# Initial Post

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Initial Post

by Ruben Marques - Monday, 29 September 2025, 10:55 PM

The system in the article provides a clear example of a simple Internet of Things metamodel that acts as the underlying blueprint for a system design, leveraging an object-oriented approach to help with organisation of the code into more logical and manageable blocks (as seen with the QRScanner or LEDController), but the overall blueprint has distinct strengths and weaknesses for modern IoT applications.

**Strengths:**

Simplicity and Clarity: The T-UFF metamodel is very straightforward since its logic follows a simple path: it handles code scans  looks up information and triggers a light, doing a great job of making the entire model easier to understand  to understand, build and test as a prototype.

Modularity: By using an object-oriented design, each part of the system is a self-contained module which, as we have been studying, is great because it means you can update or fix the QR scanner code without breaking the LED light code.

Low Cost for a Fixed Problem: For the specific task of tracking items in a small, unchanging warehouse this design is very cheap to implement using basic hardware like an Arduino and Bluetooth modules.

**Weaknesses**

**Lack of Environmental Awareness:** This is the most significant weakness. The model has no understanding of the real world. If a box is dropped in an aisle, the T-UFF system would still light up the path, leading the worker right into the obstacle. It can only follow its pre-programmed instructions.

**Poor Scalability:** The reliance on Bluetooth is a major limitation. Bluetooth has a very short range and can be unreliable in large, busy environments. The design would fail in a large warehouse, as it cannot scale to handle hundreds of shelves or longer distances.

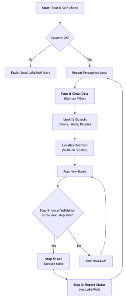
**Rigid and Inflexible:** The system is "hard-coded" to a physical infrastructure of QR codes and LED light strips. If the warehouse layout changes, a person has to physically move the lights and update the database. A truly "smart" system should be able to adapt on its own.

**Upgraded for Humanoid Robot**

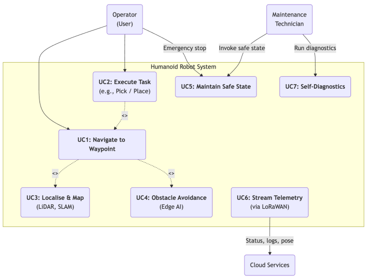
To support a humanoid robot, a smarter metamodel is required by integrating modern technologies that can work to overcome the identified weaknesses.

The T-UFF system's critical lack of environmental awareness is solved by incorporating LiDAR, which generates a precise 3D map of the surroundings to enable robust Simultaneous Localization and Mapping (SLAM) (Badue et al., 2021), making sense of this rich sensory data in real-time addresses the problem of rigidity. Rather than relying on a slow, network-dependent cloud, the design uses Edge AI to process information directly on the robot, enabling the instantaneous, low-latency decisions required for dynamic path planning and obstacle avoidance (Shi, Cao and Zhang, 2020). Finally, to overcome the poor scalability of the T-UFF's Bluetooth architecture, the model integrates LoRaWAN. As a Low-Power Wide-Area Network (LPWAN), it provides the long-range, energy-efficient connectivity needed to transmit essential telemetry from an entire fleet of robots, a solution purpose-built for large-scale IoT deployments where short-range technologies are impractical (Mekki et al., 2019).

Updated Flowchart:




Updated Use Case Diagram:

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**Re: Initial Post**

by Victor Angelier - Saturday, 4 October 2025, 11:40 AM

Peer Response:

Ruben's evaluation of the T-UFF metamodel demonstrates an excellent grasp of object-oriented (OO) design principles within Internet of Things (IoT) contexts. His identification of modularity, simplicity, and cost-efficiency as key strengths is persuasive and consistent with Baskara et al.'s (2024) aim of producing a lightweight Arduino-based prototype. Equally compelling is his recognition of weaknesses in environmental awareness and scalability, reflecting the limitations of fixed-infrastructure IoT systems in dynamic environments (Dang et al., 2023).

I particularly value Ruben's proposed integration of LiDAR-based Simultaneous Localisation and Mapping (SLAM) and Edge AI processing, which enhance situational awareness and reduce dependence on the cloud. The inclusion of LoRaWAN for long-range, low-power communication (Mekki et al., 2019) further aligns with scalable IoT design. However, his post omits discussion of OO design patterns, which are vital for modularity and adaptability in resource-constrained environments. Applying patterns such as Strategy (for dynamic navigation algorithms) and Observer (for sensor-cloud synchronisation), as outlined by Romano and

Kruger (2021, p. 187, Chapter 7), could optimise control flow and data handling.

Equally, in IoT architectures with limited processing capacity, maintaining low Cyclomatic Complexity (CC < 10 per module) is essential to ensure efficiency, testability, and maintainability while preventing algorithmic overhead (Schultz, 2021). Integrating such metrics alongside design patterns would strengthen long-term sustainability and support energy-efficient software development (Şanlıalp, Öztürk and Yiğit, 2022).

Ruben's contribution is analytically rigorous and forward-thinking. How might these patterns and complexity metrics be incorporated to ensure the humanoid robot's software remains efficient across multiple Edge nodes?

References

Baskara, W.P. et al. (2024) 'T-UFF (Tracker stuff): Application development for warehouse tracking', IOP Conference Series: Earth and Environmental Science, 1294(1), p. 012025.
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**Re: Initial Post**

by Lauren Pechey - Friday, 24 October 2025, 2:14 PM

Hi Ruben!

I really enjoyed reading your analysis. You did an excellent job highlighting the strengths of the T-UFF system, particularly its simplicity, modularity, and cost-effectiveness for a small-scale application. Your explanation of the weaknesses — such as limited environmental awareness, scalability issues, and rigidity — was clear and well-justified.

I also liked your proposed upgrades for a humanoid robot. Integrating LiDAR and SLAM for environmental awareness, Edge AI for low-latency decision-making, and LoRaWAN for scalable communication all make the model much more robust and suitable for modern IoT applications. Your use of recent references strengthens your arguments and shows a strong understanding of the topic.

One small suggestion would be to include a simple visual of your updated flowchart or use-case diagram, which could make the improvements even easier to grasp.

Overall, this is a well-structured and insightful analysis — great work!

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