comparing between log and stump by using a clear plastic placed on a cross-section of stump or log and drawing the pattern of timber. This demonstrates its shape, arc, size, appearance, and indentation for comparing between stump and confiscated timber, as shown in Figure 1.

Furthermore, there is another method to verify timber by comparing the structural characteristics of timber that can be seen by using a magnifying glass to look at the timber at the cross-section that was cut by a knife. There are two key structural characteristics of timber which can be clearly seen using the magnifying glass: Pores and Parenchyma.

However, there may be an issue that the stump is absent from the land claimed. For this case, the recording method is used to interrogate the landowner and the neighboring landowners on the existence of trees.

Figure 1: *An example of comparison between stump and confiscated timber*

There is a paper-based timber traceability system used in Thailand, but it does not cover all types of timber especially timber on private land. The system is operated by the government as per the rules and procedures specified by laws. Hammering and documents declaring timber inventory are implemented for timber identification as shown in Figure 2.

Figure 2: *Hammering of the personal hammer on the stump*

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Mongkol Ekpanyapong

Director, AI Center, AIT
Department Head, Industrial Systems Engineering, AIT

Global Positioning System (GPS) devices can provide location data using satellites to estimate the coordinates from the GPS receivers of the earth through triangulation. GPS tracking is used widely for vehicle tracking, animal tracking and high valued goods. GPS systems are now commonly used in forestry. Timber tracking systems use GPS data to localize the timber in the forest. Location information is obtained in real time. When connected to communication systems, GPS can be used to track shipments and provide estimated delivery times. The advantages of GPS are real time capability and are commonly used in the industry. GPS limitations are its accuracy when signals are lost and required medium to high power consumption for a real-time communication system

Radio Frequency Identification (RFID) Similar to barcoding, RFID systems create a unique reference for timber products where the ID numbers and other logs data is wirelessly transmitted between RFID tags and the RFID readers. In timber tracking systems, RFID nails are used.

Figure 3: *RFID Nails for timber tracking*

The mechanism is resistant to forgery. There are two types of RFID tags: active tags and passive tags. The difference between active and passive tags is their power consumption and transmission areas. Active tags can transmit signals over 5-10 meters but additional power supply is needed for them. Passive tags' transmission areas are shorter (between 5 to 10 centimeters) but it does not consume energy. The advantages of RFID include easy tracking for active tags and low power consumption for passive RFID tags since it utilized transmitter waves. However, RFID are relatively expensive for long-term usage and may not be practical for certain timber products (e.g. small circumference rubberwood logs that are traded in bulk). RFID also requires trained staff and often needs internet connection or mobile phone networks [3].

Blockchain technology is a recently available method that focuses on decentralized ledger blocks of information that is distributed among the networks. A blockchain structure is a node format flexible database. The data is distributed between all nodes.

For example, when information is changed in one node, all nodes connected are updated.

The image above shows that each block has two "hash", a hash is a key. Each block will contain the data and any data amendments made to the block with the timestamp. When changes are made, a new block is created containing the previous block hash (or keys) which if the keys do not match, fraud is detected. Blockchain data is immutable and when deployed, requires encrypted keys. One from the local host and one from the verifying host to make changes. Blockchain records all its history of changes that occur in the system. This technology creates a new level of transparency and allows the network to assign the confidential transaction for an insecure environment [5].

Blockchain has potential for timber traceability in terms of data security but the peer-to-peer network system is not yet tested for scalability and efficiency. The advantage of blockchain is secure and verifiable data. Otmetka is one of the company that is working to apply blockchain to secure timber traceability. The company promises 100 percent traceability guaranteed, wherein they digitize the timber industry with blockchain. Otmetka has developed a new marking system to avoid barcodes or RFID nails with OtmetkaID, where they can individually mark logs with camera technology. The marking, OtmetkaID, can provide geographical origin with their unique, encrypted single used codes with links to time-specific geographic position during cutting.

Figure 4: *OtmetkaID stamp into the log and customized number marking*

Their system allows for integrating of other marking techniques, such as numbers, color codes, barcode labels/QR codes, RFID. Their solution is currently used in 20 countries around the world.

Blockchain system are highly secured and beneficial for applying to existing systems where traceability

The advantage of blockchain is secure and verifiable data. One company is working to apply blockchain to secure timber traceability called Otmetka. The company promised 100 percent traceability guaranteed, where they digitize the timber industry with blockchain.

system and data is semi-digitalize. The system does not share the range of the blockchain network. As blockchain is a peer-to-peer technology, larger network will require more data and computing power to operate.

Machine Vision / AI technology utilizes large database of species to help identify the timber species. Machine Vision takes wood image collection that exist and creates a model to match any new images added to existing collection with a percentage of accuracy. Hermanson, Wiedenhoeft, and Gardner successfully tested in 2014 machine vision system for automated field-level wood identification that is equivalent to a field personnel one-week training. Machine vision is a trained model that computer learns to interpret images the same way humans do. Some of the setbacks include, requiring large data sets of thousands of images to enable machine to understand one item and needed experts to individually label each image to teach the computer. The data collection is time consuming and costly and without data this system cannot be developed. Xylorix, Malaysia based company has developed a system using machine vision to identify wood. The system identifies wood using simple tools by equipping the mobile phones with macro lens and taking a picture within its application. The solution they provide is as shown below in Figure 5:

Although the solution seems promising, more detailed information on accuracy and data sources for wood samples are not available for review. Xylorix system testing will be needed to know the full capability for identifying timber.

In conclusion, there are many alternative promising digital technologies that could help address timber traceability with a better efficient than traditional approach. However, it still needs to be proved which technology would be best for actual scenarios.

Figure 5: *Mobile AI solution for wood identification by Xylorix, Malaysia*

REFERENCE

https://otmetka.com/marking-techniques/

BULLETIN

A summary of news from AIT&AIT Solutions

June - December 2022

AIT&AITs

DECEMBER 2022

Chairman of ESG Council, Indorama Ventures (IVL) Bridges the Gap between Business and Environmental Aspirations

The Chairman of ESG Council at Indorama Ventures (IVL) Mr. Yash Lohia was the fourth speaker of AIT's signature event, the Distinguished Entrepreneurs Talk Series held on 29th November 2022. More than 150 scholars, faculty, directors, and staff attended this event which was held in hybrid mode (onsite and online) at the AIT Conference Center.

Mr. Yash, the son of Mr. Aloke Lohia, founder of the US$14 Billion company, talked about The Bridge between Business and Environmental Aspirations taking the audience in a journey from when he started in the company at a very young age of 2 months old until he became the Chief Sustainability Officer, becoming the bridge between the environmental aspirations of the next generation and the tried and trusted business models of recent times.

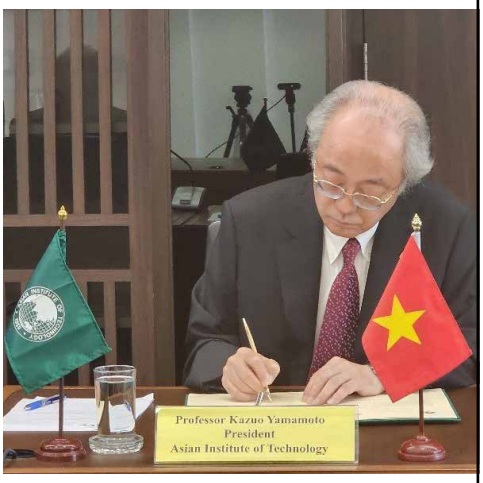
The recording of his talk is available upon request, please send email to *entrepreneurship@ait.ac.th*

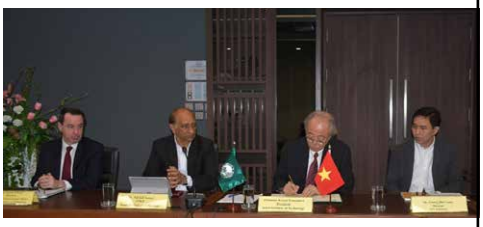
UN Environment Programme and AIT launch publication report on Covid-19 and the Water Sector

The UN Environment Programme in collaboration with the Asian Institute of Technology (AIT) held a soft launch of its publication report on "Covid-19 and the Water Sector" on 9th December 2022 at the AIT Entrepreneurship Center and online. The book is a comprehensive assessment of the impact of Covid-19 on the water sector based on a review and analysis of available information and data. Prof. Chettiyappan Visvanathan, Faculty at the School of Environmental, Resources and Development, the main author of the book presented the outline of the book, beginning from literature review, sector experts review and feedback after the two webinars that were organized to share the draft report and get comments from the participants.

The book covers the following topics: COVID -19 & Water Security Risks; COVID-19 & Water, Sanitation and Hygiene (WASH); COVID -19 & Water Demand and Supply; COVID-19 & Wastewater; COVID -19 & Ambient Water Pollution; Conclusions & Recommendations. The report will be available to download in January 2023. Please send email to *entrepreneurship@ait.ac.th* to get the report.

NOVEMBER 2022





AIT and CIC, Vietnam Sign MoU for Knowledge Transfer and Technical Support

A Memorandum of Understanding (MoU) was signed between the Asian Institute of Technology (AIT) and the CIC Technology and Consultancy JSC (CIC) to enable cooperation for conducting knowledge transfer and technical support activities in the fields of structural engineering and software development.

The activities under the scope of the MoU includes knowledge transfer seminars on topics involving structural engineering (structural performance-based design, wind tunnel testing, and structural health monitoring) and allied fields such as Building Information Modeling (BIM), software applications in structural engineering, and training on CSI software and relevant structural engineering topics for engineers in Vietnam.

Prof. Kazuo Yamamoto, AIT President, highlighted AIT's role as a pioneer institution to help meet the region's growing needs for advanced learning in engineering, science, technology, management, research, and capacity building. Prof. Yamamoto said, "AIT Solution's core strength is structural engineering and software development, which can complement CIC's strength in the application of information technology throughout the construction industry. This collaboration will initiate various joint activities with CIC in conducting knowledge transfer seminars on Building Information Modeling, Structural Engineering, and Software Applications in Structural Engineering. I am confident that this partnership will be mutually beneficial and successful."

Brunel University, UK Visit to AIT-TU Wind Tunnel Facility

The structural engineers from AIT Solutions on 9th November 2022 facilitated the visit of Professor Trevor Hoey, Pro Vice-Chancellor International & Sustainability, Brunel University London, United Kingdom, and Professor Rakesh Kanda, Professor of Exposome Science, Vice Dean International, Brunel University London, United Kingdom, to Asian Institute of Technology and Thammasat University wind tunnel facility.

During the visit, an overview of the wind tunnel test facility was provided to the visitors. Also information on the ongoing research and project work utilizing the wind tunnel facility was shared by AIT Solutions engineers.

NOVEMBER 2022

Experts from Different Countries gather to Discuss the Future of AI

A conference entitled 'AI: The Path Forward from Asian and European Perspective' was organized from 3 to 5 October 2022 at the Asian Institute of Technology.

The event brought together academic institutions, research centers, businesses and corporations from different countries to exchange the latest advances, experiences, and work in data science and AI. Twenty presentations and fifteen poster exhibits were made, highlighting the successful partnership and collaboration among 14 Data Science and Artificial Intelligence (DS&AI) project partners.

Recent advances in Data Science and AI have equipped governments, and industries to revolutionize the economy, transform organizations, and improve services, operations, and decision-making. Stating that the roles, impacts, and benefits of Data Science and AI are evident in the current data-driven economy, AIT President Prof. Kazuo Yamamoto stressed the need to develop talent and capabilities for Data Science and AI to reach their full potential throughout the region.

The event's main highlight were the thematic sessions on industrial, educational, and research issues. In the industry session, industrial experts from Thailand, Sri Lanka, and Indonesia discussed the effects and advantages of Data Science and AI on various business domains.

JUNE 2022

AIT, Microsoft, SCB, and depa Join Alliance to Develop AI Talents and Pioneer Thailand's Economy

Asian Institute of Technology (AIT), Siam Commercial Bank (SCB), Microsoft Thailand, and Digital Economy Promotion Agency (depa) signed a Memorandum of Understanding (MoU) to collaborate on the "Digital Manpower Development" program on June 23rd, 2022. This collaboration aims to develop and prepare future talents in Artificial Intelligence (AI) to meet the demand of the job market and support the new S-Curve businesses and industries to enhance Thailand's digital economy.

The program developed under this MoU is specifically targeted to tackling five fundamental skills in AI, particularly Fundamentals of AI and Cloud Computing in Practice; Machine Learning; Computer Vision; Natural Language Procession (NLP); and Conversation AI. The courses will allow the soon-to-graduate bachelor seniors and recent graduates to maximize their chances of employability by giving them an opportunity to earn "AI on Cloud" certificate through this Public Private Academic Partnership.

Training on Structural Performance-based Design for Engineers from DMCI, Philippines

As part of its knowledge sharing activities, AIT Solutions conducted trainings on Structural Performance-based Design for 12 engineers from DMCI. Philippines. The training was conducted in three batches of four engineers each over a duration of five months. The training comprised of lecture sessions, hands-on project sessions, and visit to structural engineering and wind tunnels facilities.

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