SRI VENKATESWARA COLLEGE OF ENGINEERING
(AUTONOMOUS)

Department of Electronics and Communication Engineering

EDUCATION FOR A BETTER SOCIETY
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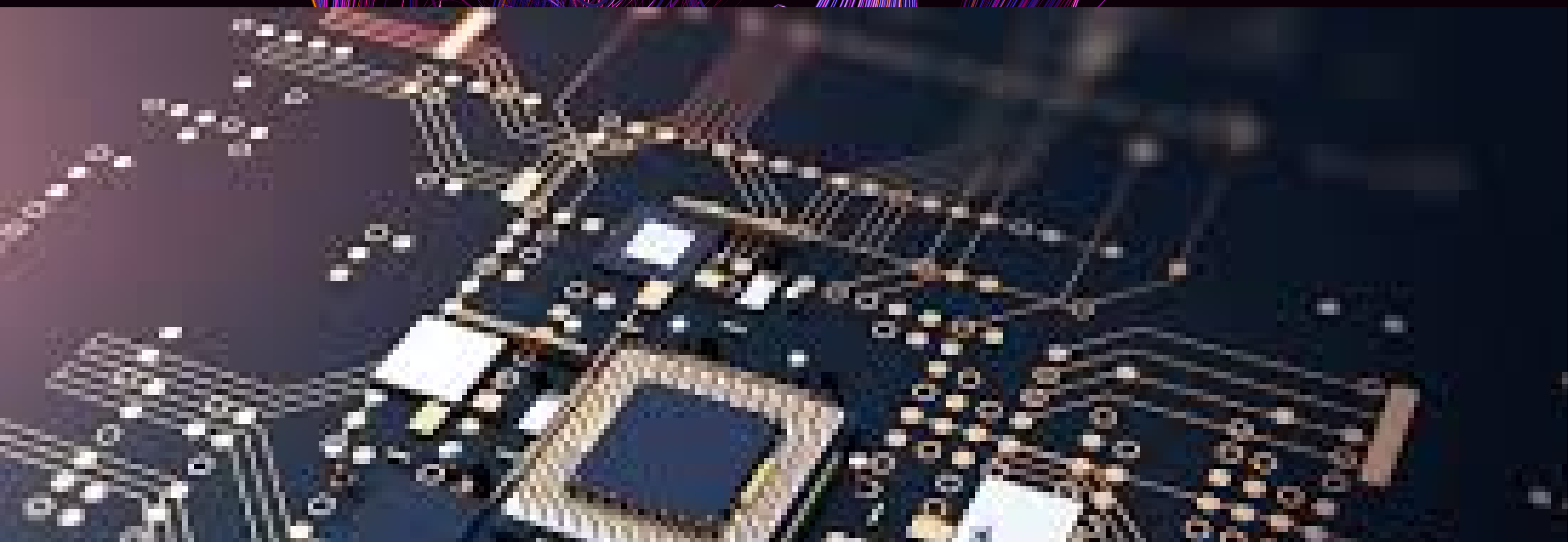
SINCE 1981

RISE MAGAZINE

Recent Innovations In Sophisticated Electronics



DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

RISE-MAGAZINE

Recent Innovations In Sophisticated Electronics

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VOLUME 25 JULY-DEC-2024

DEPARTMENT PROFILE

- Electronics and Communication Engineering has emerged as the major driving force in the present day Information Technology revolution. It is acting as a bridge between different disciplines of engineering and technology. It has penetrated into other prominent sectors such as health care, instrumentation, agriculture, automation, signal processing, remote sensing etc.., The recent developments such as IoT, Artificial Intelligence and the mercurial advancements in the field of communication.

Vision

- To be a focal centre for academic excellence in competing global standards and dynamics in the field of Electronics and Communication Engineering with research and services focusing on effective communication skills, entrepreneurial, ethical and social concern.

Mission

- To impart quality technical education in Electronics and Communication Engineering with well established infrastructure, state of the art laboratories, core instructions and cognizant faculty.
- To prepare the young and dynamic Electronics and Communication Engineers professionally deft and intellectually adept with knowledge, behaviour and information competency.
- To enable the learners for changing trends in the field of Electronics and Communication Engineering with a focus on career guidance, placements and higher education by Industry-Institute relationship.

PROGRAM EDUCATIONAL OBJECTIVES

PEO1: Graduates should be cognizant in basic science, fundamental engineering stream along with core related domains in ECE and Allied fields.

PEO2: Graduates should understand issues related to design, problem solving, and intellectually adept with knowledge, behavior and information competency.

PEO3: Graduates should demonstrate their technical, communication, research, aptitudes along with leadership skills in professional environment to empower employability, higher education and entrepreneurs successfully through industry-institute interaction.

PEO4: Graduate should be motivated with high ethical, human values and team work towards development of the societ.

PROGRAM OUTCOMES

PO1: ENGINEERING KNOWLEDGE: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: PROBLEM ANALYSIS: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: DESIGN/DEVELOPMENT OF SOLUTIONS: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: CONDUCT INVESTIGATIONS OF COMPLEX PROBLEMS: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: MODERN TOOL USAGE: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: THE ENGINEER AND SOCIETY: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: ENVIRONMENT AND SUSTAINABILITY: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: ETHICS: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: INDIVIDUAL AND TEAM WORK: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: COMMUNICATION: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: PROJECT MANAGEMENT AND FINANCE: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: LIFE-LONG LEARNING: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES

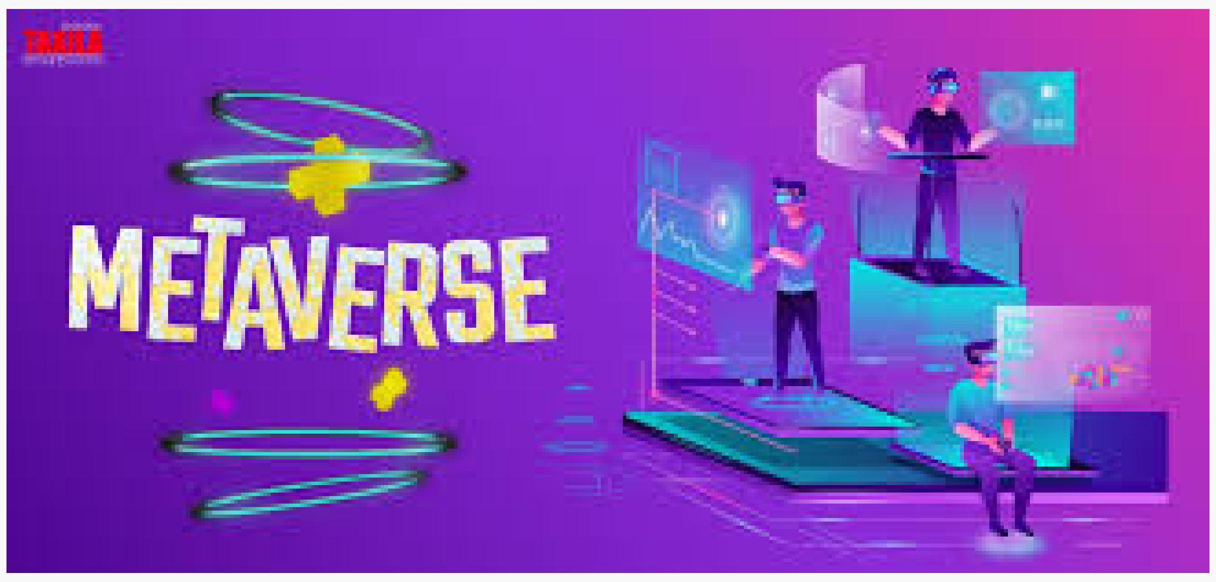
PSO1: An ability to get an employment in Electronics and Communication Engineering field and related industries and to participate & succeed in competitive examinations like GRE, GATE,TOEFL, PSUs, etc.

PSO2: Should be able to design and test various electronic systems that perform analog and digital processing functions.

Metaverse

With the rapid development of digital technology, all areas of society may accelerate their entry into the virtual world, thus blurring the boundary between the physical and digital worlds and promoting a Metaverse. The Metaverse will become an important public infrastructure. This paper first introduces the concept of Metaverse, including the origin and development of Metaverse, the concept of Metaverse, and the key features of Metaverse. Then, the construction of Metaverse is analyzed from various aspects such as technical support, current progress as well as feasibility, and limitations. Finally, it is concluded that Metaverse is a new windfall for the future development of the Internet, and further development of Metaverse needs to be realized from multiple perspectives, such as industrial investment, regulation, industry integration, and technological breakthroughs. The Metaverse is a virtual world that incorporates all aspects of digital technology, including video conferencing, games such as Minecraft or Roblox, cryptocurrency, email, virtual reality, social media, and live streaming. In the past, the Metaverse was stuck in the concept stage. With the digital age and the constant development of Internet giants, the distance between virtual concepts and reality is shrinking.

Since ancient times, people have always had a good wish for life, and people always want to transform their life to make them better. In 1992, Neal Stephenson's science fiction snow crash described a world parallel to the real world, in which people can live a different life from the real world. With the development of technology, the fantasies in snow crash gradually become more real. To achieve the operation of this virtual world, people need the support of a variety of reality technologies, such as the development of AR devices, which makes it easier for people to enter the virtual world, shorten the distance between virtual and display, and have a more sense of substitution. The development of VR devices also makes it easier for people to cross the physical distance of the real world and connect.



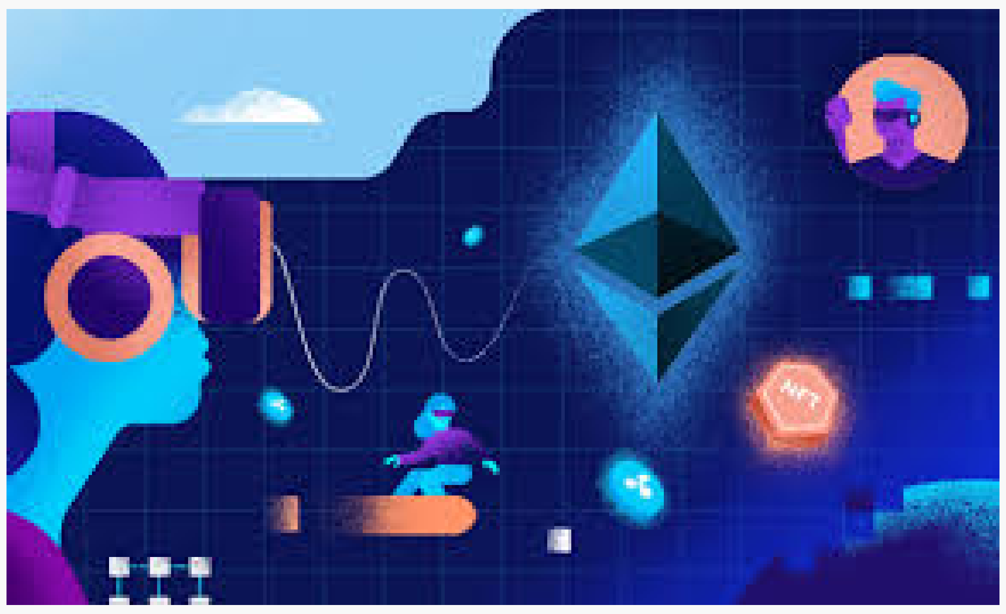
Metaverse has received a lot of attention from the investment community, but there are still issues limiting its growth. Dionisio et al. Argued that the first pertains to current limits in computational methods related to virtual worlds. The second is economic and political barriers. Bourlakis et al. pointed out that the urgent need for policy-making. Specifically, if the retailers selling in the second life do not transfer their funds outside the virtual world, whether their professionals will be taxed and how to ensure the good operation of meta universe retailers is a very key issue. Thus, several questions regarding the limitations of Metaverse remain to be addressed.

Several theories have been proposed to the application areas of Metaverse. Bourlakis et al. claimed that the introduction of Metaverse is an important extension of the traditional retail business environment. Duan et.al. focused on university campuses and discussed Metaverse how applied on campus. Duan et.al. focused on university campuses and discussed Metaverse how applied on campus. MacCallum and Parsons focus on AR and Metaverse on the learning aspect. Besides, Siyaev, A., & Jo focus on the application of new technology in aircraft maintenance. Based on the research of scholars, this paper will propose a new path for the future development of the Metaverse, namely industry convergence.

From the perspective of the current development of the Metaverse, it is still in the initial stage and has high development potential. To further understand the Metaverse and find its advantages and problems, it is going to sort out the status quo of the meta-universe and find its current achievements and future directions to support its better development.

"Meta universe" originates from games, surpasses games, on the one hand, the infrastructure and framework of "meta universe" dominated by games tend to be mature; On the other hand, the boundary between games and reality began to melt. The creator was only the earliest player, not the owner. The rules were decided by the community.

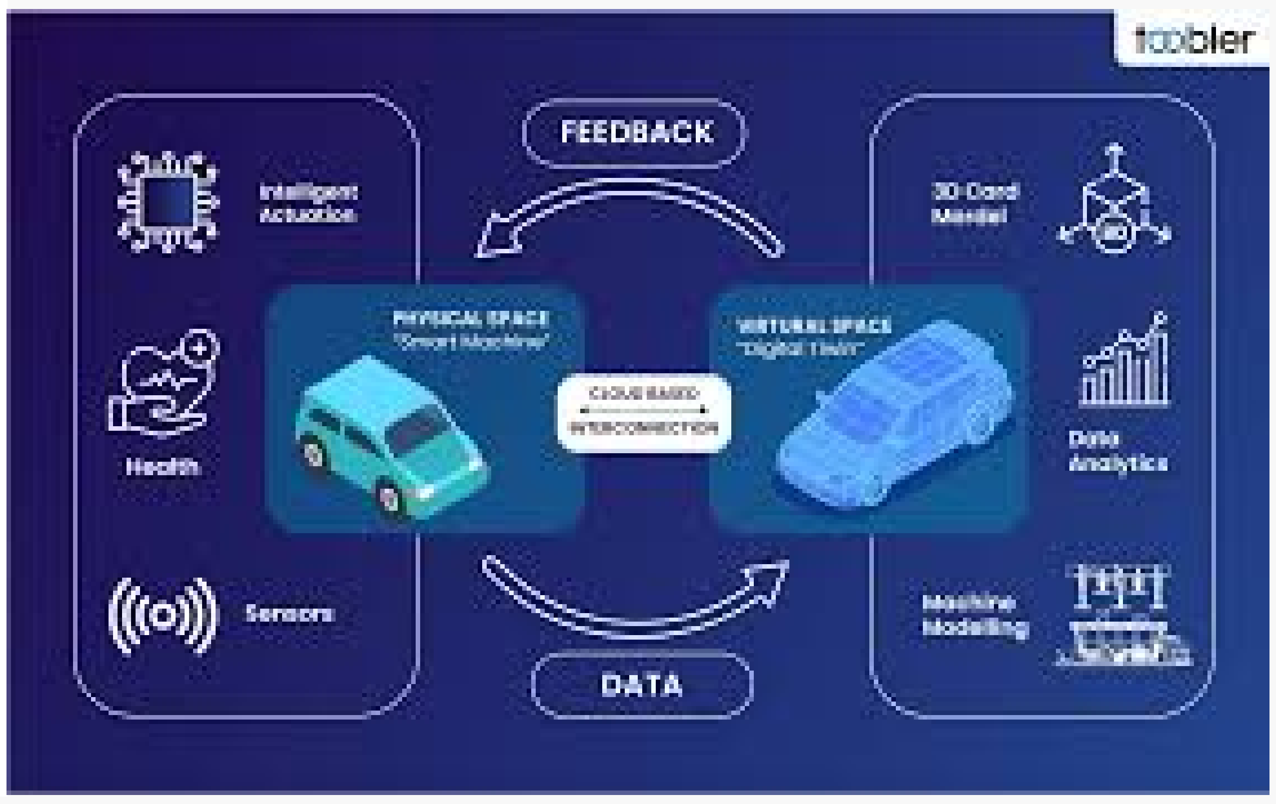
--------------23BFA04509- V Usha Sree



Digital Twins

Digital Twin technology is an emerging concept that has become the centre of attention for industry and, in more recent years, academia. The advancements in industry 4.0 concepts have facilitated its growth, particularly in the manufacturing industry. The Digital Twin is defined extensively but is best described as the effortless integration of data between a physical and virtual machine in either direction. The challenges, applications, and enabling technologies for Artificial Intelligence, Internet of Things (IoT) and Digital Twins are presented. A review of publications relating to Digital Twins is performed, producing a categorical review of recent papers. The review has categorised them by research areas: manufacturing, healthcare and smart cities, discussing a range of papers that reflect these areas and the current state of research. The paper provides an assessment of the enabling technologies, challenges and open research for Digital Twins.

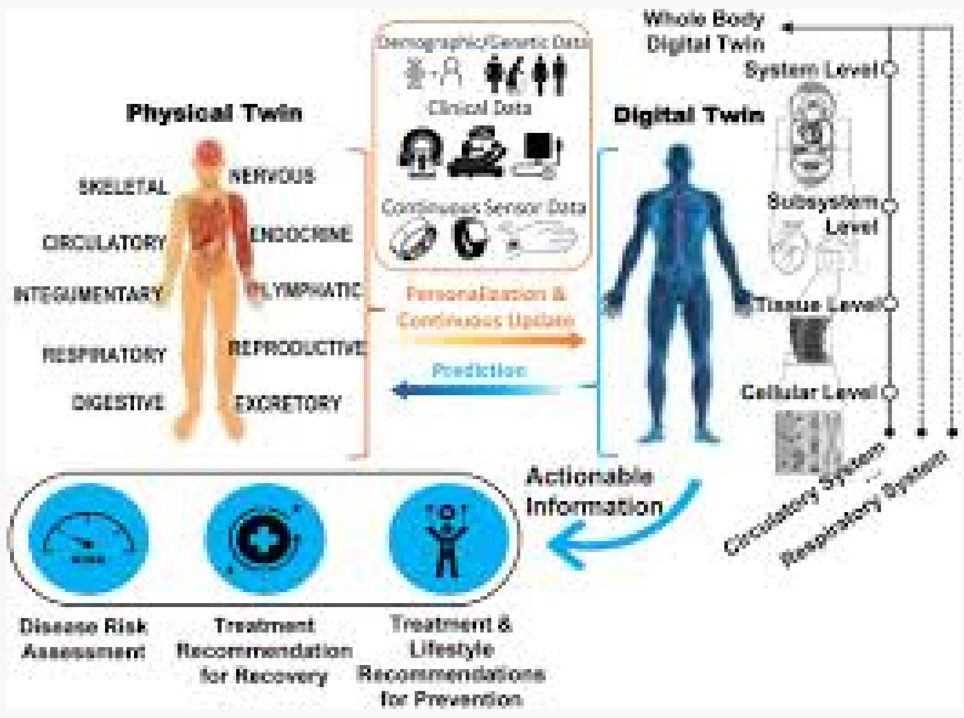
Digital Twin is at the forefront of the Industry 4.0 revolution facilitated through advanced data analytics and the Internet of Things (IoT) connectivity. IoT has increased the volume of data usable from manufacturing, healthcare, and smart city environments. The IoT's rich environment, coupled with data analytics, provides an essential resource for predictive maintenance and fault detection to name but two and also the future health of manufacturing processes and smart city developments, while also aiding anomaly detection in patient care, fault detection and traffic management in a smart city. The origins of the Digital Twin are set out in this section. The review sets out clear definitions while also looking at some of the misconceptions found with wrongly identified Digital Twins. Formal ideas around Digital Twins have been around since the early 2000s. That said, it may have been possible to define Digital Twins earlier owing to the ever-changing definitions.

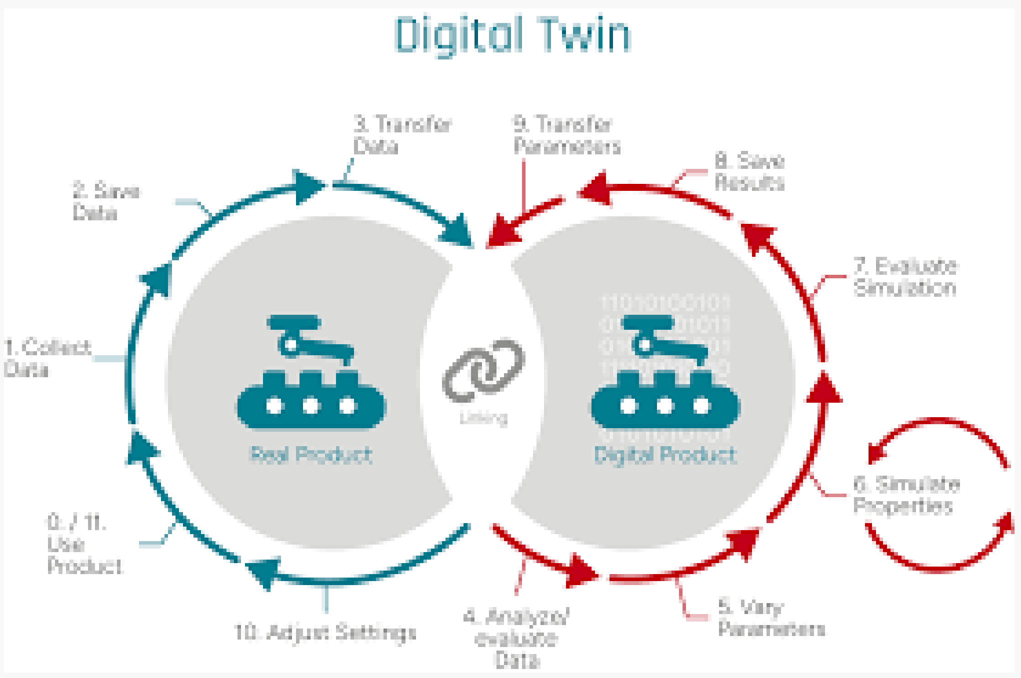


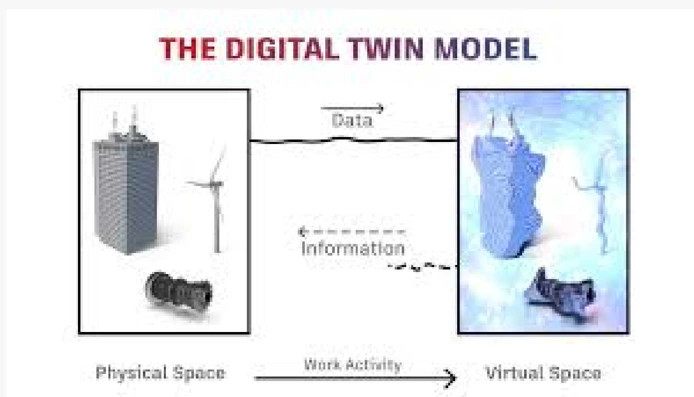
The first terminology was given by Grieves in a 2003 presentation and later documented in a white paper setting a foundation for the developments of Digital Twins. The National Aeronautical Space Administration (NASA) released a paper in 2012 entitled "The Digital Twin Paradigm for Future NASA and U.S. Air Force Vehicles", setting a key milestone for defining Digital Twins.

A digital model is described as a digital version of a preexisting or planned physical object, to correctly define a digital model there is to be no automatic data exchange between the physical model and digital model. Examples of a digital model could be but not limited to plans for buildings, product designs and development. The important defining feature is there is no form of automatic data exchange between the physical system and digital model. This means once the digital model is created a change made to the physical object has no impact on the digital model either way.

General Electric (GE) first documented its use of a Digital Twin in a patent application in 2016. From the concept set out in the patent, they developed an application called the "Predix" platform which is a tool for creating Digital Twins. Predix is used to run data analytics and monitoring. In recent years, GE has scaled back their plans for a Digital Twin, planning to focus on their heritage as an industrial multinational rather than a software company. Siemens, however, has developed a platform called "MindSphere" which has embraced the Industrial 4.0 concept with a cloud based system that connects machines and physical infrastructure to a Digital Twin. It uses all the connected devices and billions of data streams with the hope of transforming businesses and providing Digital Twin solutions.







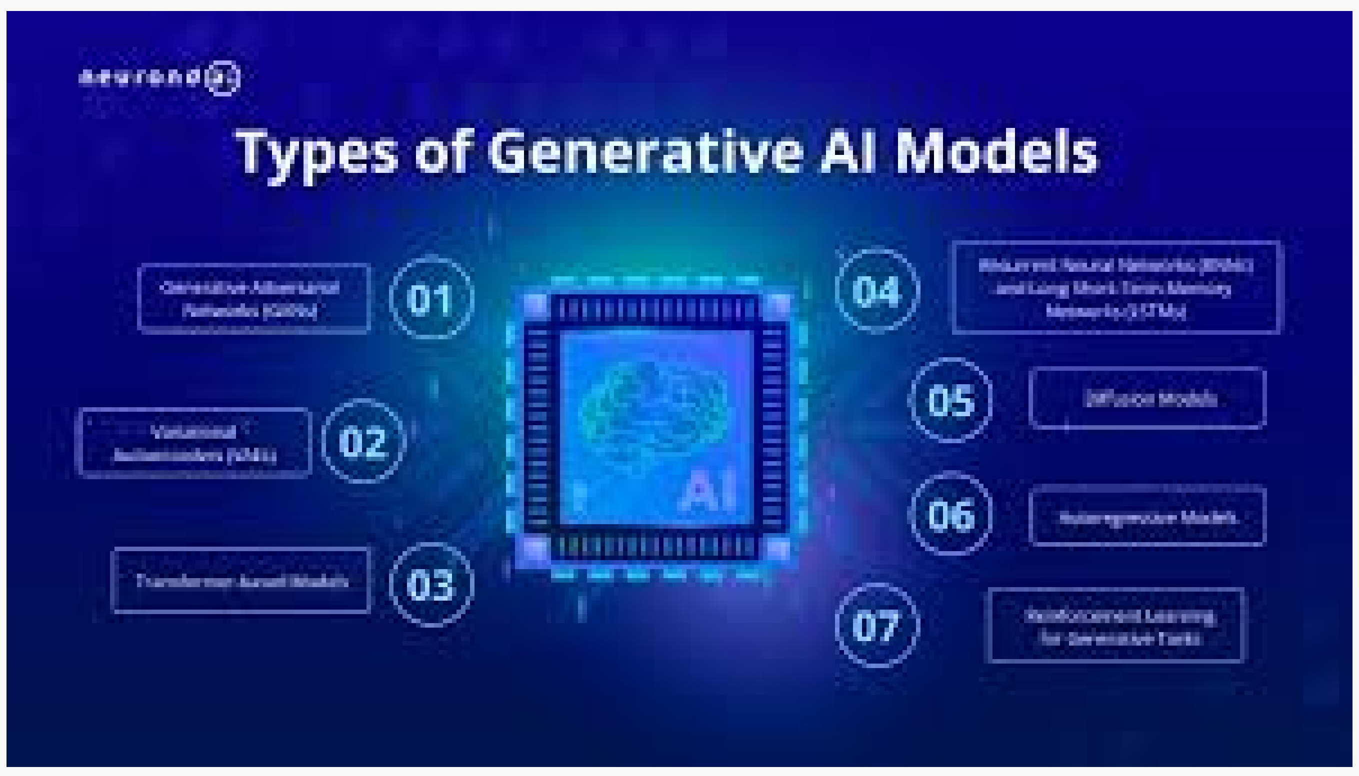
It is becoming more evident that Digital Twin runs in parallel with AI and IoT technology resulting in shared challenges. The first step in tackling the challenges is to identify them. Some of the common challenges are found with both data analytics and the Internet of Things, and the end aim is to identify shared challenges for Digital Twins.--**23BFA04522- Y Sandhya**

Generative AI

Generative artificial intelligence (GenAI) tools are an emerging class of new-age artificial intelligence algorithms capable of producing novel content in varied formats such as text, audio, video, pictures, and code based on user prompts. Recent advances in machine learning (ML), massive datasets, and substantial increases in computing power have propelled such tools to human-level performance on academic and professional benchmarks , 1 comparable to the ninetieth percentile on the SAT and the bar exam.

This rapid progress has led many to to believe that the metamorphosis of these technologies 2 from research-grade demos to accessible and easy-to-use production-grade goods and services carries the potential to supercharge business processes and operations while enabling entirely new deliverables heretofore rendered infeasible by economic or technological factors. It took OpenAI's ChatGPT, a conversational web app based on a generative (multimodal) language model, about five days to reach one million users (compared to 2.5 months for 3 Instagram). On the business side, the Economist reports that the number of jobs mentioning AIrelated skills quadrupled from 2022 to 2023. This enthusiasm has not gone unmet by investors. Generative AI startups reportedly raised 600% more capital in 2022 than in 2020 .

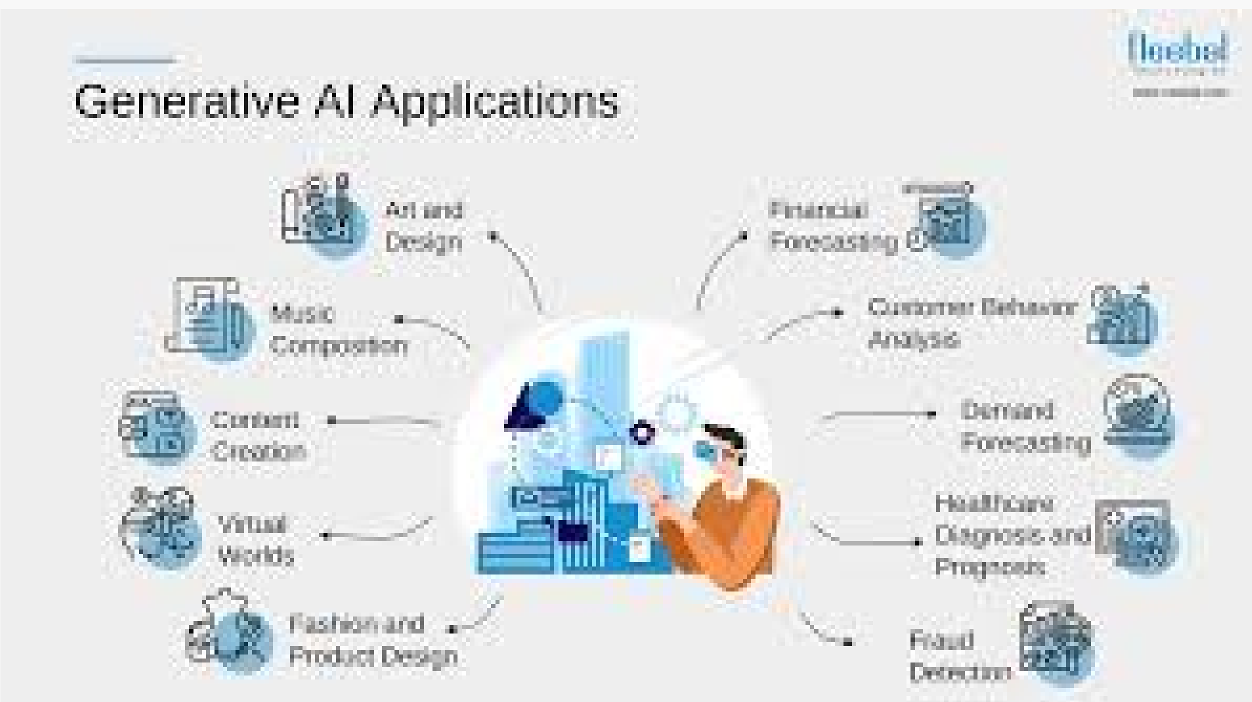
What are these new-era AI technologies? How do they function? What principles do they operate on? What makes them different than already-hyped-up conventional machine learning (ML) models? For what tasks is this class of technology most impactful? What future advances might one look forward to? These are the questions this report attempts to shed some light on. The report will also tease out how this understanding foundationally informs the best uses (and misuses) of GenAI in applied contexts.

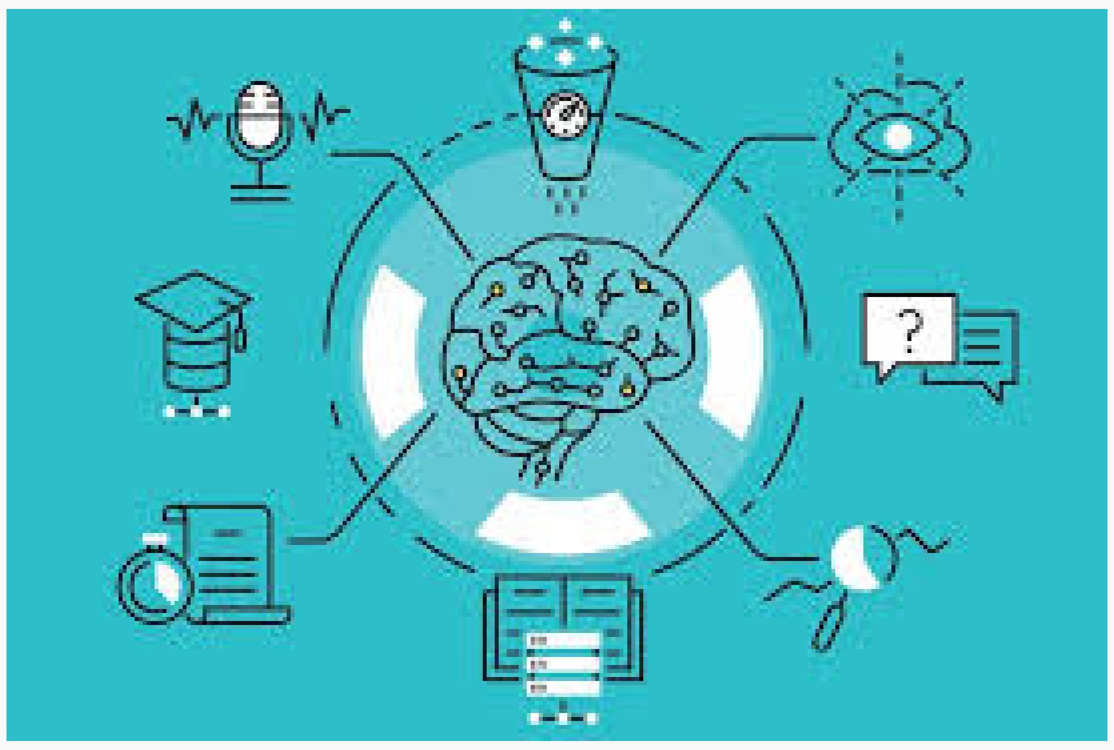


A word of disclaimer: this gradient of topics also means that, while the initial sections deal with factual, if somewhat simplified, nuts-and-bolt workings of such models, the later sections delve into hopefully reasonable, but in a manner that only time may attest to, extrapolations and speculations, as necessitated by the developing nature of this technology and its current phase in the technology adoption cycle.

While generative AI models come in many different shapes, utilizing varied statistical and computational techniques to target various modalities, ranging from code and text to audio and video, this report focuses almost exclusively on large language models (LLMs) capable of generating novel text from textual prompts. This choice is partly due to the substantial lead LLMs have in driving the overall usage of generative AI models and partly due to the centrality 5 of language in formulating and addressing commonplace information-processing tasks. That said, image- and code-based GenAI models have already witnessed successful commercial product deployment, for example, by Adobe for creating visual content and by Github as a programming assistance tool.

Given the success of language models, there has been increased interest in the possibility of recreating the magic of LLMs in other domains. Such models, generically termed foundation models, attempt to amortize the cost of limited-data downstream tasks by pre-training on large corpora of broadly related tasks or unlabelled datasets. For example, one might be able to repurpose the LLM paradigm to train a generalist robot or decision-making agent that learns from supply chain operations across all industries.





This report contextualizes large-language models within the more extensive machine learning and artificial intelligence landscape by training the origins of the principal ideas that fuel today's large language models.

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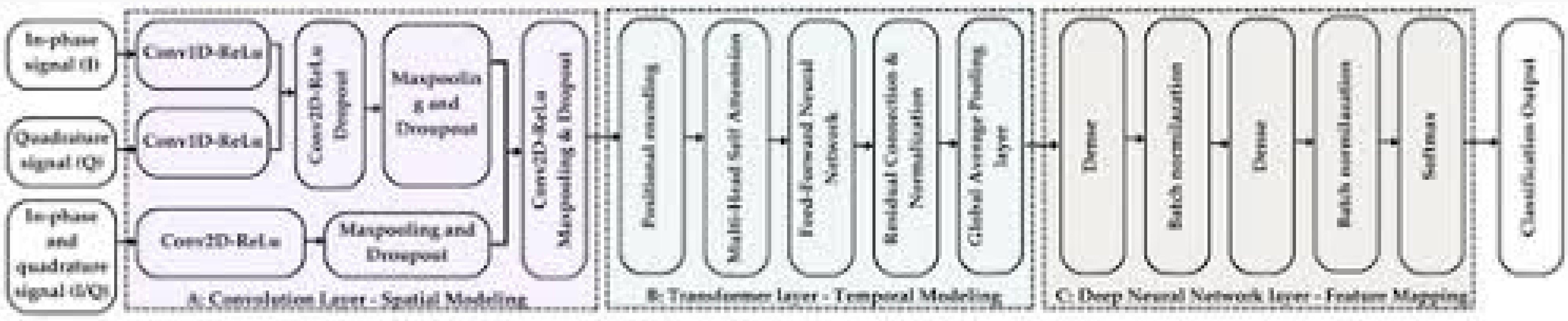
Hybrid Convolutional Transformer Classifier for Automatic Modulation Recognition

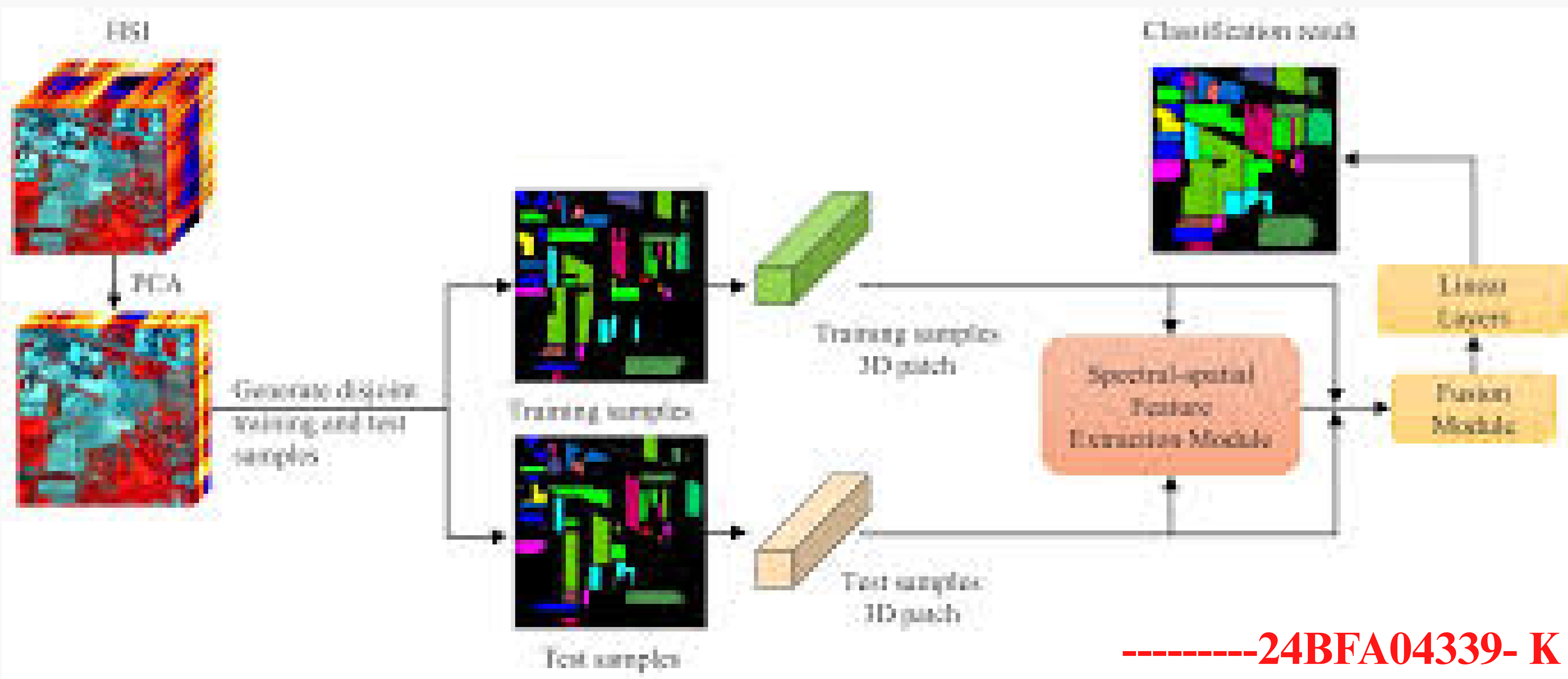
Automatic modulation recognition (AMR) methods used in advanced wireless communications systems can identify unknown signals without requiring reference information. However, the acceptance of these methods depends on the accuracy, number of parameters, and computational complexity. This study proposes a hybrid convolutional transformer classifier (HCTC) for the classification of unknown signals. The proposed method utilizes a three-stage framework to extract features from in-phase/quadrature (I/Q) signals. In the first stage, spatial features are extracted using a convolutional layer. In the second stage, temporal features are extracted using a transformer encoder. In the final stage, the features are mapped using a deep-learning network. The proposed HCTC method is investigated using the benchmark RadioML database and compared with state-of-the-art methods.

The experimental results demonstrate that the proposed method achieves a better performance in modulation signal classification. Additionally, the performance of the proposed method is evaluated when applied to different batch sizes and model configurations. Finally, open issues in modulation recognition research are addressed, and future research perspectives are discussed. Automatic modulation recognition (AMR) involves automatically categorizing the modulation type from received complex-valued raw radio signals without any prior understanding of the signal information or channel properties. In modern communications and ignal-processing systems, AMR guarantees reliable communication in diverse wireless environments, increases spectral efficiency, and improves signal detection. However, the radio environment is becoming more chaotic because of recent advancements in wireless communications technologies, making AMR more challenging.



Conventional AMR techniques can be divided into two basic categories: feature based (FB) and probabilistic likelihood based (LB). LB methods use the likelihood function for each signal and model multiple hypotheses based on the number of signal types. The performance of the classifier is obtained using the likelihood ratio test. In contrast, FB methods involve the extraction of meaningful features from the received signal that are then used for classification. Typical LB methods include the average likelihood ratio test (ALRT), generalized likelihood ratio test (GLRT), and hybrid likelihood ratio test (HLRT). Common types of features used in FB methods include higher-order statistical features, cyclic features, constellation shapes, entropy features and transform domain features.

The HCTC model, referred to as the Hybrid Convolutional Transformer Classifier model, is proposed in this work for modulation classification and shows significant classification performance. The proposed HCTC model explores the use of a convolutional layer, a transformer encoder, and a DNN for the extraction of spatial and temporal features from I/Q sequences. The proposed model was evaluated using the benchmark RadioML database, and its performance was compared with those of 14 widely used algorithms. The performance evaluation metrics included recognition accuracy across SNRs, confusion matrices, and the numbers of parameters used for training and FLOPs. The experimental results demonstrate that the proposed HCTC model achieves a better performance in the classification of the modulation signal. In addition, the proposed HCTC method was studied for different batch sizes and model configurations. In future studies, ensemble hybrid DL methods and image representation models for modulation recognition should be developed.



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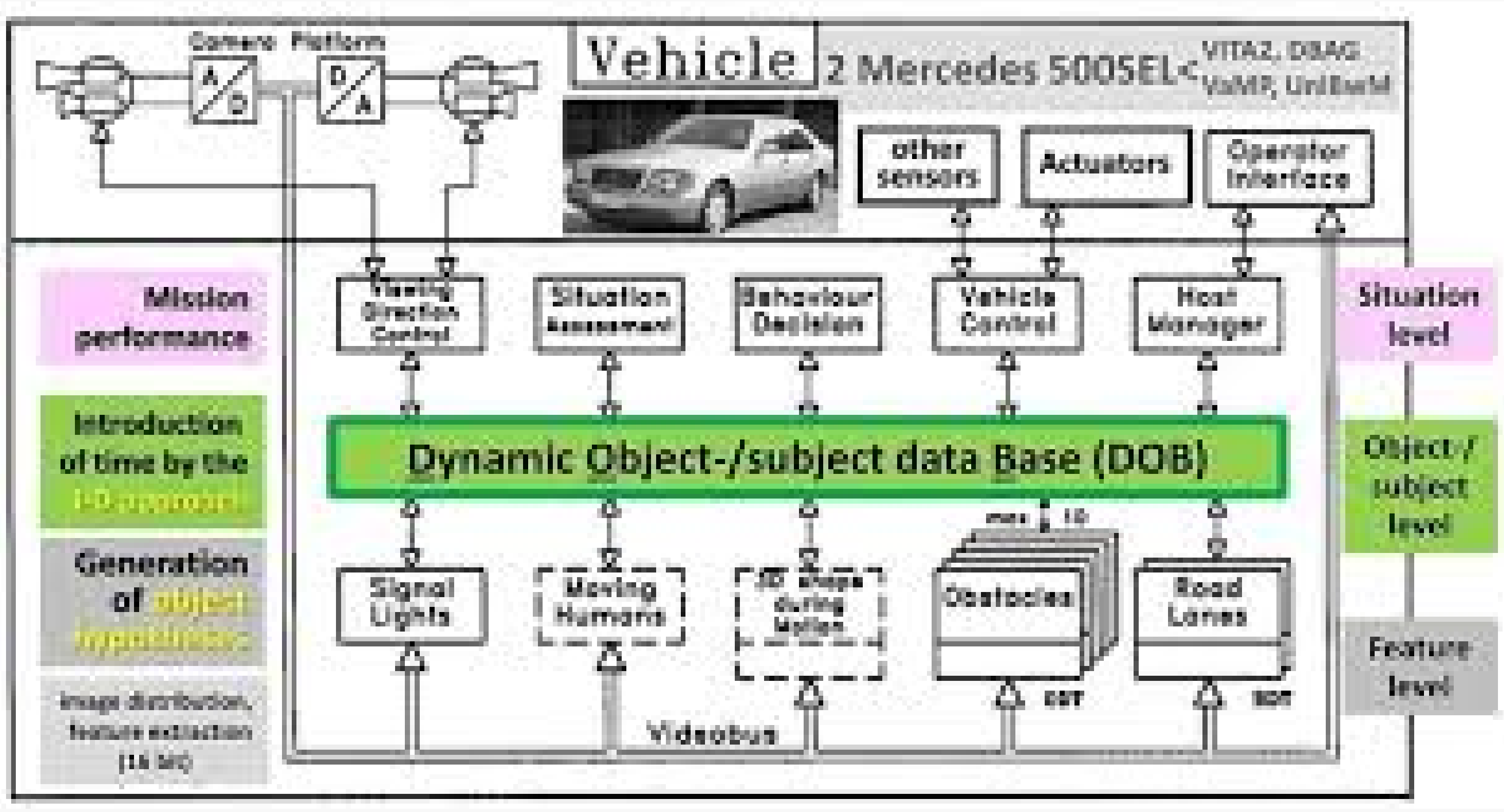
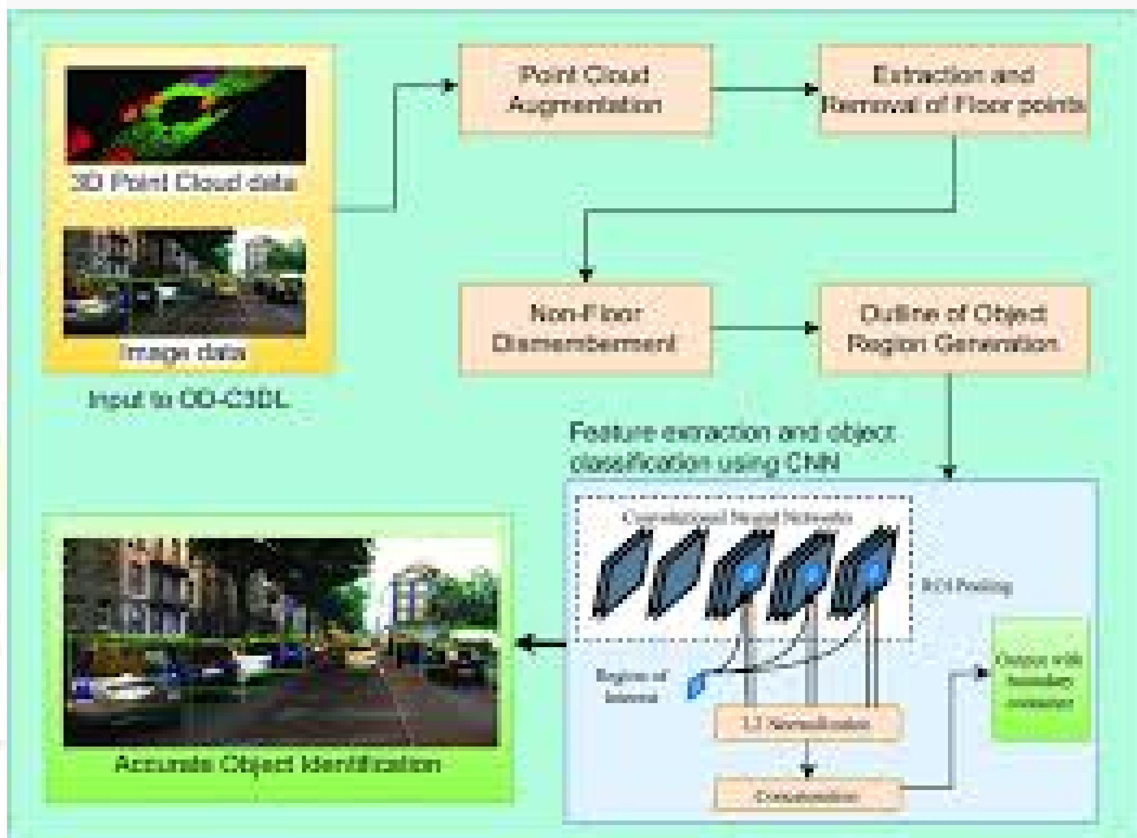
Evolution of the “4-D Approach” to Dynamic Vision for Vehicles

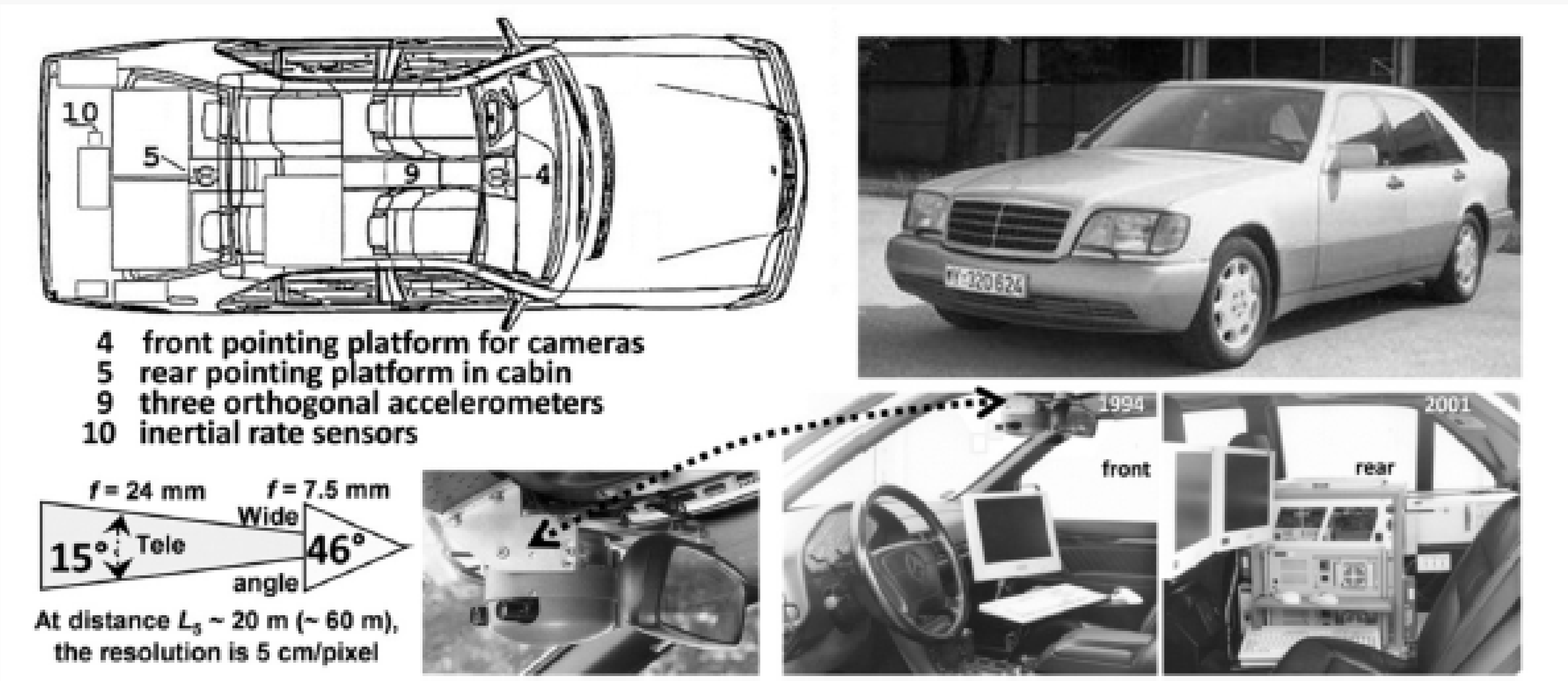
Spatiotemporal models for the 3-D shape and motion of objects allowed large progress in the 1980s in visual perception of moving objects observed from a moving platform. Despite the successes demonstrated with several vehicles, the “4-D approach” has not been accepted generally. Its advantage is that only the last image of the sequence needs to be analyzed in detail to allow the full state vectors of moving objects, including their velocity components, to be reconstructed by the feedback of prediction errors. The vehicle carrying the cameras can, thus, together with conventional measurements, directly create a visualization of the situation encountered. In 1994, at the final demonstration of the project PROMETHEUS, two sedan vehicles using this approach were the only ones worldwide capable of driving autonomously in standard heavy traffic on three-lane Autoroutes near Paris at speeds up to 130 km/h (convoy driving, lane changes, passing).





Up to ten vehicles nearby could be perceived. The three-layer architecture of the perception system is reviewed. At the end of the 1990s, the system evolved from mere recognition of objects in motion, to understanding complex dynamic scenes by developing behavioral capabilities, like fast saccadic changes in the gaze direction for flexible concentration on objects of interest. By analyzing motion of objects over time, the situation for decision making was assessed. In the third-generation system “EMS-vision” behavioral capabilities of agents were represented on an abstract level for characterizing their potential behaviors. These maneuvers form an additional knowledge base. The system has proven capable of driving in networks of minor roads, including off-road sections, with avoidance of negative obstacles (ditches).

The development of digital microprocessors (µPs) started in the 1970s; since then, growth in performance of about one order of magnitude every 4 to 5 years has been observed. The volume and power needed for a computer system stayed about the same, so that the system could fit into a (ground) vehicle. Studying computer vision for guidance of ground vehicles started in the 1960s in the USA; the chapter cited gives a brief history of early activities in the field. When the author in 1975 received a call to a newly founded university in Munich, he decided to build a "Hardware-In-the-Loop" (HIL) simulation laboratory for developing the sense of vision for vehicles in general. This unusual step has paid off in the next decades. The first PhD thesis on vision for a road vehicle with this simulation loop appeared in 1982. Details on the 4-D approach may be found. In 1984, the first real test vehicle, a 5-ton van, was purchased and equipped as a test vehicle for autonomous mobility and computer vision: VaMoRs. In 1987, it drove fully autonomously on a free stretch of the new Autobahn A94 near Dingolfing with speeds up to the maximum of the vehicle: 96 km/h. After this demonstration, computer vision was accepted for both longitudinal and lateral control in the EUREKA-project PROMETHEUS from 1987 until 1994, replacing electromagnetic fields from buried cables for lateral guidance.



It is interesting to note that feedback of prediction errors has recently become a topic in cognition in the fields of psychology and philosophy. It would be interesting to check whether EMS-vision combined with neural net methods could merge the positive aspects of both approaches.

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