Digital Twin of Embedded System using Real- Time Sensor Mirroring

Andrix Vinusha G
UG Scholar Department of ECE
Erode Sengunthar Engineering College
Erode,India
v2vinusingh@gmail.com

Hemaniverthane C R
UG Scholar Department of ECE
Erode Sengunthar Engineering College Erode,India hemaniverthane2005@gmail.com

Karthiga M
UG Scholar Department of ECE
Erode Sengunthar Engineering College Erode,India karthiga.murugesan46@gmail.com

Dr.Bharathidasan S
Associate Proffesor Department of ECE
Erode Sengunthar Engineering College
Erode,India
esecbharathi@gmail.com

How to Cite this Article:

G, A. V., R, H. C. & M, K. (2026). Digital Twin of Embedded System using Real- Time Sensor Mirroring. International Journal of Creative and Open Research in Engineering and Management, <i>02</i>(04). https://doi.org/10.55041/ijcope.v2i4.496

https://doi.org/10.55041/ijcope.v2i4.496

Abstract - Digital binary tech is honestly a little wild it connects the real world to digital systems in ways that feel straight out of science fiction. In this paper, we get into how to actually build and design a digital twin for embedded systems. The whole idea? Capture exactly what the sensors pick up, right as it happens. That way, you can track everything, really see what's going on, and catch issues before they blow up. We collect real-time data from all kinds of sensors temperature, vibration, voltage, current, SpO2, you name it. All that info gets processed and zipped through secure IoT channels, then the digital twin gets to work. There's a cloud-based dashboard that shows exactly what's happening in the system, live. So you always know how things are running no second guessing. Think of the digital twin as the system's smart shadow. It crunches sensor data with algorithms, predicts when something's about to fail, and keeps checking nonstop. So, you spot problems early, without shutting anything down. The result? Better performance, less downtime, and fewer nasty surprises. This setup is perfect for places like factories and hospitals, where the sensor data never lets up. When we tested it, the real system and its digital twin stayed perfectly in sync, working together with zero fuss. We saw more reliability, faster problem detection, and remote monitoring was way easier. By mixing embedded smarts with predictive analytics, the digital twin makes these systems smarter, safer, and more efficient keeping them ready for whatever today throws their way.

Key words- Digital Twin, Embedded Systems, ESP32, IoT, Predictive Maintenance, Real-Time Monitoring, Sensor Mirroring.

I. LITERATURE SURVEY

the digital twin technology is really changing the way we monitor and control things it started with the idea of making a copy of real things a digital twin is like a computer version that talks to the real thing in real time this means the people who design systems can watch what is happening try out things and figure out if something might go wrong before it actually does the digital twin technology is very useful because it helps us understand how things work and what might happen to them the digital twin is a part of this and it is helping us make better systems the internet of things and sensors and embedded systems have been used together for a time this has made twin technology something that people are more used to it is seen as a way to do things that actually works in the world especially in industries and healthcare digital twin technology is becoming more popular because of this in the beginning digital twins were used in health systems to help doctors keep an eye on health and manage medical equipment health systems used sensors that could connect to the internet to collect information about peoples bodies like their temperature heart rate and oxygen levels this information was then sent to a computer model that was stored online this way doctors and medical staff could look at health information from far away and see everything clearly.

It helped them take action before anything bad happened to the patients and their digital twins however the early systems had limitations in terms of latency accuracy of data and lack of embedded processor integration with recent advancements in digital twin technologies and their growing sophistication we now have access to a number of cloud-based solutions for creating digital twins these digital twin platforms are filled with lots of data that can be quickly analyzed on a real-time basis via the cloud by pooling data from many devices and is able to present all of this information in various ways at the same time the cloud also makes it possible for us to leverage fantastic new capabilities that allow us to perform complex calculations quickly and easily to increase the capacity of our work being done the drawback to using a digital twin platform is that it needs to have a continuous state of connectivity to be able to operate therefore when an internet connection is lost .

the digital twin platform now doesn't have access to its data it thus can lead to slow decision-making and inaccurate decisions when using a digital twin platform with less automated devices machines such as reducing the factors that caused digital twin platforms to have long development cycles through adding basic machine learning algorithms into digital twins predictive analytics to use predictive analytics to determine when there will be a failure of prediction based on historical analytical sensor data to predict the operation of a digital twin resulting in increased reliability of the digital twin platforms however developing them was expensive from a resource standpoint and therefore required advanced hardware-based infrastructure.

Another crucial research topic was how to leverage digital twins as a tool to sense both emotional and physiological states. These were accomplished with biometrics. Biometrics were used to measure a person's emotional status, stress levels and physiological response to various stimuli. This included capturing data from facial expressions, variability in heart rate & blood pressure, and the amount of oxygen in the blood to create a digital representation (a digital twin) of that person's emotional state. This application demonstrated how flexible digital twin technology was; however, its capability was still limited to applications in human-centered areas as opposed to applications in the industrial & embedded domains, where machines utilized in conjunction with the environment existed. After that, researchers developed robotic digital twins, integrating IoT and IoRT; this type of model consisted of robots with multiple sensors and communication systems that allowed them to connect with digital models in order to be able to monitor and provide remote assistance to both patients and caregivers.

They were extremely precise and autonomous, but they required very expensive robotic systems along with complex networking architectures, meaning their deployment was limited to high-cost embedded uses. Simultaneously as the development of the original healthcare application, the introduction of industrial automation was also becoming more comfortable with adopting digital twin concepts, both in manufacturing and in energy generation. The digital twins were employed to monitor machine health and diagnose potential failure modes with respect to machines through sensors such as vibration, temperature and current. Researchers looked at architectures in the past. These hybrid architectures brought together edge and cloud computing to make twin systems. The hybrid architecture made it possible for important calculations to happen at the edge. At the time the cloud handled long term data storage, analysis and management Hybrid architectures were more reliable They needed a lot of coordination, between different layers.

This made the whole system more complicated. The hybrid architectures were still an option because they were more reliable.. The complexity of the hybrid architectures was a problem. Hybrid architectures and their complexity were a challenge. Most of these models were made for systems that are used in factories and things like that. These models were not made for systems that are part of other things. The models are usually used in installations not in small embedded systems, like the ones we have now.

The second big area of research was about keeping equipment running smoothly with maintenance. This is done using Internet of Things and digital twin technologies. So Internet of Things-based twins use sensors to get information about how much stress equipment is under how hot it is and if it is vibrating too much. This information is used to figure out if something is going to break. By adding Internet of Things modules people can check and control equipment from far away. These methods are good at fixing equipment after something has gone wrong. They are not as good at constantly checking equipment to prevent problems before they happen with digital twin technology.

Predictive maintenance with twin technology is important, for keeping equipment running smoothly. Digital twins have been used in different areas over the years. These areas include healthcare and aviation and smart cities and automotive systems Digital twins are used in each of these areas. But what is really interesting about twins is that they bring together the physical world and the virtual world. This means that digital twins connect the data from the real world with a virtual version of that data in a simulation environment. Digital twins make it possible to have a collaboration, between the virtual worlds of digital twins.

This provides a means for more efficient and cost-effective model development/testing/optimizing using a virtual model without the requirement to physically modify the system, therefore improving the safety of those systems. However, an unaddressed issue exists with respect to the use of digital twins for embedded applications.

Researchers looked at architectures in the past. These hybrid architectures brought together edge and cloud computing to make twin systems. The hybrid architecture made it possible for important calculations to happen at the edge. At the time the cloud handled long term data storage, analysis and management. Hybrid architectures were more reliable.. They needed a lot of coordination, between different layers. This made the whole system more complicated. The hybrid architectures were still an option because they were more reliable.. The complexity of the hybrid architectures was a problem. Hybrid architectures and their complexity were a challenge. Most of these models were made for systems that are used in factories and things like that.

These models were not made for systems that are part of other things. The models are usually used in installations not in small embedded systems, like the ones we have now. The second big area of research was about keeping equipment running smoothly with maintenance. This is done using Internet of Things and digital twin technologies. So Internet of Things-based twins use sensors to get information about how much stress equipment is under how hot it is and if it is vibrating too much. This information is used to figure out if something is going to break. By adding Internet of Things modules people can check and control equipment from far away. These methods are good at fixing equipment after something has gone wrong. They are not as good at constantly

checking equipment to prevent problems before they happen with digital twin technology.

Predictive maintenance with twin technology is important, for keeping equipment running smoothly. Digital twins have been used in different areas over the years. These areas include healthcare and aviation and smart cities and automotive systems. Digital twins are used in each of these areas. But what is really interesting about twins is that they bring together the physical world and the virtual world. This means that digital twins connect the data from the real world with a virtual version of that data in a simulation environment.
Digital twins make it possible to have a collaboration, between the virtual worlds of digital twins. This provides a means for more efficient and cost-effective model development/testing/optimizing using a virtual model without the requirement to physically modify the system, therefore improving the safety of those systems. However, an unaddressed issue exists with respect to the use of digital twins for embedded applications.

II. SYSTEM DESCRIPTION

The proposed system aims to create and implement a Digital Twin of Embedded Systems that can mirror the status of the physical system in real-time. This architecture defines the interaction between the physical world and its digital twin using sensor networks, an ESP32 microcontroller, IoT communication, and cloud visualization. The main aim is to enable real-time monitoring, predictive maintenance, and decision-making without the need for physical intervention.

The proposed system integrates hardware and software components to sense, process, and analyze data in real-time. The hardware components include physical sensors that measure environmental and system parameters. The software components include cloud and digital twin platforms that visualize and analyze data trends. They work together to create an intelligent environment where all changes in the physical machine are reflected instantly in the digital twin.

The architecture of the system under consideration is organized into a four-layer structure: the Physical Layer, Edge Layer, Cloud Layer, and Digital Twin Layer. Each layer has specific tasks to perform, which work together to ensure the proper flow of data between the physical and digital worlds.

Fig. 1 System Architecture

Figure 1 shows the whole system setup that lets data inflow in real time from the physical detectors to the ESP32 microcontroller, also to the IoT pall, and eventually onto the digital binary dashboard. The system's Ulti-layered design helps keep an eye on effects, stops data from getting backed up, and makes it easy to grow. The Physical Subcaste has detectors for temperature, vibration, voltage, current, and SPO2, all hooked up to the machine or device being watched. The detectors keep reading analog signals that show real data from the world around us.

The signals get converted into digital form using the ESP32 microcontroller's erected- in ADC (Analog to Digital Converter). This helps to collect data directly and precisely for the coming steps. Temperature and vibration detectors play a really important part in artificial settings because they help catch problems early on. Vibration detectors pick up on unusual mechanical movements that show when comportments are wearing out or effects are out of balance. At the same time, temperature detectors help avoid overheating and keep the process running smoothly. In healthcare, SPO2 and twinkle detectors play a crucial part in keeping track of cases by constantly covering their oxygen situations .

the intelligence point of the system is served by the edge layer. The ESP32 microcontroller is used for original data collection, processing and filtering. The ESP32 microcontroller handles all detectors' dispatches through both Wi- Fi and Bluetooth. The data getspre-processed to suffer noise and outliers. It sends the data in optimized digital packets to reduce the network business for transmission. When several detectors are coincidently connected to the system, this is fulfilled at the edge position of the system to insure the system is always responsive.

After the data has been cleaned up it is sent to the Cloud Layer in a way using simple communication methods like MQTT or HTTP. The cloud platform then takes care of the data it gets stores it in databases and makes it easy to look at and analyze in time. The Cloud Layer makes it easy to scale up and get to the data from anywhere in the world. This means that people who are allowed to can check on machine health or patient parameters from anywhere, at any time using cloud computing. The data flow mechanism between Edge Layer and Cloud Layer is illustrated in Fig. 2. It identifies the exchange of data between ESP32, IoT gateway, and cloud storage and explains how real-time data are being transmitted, filtered, and stored for further processing and visualization.

The Cloud Layer looks at information. Figures out what might happen next using special math and machine learning algorithms. It does this by comparing what is happening now to what happened in the past.

The Cloud Layer can then find things that're not normal and send out warnings before something breaks. This means the Cloud Layer helps things work better and reduces the time they are not working.

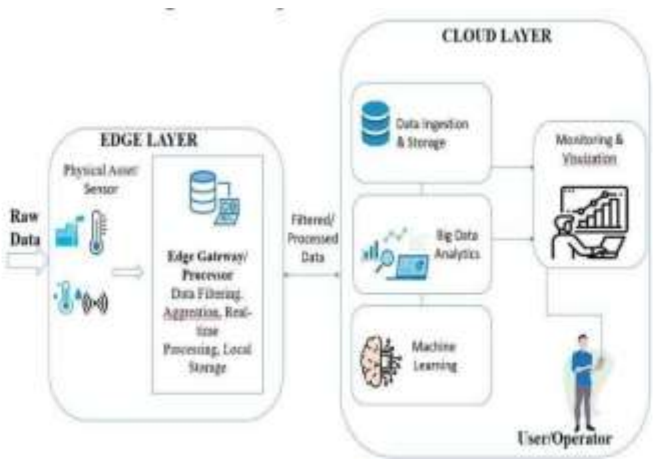

Fig. 2 Edge Layer to Cloud Data Flow for Digital Twin Synchronization

The Cloud Layer does this with something called maintenance. The Digital Twin Layer is the virtual replica of the embedded system in the physical space. It replicates all the real- time parameters being fed from the cloud and displays them on an interactive dashboard. The digital twin update itself with continuous replication of real-world behaviour, permitting users to view trends .

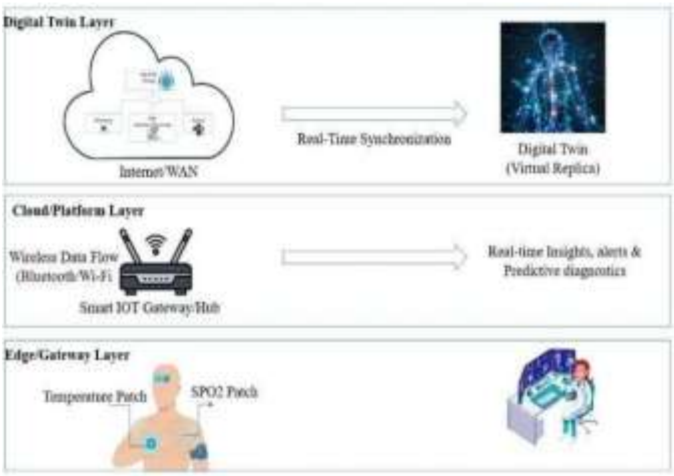

Fig. 3 Layered Digital Twin Model – Physical, Edge, Cloud, and Virtual Layers

The digital twin model has parts that work together. Figure 3 shows how the Physical Edge, Cloud and Digital Twin parts talk to each other. It also shows how data moves from one part to the next from when it's first collected by sensors to when it is shown in a virtual format. The figure points out the loop that helps make sure everything is up to date in time which helps with making good decisions about what to do next, with the digital twin model and the digital twin model. The Internet of Things Data Unit is in charge of helping the ESP32 talk to the cloud server. When the Internet of Things Data Unit sends data packets it makes sure they are secret so that nobody can get to them without permission or change them. The Internet of Things Data Unit also lets the ESP32 and the cloud server talk to each other in both directions. This means that the cloud server can send commands to the ESP32 or the ESP32 can send information back to the cloud server. This helps the physical system work on its own. Makes sure it is controlled properly.

The Internet of Things Data Unit is important, for making sure the system and the digital twin work well together. The system is really good because it can handle a lot of things at the time. You can easily add sensors or devices to the system without having to make a lot of changes. This is because the system is made up of small parts that can be connected in different ways. This makes the system very useful for different things like keeping an eye on machines in a factory monitoring people's health and checking the environment. The system is also very flexible so it can work well in situations where power's limited, like, in small devices and it can also work well in big industrial settings where a lot of power is available.

The systems flexibility is one of its points and it is a key benefit of this architecture. The system we are thinking about needs to be really good at keeping everything in sync in time. The ESP32 has a way of communicating that makes sure there is not much delay between when the sensors get the data and when we see it. This helps the digital and physical systems work together better so they are almost doing the thing at the same time. The ESP32 system also uses special time stamps on the data and a kind of feedback loop, with a twin to make sure the virtual model is doing what the real system is doing. This makes the synchronization of the system even better. Lastly, the Digital Twin of Embedded Systems suggested here presents an economical yet clever monitoring solution that unites industrial automation and healthcare prospects. Through the integration of embedded sensors, real- time processing, IoT communication, and cloud analytics, predictive maintenance and operational excellence are obtained. This represents a major stride toward the attainment of smart, autonomous embedded systems with the ability of self- monitoring, self-analysis, and adaptive control.

III. METHODOLOGY

The Digital Twin of Embedded Systems is a way to connect the world to a computer version of it. This is done in a simple step. First, we collect information from the world. Then we process this information. Send it to the computer. We use this information to create a copy of the real world, which is called the Digital Twin of Embedded Systems. The Digital Twin of Embedded Systems helps us understand what is happening in the world right now how things are working and what might happen next. We use the Digital Twin of Embedded Systems to get an idea of how things will work in the future. The Digital Twin of Embedded Systems is like a mirror image of the world but it exists only on the computer.
This helps us make decisions and fix problems before they happen. The Digital Twin of Embedded Systems is very useful for making sure that the real world and the computer version of it are always, in sync. The block diagram of the system as proposed demonstrates the process flow, indicating how data flow is There is a connection between the sensors,the ESP32 microcontroller, the IoT device the cloud platform and the digital twin dashboard.
This connection is important, for seeing how things that happen in the world are turned into virtual things that we can see on a screen right away. The digital twin dashboard and the IoT device work together with the ESP32 microcontroller and the sensors to make this happen. The cloud platform is also a part of this process helping the sensors and the ESP32 microcontroller and the IoT device to work together with the digital twin dashboard. The data collection phase is where the system operation begins. We have a lot of sensors that are connected to the machine or healthcare device. These sensors measure things, like temperature, vibration, SPO2, voltage and current. The data collection phase is really important because it is the starting point of the system operation. It uses all these sensors. These sensors continuously record data expressing environmental and operating parameters. In industrial applications, temperature and vibration sensors are crucial for overheating or mechanical malfunctions detection, whereas in healthcare scenarios, SPO2 and heartbeat sensors are important for monitoring patient vital signs.

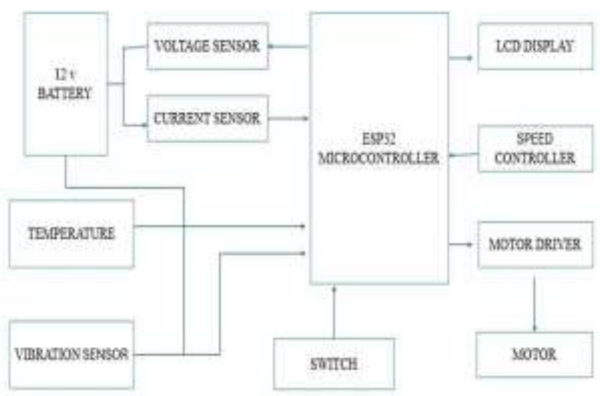

Fig. 4 Block Diagram

The signal processing is done at the edge layer. This is where the ESP32 microcontroller comes in. The ESP32 microcontroller is really good at taking all the analog signals from the sensors and turning them into signals. This happens because the ESP32 microcontroller has a built in thing called an ADC that does this job. The information from the sensors then goes through some routines to get rid of noise and to make sure all the readings are on the level. This means the readings are clean and you can trust them. The main reason we do this with the ESP32 microcontroller is to make sure the readings are accurate and to avoid sending out information, with the ESP32 microcontroller. When the data is cleaned up the system moves on to the step which is sending the data. The ESP32 uses Wi-Fi to send the cleaned up data to the internet cloud. This is done in a way using special rules like MQTT or HTTP.

sure the data transmission is fast and reliable. When the data gets to the cloud platform it is. Managed so we can get to it all the time. The cloud is like a container that holds all the data in one place. It puts everything together adds the time it was received and stores it for a while if it needs to.

We can check on things from else using a computer or a phone. The cloud platform has a lot of power to do the work of looking at the data making pictures of it and comparing how things are doing. The cloud platform does all this work, for the data. The stage of creating a digital twin is to project the real-time sensor data onto a virtual model. This virtual model shows real-time values like temperature, vibration, voltage, and current, mirroring an exact virtual copy of the physical device or machine. Any change picked up by the physical sensors updates the digital twin interface in real time. This real-time synchronization gives situational awareness and transparency to operators and maintenance engineers.

To identify the workflow, the steps of implementation of the suggested system are presented in a simple sequential manner. The flow diagram shows the sequence of operations from machine selection up to digital twin visualization.

Step 1

Step 2

Step 3

Step4

The internet data unit acts like a door that helps get the data to the place. It makes sure the data is, in the format and that it is really coming from the right place. Then it sends the data to the cloud in a way. The whole process is set up to make sure the data gets there quickly and that it works every time. The ESP32 and the internet data unit work together to make

International Journal of Creative and Open Research in Engineering and Management
ISSN: **3108-1754 (Online)**
Volume 02 Issue 04 April-2026 | Impact Factor: 3.5

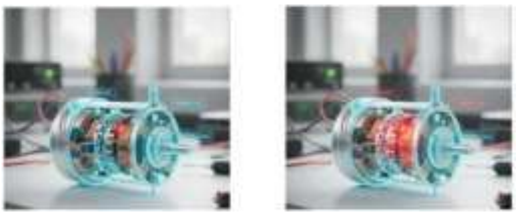

Fig. 5 Stepwise Implementation Flow of the Proposed System

The implementation process is done in steps one, after the other. follows:

Step 1: Choose the machine or device to be monitored

Step 2: Install the proper sensors—temperature, vibration, or SPO2 on the machine to acquire data.

Step 3: Now we need to create a digital picture of the machine. This digital picture of the machine will be the thing we look at when we think about the digital twin of the machine. The digital twin of the machine is really a copy of the machine but it is, on a computer.

Step 4: When the digital twin is working it keeps showing the sensor readings if everything is okay. If there is a problem it will notice strange things like the vibration getting stronger the temperature getting too high or the voltage getting too low. This will trigger a warning so we can do something about it before it gets worse and fix the problem.

The digital twin is really good, at helping us stay on top of things with the twin. The system is designed in a way that makes sure every step of the way is clear and easy to understand. This makes it easier to get the results every time and to make the system design bigger if needed.

The system design uses 3D visualization which helps people using the system to see how it is working and what is going on when something goes wrong with the system design. The 3D. The system design work together to make it easier for people to see the dynamic behaviour of the system design and the fault conditions of the system design.

So we do data visualization first. Then we do analysis and forecasting. Our system is always checking the sensor data to see if there are any problems. It looks for things that're not normal. The system uses math to figure out if everything is working like it should. It checks to make sure all the settings are okay. This helps us stop things from breaking down when we do not expect it.

Predictive intelligence is really important for this. It helps us save money on maintenance, for the Cloud-based analytics engine and other things. The Cloud-based analytics engine is always. It helps us with predictive intelligence and other things. The system talks back and forth between the physical parts. If the digital twin finds something strange it can send a signal back to the ESP32 microcontroller. This signal helps fix what the machine is doing or makes it safer. The system works in a circle making it stronger and needing help from people. The digital.

The ESP32 microcontroller work together to make this happen which is really good, for the system. The physical world and the digital world need to be in sync all the time. This is made possible by using data packets that have timestamps and by checking them in the cloud. Even when the network is not working properly the system can still keep going because it can send the data again and store it for a while. This means that the digital twin always shows what is really happening be more sustainable, in many areas, including the use of the Modular system. In general, this digital twin model is a major contribution toward the establishment of smart, self-aware, and networked embedded systems that can enable predictive intelligence and real-time performance optimization.with the machine or device at that moment. The digital twin is like a copy of the machine or device. It needs to be accurate and up, to date all the time so it can represent the true state of the machine or device. Data protection is really important when we are putting something into action. All the data that we send is locked with codes so only the right people can see it. We also need to log in to use the system so people who are not allowed cannot get in.

The cloud platform checks everything to make sure it is working correctly all the time and it also keeps copies of the data so we do not lose anything. We use these methods to make sure that data protection, for industries and healthcare is kept secret and that we can trust it. The whole thing is really simple it works well. It is flexible.

The modular structure of the system makes it easy to add controls or sensors to the system without having to change the way it is built. The system is also very good at what it does in factories and hospitals which makes the system a good value and flexible, for the industrial settings of the system.

IV. CONCLUSION

The Digital Twin of Embedded Systems makes it easy for the physical world and the digital world to work together. This happens because the Digital Twin of Embedded Systems can copy what the sensors are saying in time. The Digital Twin of Embedded Systems uses the ESP32 microcontroller to connect to the internet and cloud services. This means the Digital Twin of Embedded Systems can watch what is happening in factories and hospitals closely. The Digital Twin of Embedded Systems is smart and always working. It keeps everything safe. The Digital Twin of Embedded Systems can also predict when something might go wrong. It does this by finding problems before they cause the system to stop working. This means the system never has to stop. It always works at its best. The Digital Twin of Embedded Systems uses data to figure out what is happening. This makes it better at finding faults. It helps people make good decisions before something goes wrong.

The Digital Twin of Embedded Systems is very good, at helping people take care of the Digital Twin of Embedded Systems. This system is made to be flexible. Can be used in many different situations. It can be changed easily to fit types of applications. The system can also work on its own without people having to get involved all the time. It does this by using feedback to make sure everything is working correctly. The system has a lot of sensors that work together with versions of themselves to create a very accurate picture of what is really happening. The Modular system and the Modular system design are very important for this. The Modular system is good because it helps things longer and work better.

REFERENCES

[1] A. Vallee, "Digital Twin for Healthcare Systems," *Frontiers in Digital Health*, vol. 5, no. 1253050, pp. 1–8, 2023. DOI: 10.3389/fdgth.2023.1253050.

[2] Bharathidasan, S. (2009). Image fusion for intelligent transport device. *National Conference on Computing, Control and Communication Systems (NCCS'09)*, Hindusthan College of Engineering and Technology, Coimbatore.

[3] B. Subramanian, A. Anandpaul, J. Kim, and M. Maray, "Digital Twin Model: A Real-Time Emotion Recognition System for Personalized Healthcare," *IEEE Access*, vol. 10, pp. 82809–82821, 2022. DOI: 10.1109/ACCESS.2022.3193941.

[4] Bharathidasan, S. Classification of leukocytes by microscopic images. *National Conference on Modeling Analysis and Simulation of Computers and Telecommunication Systems*, Government College of Engineering, Salem.

[5] M. Alam and A. Ahmed, "IoT-Enabled Digital Twin Framework for Industrial Equipment Monitoring," in *2022 International Conference on Smart Electronics and Communication (ICOSEC)*, Trichy, India, 2022, pp. 412–417. DOI: 10.1109/ICOSEC55829.2022.9923248.

[6] Bharathidasan, S. (2024, April 17–18). Enhancing photovoltaic system resilience: A logistic regression approach to fault diagnosis. *3rd International Conference on Recent Advances in Electrical, Electronics, Ubiquitous Communication and Computational Intelligence (RaEEUCCI–2024)*. IEEE.

[7] L. Wang and J. Yu, "An Edge Computing Enabled Digital Twin for Real-Time Industrial Monitoring," in *2020 IEEE International Conference on Industrial Informatics (INDIN)*, Warwick, UK, 2020.pp.735–740.DOI: 10.1109/INDIN45523.2020.9442098.

[8] Bharathidasan, S. (2023). *Internet of Things*. RK Publications. ISBN: 978-81-19140-22-0.

[9] Y. Zhang, X. Li, and M. Zhang, "Digital Twin Driven Predictive Maintenance for Smart Factories," *IEEE Transactions on Industrial Informatics*, vol. 18, no. 6, pp. 4128–4138, 2022. DOI: 10.1109/TII.2021.3118732.

[10] Bharathidasan, S. (2022, May 20). *Design of a Secure Wi-Fi Based Home Automation System Using IoT* (Application No. 20224102705). The Patent Office, India

[11] M. E. Iliuta, S. I. Caramihai, E. Pop, and B. Tiganoaia, "A Digital Twin Based Approach in Healthcare," in *2023 24th International Conference on Control Systems and ComputerScience (CSCS)*, Bucharest, Romania, 2023, pp. 381–386. DOI: 10.1109/CSCS59211.2023.00063

[12] Bharathidasan, S. (2023). Automatic fire extinguisher robot using IoT.*International Journal of Research Publication*

and Review, 4(3).

[13] K. Prakash and V. Ramesh, "A Cloud-Based Digital Twin Architecture for Predictive Maintenance in Manufacturing Systems," in *2021 International Conference on Emerging Trends in Engineering and Technology (ICETET)*, Chennai, India,2021, pp. 89–94. DOI: 10.1109/ICETET51264.2021.9493067.

[14] Bharathidasan, S. (2021). Advanced security analysis of IoT environment using deep learning techniques. *Linguistica Antverpiensia, New Series–Themes in Translation Studies, 2*, 2034–2042.

[15] H. Singh and P. S. Rawat, "IoT-Based Digital Twin for Remote Equipment Monitoring Using ESP32," in *2022 International Conference on Communication and Electronics Systems (ICCES)*, Coimbatore, India, 2022, pp. 1785–1790. DOI: 10.1109/ICCES54183.2022.9832315.

BIBLIOGRAPHY

Dr.S.Bharathidasan is an Associate professor (S.G) in the Department of Electronics and communication, holds M.E in Applied Electronics. (Karunya University, Coimbatore). He has nearly 19 years' experience in teaching and completed Ph.D (Wireless Sensor Networks) in Anna University, Chennai. Presently, He is working as Associate professor in Erode Sengunthar Engineering College, Tamilnadu.

Andrix Vinusha G, currently pursuing B.E final year under the stream of Electronics and Communication Engineering at Erode Sengunthar Engineering College, Erode.

Hemaniverthane C R, currently pursuing B.E final year under the stream of Electronics and Communication Engineering at Erode Sengunthar Engineering College, Erode.

Karthiga M, currently pursuing B.E final year underthe stream ofElectronicsand Communication Engineering at Erode Sengunthar Engineering College, Erode.