An intelligent Service Based System on Wireless Sensor Networks for supportable consignment Transportation

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Abstract.
Goods mobility may benefit from intelligent service supply systems. It is difficult to build these systems because they must take into account so many variables that are impacted by the attributes of such diverse and complex systems. It was the goal of this proposed study to design an adaptive intelligent essential services framework that can identify contextual information from a broad range of services and embedded devices in WSNs. Additional flexibility is needed for the intelligent essential services framework so that it can analyse unique examples of unanticipated and undesirable scenarios in the freight transport procedure. We explored the issues of multi-dimensional specifications of collected information and the selection of suitable AI techniques for the classification of relevant data in order to solve the issue of acceptable contextual data supply. Favouring prospective service provision by maintaining high-quality data supply routes and preventing wireless communication channels from being overburdened are the goals. Data warehouse conceptual frameworks, situationally data identification algorithms, and artificial intelligence (AI) approaches for recognising transportation circumstances are all included into the suggested method. The prototype system's algorithmic analysis is shown utilising a suitable simulation platform in experimental study.
Keywords. Smart System; Context-Aware Services; Wireless Sensor Networks (WSNs); Consignment Transportation

1. INTRODUCTION

The integration of intelligent components into freight transportation systems is a hot topic among researchers right now [1, 2]. Modern tools that use novel digital resources that can adapt to a wide range of communication infrastructures and vehicle automation tools are being developed [3]. When developing smart support systems, additional research is needed to detect information from WSNs [4, 5]. WSN architecture must be flexible to cope to the varied nature of ITSs, as well as new techniques of communication and information technology.In the creation of ITS technologies, the most critical need is that these processes do not disturb motorists while they are on the road. An effective transportation management programme must ensure that users get what they need when they need it, where they need it. In addition, it should be tailored to the demands of the users, making just the required adjustments to ensure the safety of the transit process. A intelligent software delivery system for freight transportation management was the goal of this study. The designed system attempts to achieve the objectives of usefulness, flexibility, security, and efficiency maximisation by providing a functioning regime that does not overburden wireless communication networks. At this point, we're focused on developing an intelligent service delivery system that can track user behaviour in real time and recognise relevant context. Freight transport procedures need situation knowledge. The architecture of WSNs serves as the foundation for the newly built intelligent service providing system. The identification of the data obtained was applied in the phases of transportation and allowed for efficient freight transport administration.

A element design for a technique works service delivery is the focus of the suggested methodology. Research on the ICT infrastructure for multimodal transportation management conducted in the past is relevant to the present study [6]. This research is expected to help construct autonomous transportation infrastructures with extendable diverse communication, which would improve the safety of these procedures. Because they need a different methodology and are thus beyond the scope of our research, we did not include any sections on cyber security in our study. To strengthen the independence of user–vehicle exchanges, a structured awareness of new and prior transportation advances is required.

Artificial Intelligence (AI) approaches have been used to predict the future. There are a range of new types of WCC and WSNs in the ICT infrastructure. Online identification of moving object locations necessitates the merging of diverse services with systems based on geographic information systems. Sensed data may now be integrated into moving vehicle data monitoring procedures, as well as systems for predicting survey data about the vehicle's circumstances, thanks to smart system architectures. During this study, we focused on limiting unneeded information, prioritising the service delivery process in order to increase driving safety, and formalising the limits of data flows owing to inappropriate data transfers.

The following is the study's organisational structure: Section 2 reviews studies on context-aware process and systems engineering research. Section 3 presents a technique to the construction of an adaptive intelligent software supply system, with an emphasis on the representation of the recommended system's element framework. Section 4 provides examples of probable disputes in the arranging of consignment transportation and the ways in which they might be resolved. Section 5 of the paper presents the algorithms used to classify and limit context data for motorists, based on the backdrop of AI and mathematical methodologies for decision support. Section 6 provides a quick overview of experimental research opportunities. Section 7 outlines our research's current and upcoming constraints and goals. Section 8 provides an overview of the findings as well as the study's originality in scientific terms.

2. RELATED STUDY

The creation of new kinds of providers for mobility assistance is related to the growth of ITSs and the proliferation in the application of the complex capabilities of ICT [7]. New types of network sensor systems placed at the wayside and in cars should be used to the operation and supervision of transport activities. Nevertheless, an adjustable connection among transport phenomena and the architecture of roadside units (RSUs) needs more study, with special focus dedicated to smart and autonomously acting subsystems.

It is possible to establish VANETs in a lot of formats, several of which are assisted by long-distance effective communication based on mobile protocols [8] [9]. There is also the usage of short-range technologies such as Wi-Fi. Engine, health, and environmental data may all be collected using a variety of sensors that can be installed into the car. Sensors are now able to collect data in a variety of formats, including multi-dimensional. As a means of acquiring context data, detectors may also be used to acquire data relevant to the movement and control of goods [10] [11].

It is possible to include a wide number of sensors into freight transport surveillance systems. The above is where we put our energy:

- The use of real-world sensors to monitor environmental conditions
- Detection devices that check the functioning conditions of automobiles.
- Scanners that monitor the health of people.

Surveillance of transportation and traffic data, danger alerts, recording contacts with other vehicles, e-calls for caution and details, etc., are some of the functions of RSU devices. According to the authors, there are a number of ways in which adaptable service systems might be developed [3] [6].

The Domain of analysis of the context	Aspects of the context in transportation
Surroundings and people factors	Location and identity of surroundings, people and objects and changing objects
Conceptual Definition	Set of entities that interact physically with conceptual states
Application Factors	Application settings
Environmental factors	Time, environment, products and company information

Table 1:Aspects of the context in transportation

The term "context" encompasses a vast range of ideas. We looked into the feasibility of incorporating these context awareness descriptions into our program based on the results of our analysis. To help identify critical data, the intelligent software distribution system provides access to a broad variety of multi-dimensional properties [12] [13].

Providing a V2V service is hampered by a variety of issues, such as assessing qualitative characteristics and overloading wireless channels. Many different communication strategies may be used to acquire, transfer and distribute information in an infrastructure. There are several elements to consider while developing Iot systems, including agility, inventiveness, and versatility. As a result, we focused on a limited number of information protocols. In terms of communication channels, we're primarily concerned with the issue of oversaturation of wireless channels as a result of service supply. This method focuses on evaluating service priorities in terms of aesthetics, transportation safety, necessitate and adaptability [14].

High speed and dynamic topology need high standard handling of relevant data due to the variety of components.

One of the most challenging aspects of doing this is the potential for mistakes and difficulties arising from the use of incomplete data.

3. METHODOLOGY

The goal of this study was to design an expandable architecture for a smart service providing system for freight transport operators. Averting collisions, assisting with emergency situations, and reducing gridlock were all goals.

Table 2 outlines a strategy for creating a flexible, intelligent service delivery system. The freight travel management process necessitates the identification of context-aware information at every tier. Sustainable development calls for process that helps decision makers at various levels of the freight transport management hierarchy make better decisions.

This study does not go into detail on every one of these levels. However, in the next sections, we examine several of the levels in further depth.

The Layers of the Infrastructure for the Development of Context-Aware Services	Description of Components and Functional Units
Software and algorithms for service support and specialized user interfaces	Software development tools for such purposes; Programming languages; Service provision platforms;
Scenarios and orchestration of activities for service provision	Interoperability support tools for integration of required DWs
AI methods for recognition of cargo transportation situations	Special AI methods that are included in service provision systems, such as machine learning methods and packages, neural networks, and image analysis and recognition
Methods for planning and/or re-planning of cargo transportation cycles	Plans to develop software, planning of transportation corridors, provision of related information, re-planning decisions and related activities, software realization tools.
Methods for operative work and management of all participating agents in cargo transportation processes	Operative control methods and implementation of informational and equipment infrastructure for communication between participating sides

Table 2:Infrastructure layers for the context aware services

3.1 Levels of Decision Support for Sustainable Cargo Transportation

The decision analysis mechanisms are AI-enabled. These procedures are connected to the creation of sophisticated services that may aid in the handling of unexpected situations. The phases of construction of smart essential services system are studied by recognising the priority of data conveyed for drivers throughout the mobility cycle.

The work plan is thought to be when shipping objectives are based on historical trends on contracting parties and predicted delivery requirements. The shipping pattern is created in the design stage and sent to the planning stage as goals or specified places. Efficiency factors are provided in the collecting phase to monitor network, operator, and vehicle data.

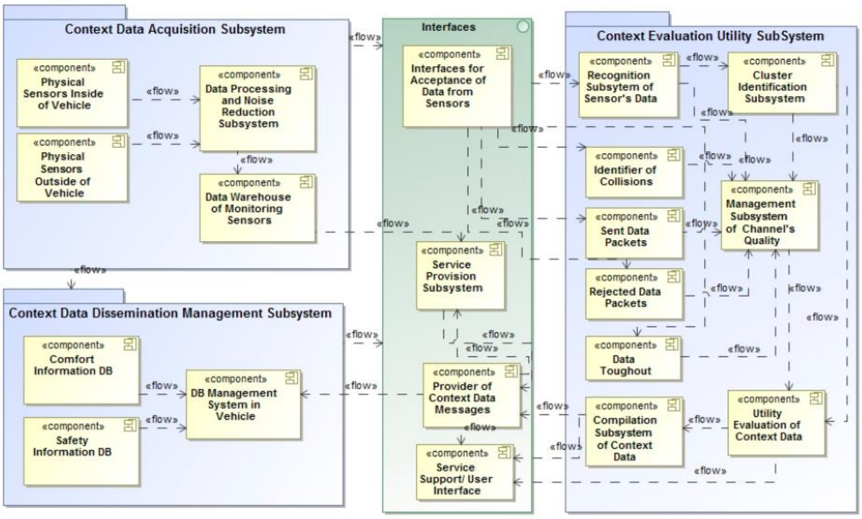

Figure 1: The IASDS architecture for the identification of data from sensors in order to provide service.

3.2 System DevelopmentRequirement

Implementation phase for safe, dependable, inexpensive and pleasant automobiles requires a wide range of technological advancements, including DSRC and IEEE 802.11 standards for Wireless Access in the Vehicle Environment, which must be followed in order to accomplish this (WAVE). Using these protocols, a novel standard of service delivery may be accomplished. For example, DSRC and WAVE may be used to provide services in automobiles in order to meet ITS development objectives and improve road safety, transport planning and the enjoyment of drivers.

Various modes of transportation have been considered in the planning process. For transportation systems in a digital environment, in particular, the development of identification algorithms for the detection of diverse scenarios is required to determine their relevance. It is important to note that these strategies are impacted by the driver service procedure.

Pleasure and entertainment-related activities are regarded less significant, and so are not directly linked to road safety. Drivers may benefit from these kinds of services, which can be supplied in typical driving scenarios. In addition to providing weather and traffic information, comfort areas may also give information on the location and costs of nearby gas stations, motels, and other businesses.

For example, field-level design, process improvement management, and web services during transit all fall within the VANET's classification.

3.3 Architecture of anFlexible Cargo Transportation Service Delivery System

In order to build an IASDS, instantaneous environmental detection and data management methods must be included.

In our prior works, we've developed a more complete conceptual design for the smart service providing system. Mobile network architecture changes and the analytic approaches for limiting superfluous information have recently received a lot of attention. Drivers must deal with an ever-increasing influx of data while on the job.

Types of Sensors That Can Be Equipped in Vehicles (INV)	Types of Virtual Equipment	Types of Communication Network between Vehicles	Types of Roadside Units (RSUs)
Video cameras	Smartphone/Tablet	VANET	RSU for speed recognition
GPS	Calendar	Services provided from ad-hoc nets	Dynamic RSU for traffic regulation
Microphones	Reminder	Reminder	Dynamic info black-boards
Movement dynamics	Information from social networks	V2V communication services	Monitoring and information about conditions of roads

Table 3:Types of sensors that vehicles equipped

Figure 1 depicts the major structural elements of the suggested IASDS's design. We utilised the syntax of the Unified Modelling Language to depict the system's element design.
In order to keep track of data, we designed the Situational data collection module and the Data dissemination subsystem, two separate software packages. Subprograms that provide frame of reference capture and propagation of contextual information are provided by the information from the acquiring sub - system. In order to classify services, prioritise services, and gather context data, functioning processes are used.
Noise reduction is made possible by the Connection quality control subsystem, which permits data throughput and preparation. As accessories for collecting information from numerous diverse sensing devices, interfaces play a significant role. They can aid in the seamless integration into the cognitive structure of the DWs' repository. Unlike the integrated devices out of which message is transferred for the context assessment subsystem, the data for processing is transferred through the elements of the integrations. Clustering methods can be used to establish data - flow prerequisites in the Situation recognition component of these processes.

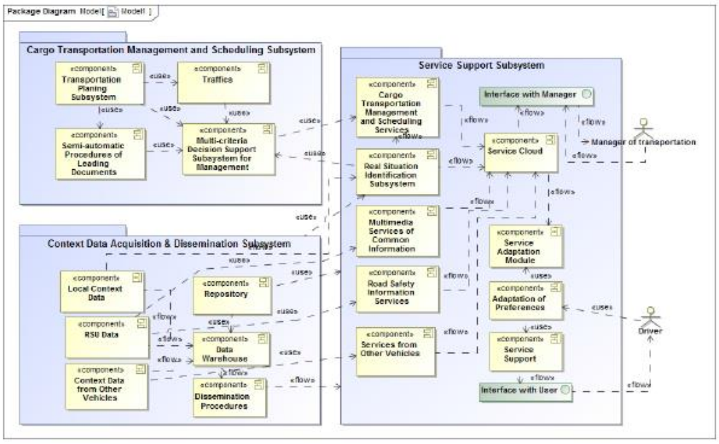

Figure 2:The Architecture of The Proposed IASDS for Recognizing Data from Sensors.

3.4 Conflict Management during the Scheduling Phase

First and foremost, the timetabling process must be examined for potential conflicts of interest. When a completely new occasion occurs, operational incongruence takes place. It is essential to bear in mind that not all dispute are wars at all, but rather multi - functional procedures that can be categorised as such.
It's crucial that the data set's existing dispute are gathered before determining which schemes should be employed to rectify them. To move ahead, the modification step is being used to decide if the contrasting activity has been modified. If one of the operations was carried out, the type of precision will be determined by other modifications for each clashing couple. Both effectiveness can be measured to see if there is a solution if neither one was completed. As a final step, the dispute is removed from the list of conflicts once both activities are completed.
The model's method depends on dispute and choice statistics. The indications of dispute play a significant role in making choices in comparison to social and demographic variables. There is a growth in the number of operations that are removed and a drop in the total of actions that are modified when there are more activities that overlap. However, the amount of time obtainable it seems to have less of an effect on the choice made. There are less chances of altering the original activity and deleting actions that seem to be in opposition with a tiny model.
The selected method for resolving the dispute was anticipated to be heavily influenced by the nature of the dispute events. There was a small chance that the original activities, which were more nimble and adaptable, were going to be supplanted. There is a larger proportion of modifications and a little less of deletions for activities that are more unique. The outcomes, on the other hand, are not as clear-cut as those from activities involving conflict. When it comes to long-term planning, it's been shown that as the time horizon for both innovative and contentious endeavours grows, so does the likelihood of modest alterations.

3.5 Algorithms for Recognizing Contextual Data Provision Objectives in Freight Transport

Freight transport requires the development of services with adaptability qualities. It is possible to create an adaptive smart service delivery system to provide these services autonomously to drivers. It is necessary to develop algorithms that determine the importance of service providing at the appropriate time and location. The technology is aware of the external surroundings

and can assist to determine the present, previous, and expected future conditions during the course of the journey, as well as aid to pick the proper path.
Various sensors enable the highway equipment architecture. Data from a broad range of RSUs may be used to monitor transportation and other contextual information along the route. Knowledge may be gained through sensor information. The data generated throughout the shipping procedure is quite complicated. Structures, measures, and inter - dependencies across sources may all vary greatly in terms of how they are provided and how large their volumes.
It is critical to the IASDS growth process to identify and handle problems by grasping the connections among them and their surrounding environment. There may be issues if this is not done, and the system may not perform effectively or adapt to the user's demands. Difference emerges if transit is categorised by road or may be inherent in the circumstance if the computer is aware of numerous simultaneous circumstances.
Rejecting non-useful data from the system may assist reduce network loads neither compromising quality of the data nor diminishing the multimodal system's performance when it comes to road safety. There has been a call for a more smart and flexible strategy to dealing with these problems, one that takes into account the system status and the assets relating to data packet creation as well as details from other vehicles and can make use of context information from the local environment, including place, time, surroundings, usage rate, driving conditions.
After looking at a list of recognised natural features, a software system was suggested to be used to evaluate each situational message's usefulness. A meta-model is used to prolong the sensors and data storage facility, which is then built for local storage using the mathematical background.
It is possible to describe the utility of each data subject as a Product of two using the matrix ML. There are values that reflect the effectiveness of relevant contextual notifications where the first index j represents the data collected from the sensor (sj).

$$M_L = \begin{pmatrix} d_{L_{11}} & d_{L_{12}} & \cdots & d_{L_{1n}} \\ d_{L_{21}} & d_{L_{22}} & \cdots & d_{L_{2n}} \\ \cdots & \cdots & \cdots & \cdots \\ d_{L_{l1}} & d_{L_{l2}} & \cdots & d_{L_{ln}} \end{pmatrix} \quad (1)$$

Weights are assigned to each sensing messages (mi) to determine the prediction effectiveness of the context awareness message (sj). Formula (2) is used to determine the matrix ML's individual element values.

$$d_{L_{ij}} = (Ty_j + H_j + Ex_j)m_i cr_i Pr_i,\ i = 1,\ldots,l,\ j = 1,\ldots,n \quad (2)$$

Tyj expresses the relevance of situational basic data types in formula (2), which is judged in the range of [1, 3]. They are based on the judgments of specialists in the transportation industry. It was essential to execute polls and use multi-criteria analysis methods to compare the viewpoints of specialists in order to formulate these algorithms. To convey messages in the safe and comfortable zones, a value of 1 has been allocated; messages in the security area, a value of 2 has been assigned. Messages having a weight of 3 appear first in the list.
In the predetermined range [0, 1], the significance of a message may be assigned, with 1 being a security notification and 0 denoting an informational/comfort message.
You may choose from a list of normalised values within the range [1, 3] to use as the function for expressing the message age using Ij, where TM denotes the time change between the present instant and that at which the text was generated. This approach is stated in (3).

$$A = \begin{cases} 1, if\ T_M > 5s \\ 2, if\ 1 < T_M < 5s \\ 3\ if\ T_M < 1s \end{cases} \quad (3)$$

The architecture and methods have been designed to help establish better circumstances for the supply of chosen information in order to decrease the number of data transitions. The situational utility values are stored in a matrix MO.

$$M_0 = \begin{pmatrix} d_{011} & d_{012} & \ldots d_{01n} \\ d_{021} & d_{022} & \ldots d_{02n} \\ \ldots & \ldots & \ldots\ \ldots \\ d_{01l} & d_{0l1} \ldots. & d_{0ln} \end{pmatrix} \quad (4)$$

When determining the predictive ability of a context awareness information, a formula is used to give each msg sent to the automobile vn a numerical value (ml). Formula (5) is used to determine the values of the matrix MO's elements, which may be written as Cartesian product:

$$d_{0ij} = (Ty_j + Exc_j + Z_j)m_i cr_i Pr_i n_i, \quad i = 1, \ldots, l, \quad j = 1, \ldots, n \quad (5)$$

To estimate the quality of a data transmission, use Zj, which may be computed using Formula (6):

$$Z_t = \frac{1+\left(\frac{C_t+D_t}{2}\right)}{T_r} \qquad (6)$$

The collision factor, Ct, is computed using the following equation:

$$C = 1 - \left(\frac{1}{1+C_{t-1}}\right)$$

Rejection parameters are included in a Dt packet, which may be computed according to a set of rules.

$$D = 1 - \left(\frac{1}{1+d_{t-1}}\right)$$

The following formula is used to compute the bandwidth factor Tr:

$$Tr = 1 + \left(\frac{tr_{t-1}}{100}\right)$$

Context utility values are included in the data exchanged with a hybrid VANET cloud subsystem. Structured data is represented as a matrix (Mc) with its own unique index (l), which reflects values of message data for the receiver entities (ri).

$$M_C = \begin{pmatrix} d_{C_{11}} & d_{C_{12}} & \cdots & d_{C_{1n}} \\ d_{C_{21}} & d_{C_{22}} & \cdots & d_{C_{2n}} \\ \cdots & \cdots & \cdots & \cdots \\ d_{C_{l1}} & d_{C_{l2}} & \cdots & d_{C_{ln}} \end{pmatrix} \qquad (7)$$

The weighting algorithm, which gives values to each signal that will be sent to the receiver, may forecast and describe the utility values of the context awareness messages. The Cartesian product of Formula (8) may be used to compute the values of this structure.

$$d_{C_{ij}} = (Ty_j + Hx_j + Exc_j + Z_j)m_i cr_i Pr_i,\ i = 1,\ldots,l,\ j = 1,\ldots,n \qquad (8)$$

where $T_{yj}$is the set of reduced parameters.

4. Results and Discussions

In order to avoid composing complex scripts, an easy-to-use user interface was employed. When it comes to supporting a driver's basic behavioural patterns, NCTUns and its subsequent version (Estinet) [15] are a great choice. Furthermore, in NCTUns versions 4 and 5, studies have concentrated on the feature that allows the testing of various ITS automobiles networks, the creation of a simple roadway network design and the simulation of RSUs based on wireless infrastructure mode. Several different types of wireless network applications were tested during the research. This design context can be used to investigate a variety of complex ITS scenarios due to its tight integration. This is necessary for simulating how the car's drivers behavioural changes in response to messages. Node mobility management and ultra-high volume automotive communication networks are among the new features in NCTUns version 5.0, as well as automatic road network construction.

As per the study objective, a variety of simulation experiments were tested out. As an example of how a network model can demonstrate factors that produce a series of texts, one situation simulated a blended VANET cloud service by stashing suitable data in the correct archives of the database system. The integrated server and the DW were linked to the network.

Activity and/or Service Type	Required Amount of Transferring Package(B/s)/ Bandwidth (KB/s)	Possibility of Influence of Packet Loss	Frequency of Transmitted Data	Tolerable Delay (in Microseconds)
Types of actions related to traffic safety in the transportation process				
Changing the lane	~100/1	Average	Event	~100
Information for traffic light control system	~100/1	Average	Periodical	~100
Warnings about hazards	~100/1	High	Event	~100
Multimedia services	~100/1	Average	Periodical	~100

Table 4:Differentiated service delivery in vehicular communication networks

Transport specialists' views were examined to finalize the algorithms used to give priority to the various forms of context and supplied messages. Decision support approaches, such as cumulative waiting and the assessment of correlation coefficients, were utilised in order to provide specific priority values to situational data and access provided by experts.

Simulated transmission of data from automobile to DW server and DW server to vehicle was employed in another simulation scenario for data flow analysis.

Table 5 lists the many kinds of sensors that were used in this investigation.

The data transmission cycles began at 60 s in length. The data transport rate was set at 27 Mb/s, while the packet's size was set at about 1000 MB. Section 5's technique for assigning priority to service providers was used in the experiment. Contextual awareness of the surrounding world was reproduced in the prototype system.

Section 5's algorithms were put to the test in yet another set of tests, this time to see whether they might be put to good use. For a brief period of time, statistical data and gathered data were put to use. Figure 3 shows the collected data, the dynamics of anticipated utility, for illustration reasons only. Comparing these two graphs, we can see how Tyj values have decreased in significance.

Only a small portion of these findings may be relied upon to be reliable. In spite of this, they demonstrate that the collected results throughout the brief trial time may be used to predict the behaviour of modifications in the service supply process. Variations in results are influenced by a variety of factors, including the channel quality characteristics. Additional studies with a large number of lost packets are needed in order to accurately estimate conflicts and the channel capacity requirements.

In each point of the journey, the prediction function may assist identify the present condition by analysing previous occurrences and forecast the future. In our earlier work, we described the algorithms for picking the proper path at probable nodes of multi-modal mobility.

Classification of Sensors by Types of Applicability	Update Rate (High – H, Average – A, Low – L)	Classification of Types of Row Data Sources	Types of Data Exchange
Physical sensors inside of the vehicle			
Speed measurement	H	Data from vehicles	INV
Acceleration measurement	H	Data from vehicles	INV
Temperature measurement inside the vehicle	L	Data from vehicles	INV
Temperature measurement outside the vehicle	In case of needfulness of such conditions	Data from vehicles and RSU	INV
Fuel Level measurement	L	Data from vehicles	INV

Table 5:Classification of WSN sensors used in freight transportation based on their kind of sensor.

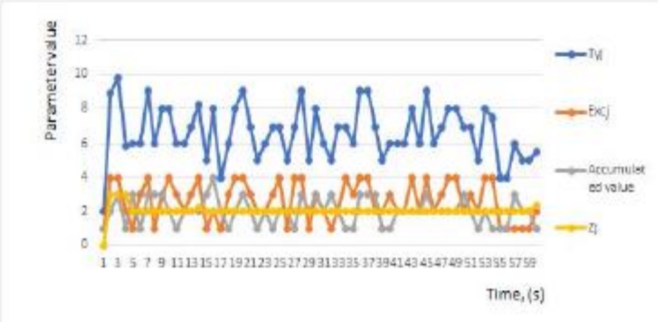

Figure 3: An example of the short-term dynamics and dependence between the new values of the anticipated changes of the cumulative projected utility (Excj), normalised Zj, and Tyj parameters shows the incomplete experimental findings.

5. Conclusion and Future Scope

Expandable architecture and multi-dimensional ways of expert systems are the basis of the suggested strategy. The goal was to create a service delivery system that could identify context-aware information and use it intelligently. The researchers used a broad range of situational data sources, including WSNs and other infrastructure ICT devices, in the design process. These context-aware procedures are examined in the research study, along with the creation of systems to achieve crucial context-aware identification goals and their impact on a larger comprehension of relevant data.

Smart service delivery systems' suggested architectural integrity is one-of-a-kind, thanks to algorithms developed to identify situations by comprehending their environment. This technique also laid the groundwork for the creation of adaptive software solutions, which are essential to the mechanization of certain circumstances. The suggested intelligent adaptive strategy allows again for utilisation of ambient relevant information, including the kinematics of the automobile, and data exchange from other cars to overcome the issues of smart service supply. Data transfer restrictions were implemented based on wireless network circumstances and assessments of wireless communication channels' performance. With these solutions, the service limiting process may be made more efficient by taking into account the wireless transmission channels' capacity.

Prototypes of the IASDS internet infrastructure were developed in this prototype. Network filtration and consolidation methods in the IASDS may assist limit the volume of useless collected data that must be communicated through automobile communications infrastructure without compromising the quality of the contextual data.. The categorization of sensors by kind was used to identify particular scenarios, as supplied by the researchers.. Techniques for collecting data that were used in this study were found acceptable.

In the future, we want to investigate more sophisticated crash event detection and unexpected circumstance forecasting situations. There will be fewer accidents and risky circumstances because implications for the way will be classified according to various kinds of wireless technology and data will be sent based on context for certain smart service models.

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