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Temperature Monitoring and Forecast System in Remote Areas with 4.0G LTE Mobile Technologies

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Abstract

The need to monitor areas of high risk in terms of temperature indexes has included two important elements for its compliance: monitoring and forecast of records in an environment. Performing this procedure manually is inefficient as it provides a flat perspective and can't predict the state of the environment with rigor. Software systems are contemporary elements in constant refinement, which satisfy emerging needs of a context, so that, in relation to monitoring and forecast an environment, it allows a sophisticated automation of the process, and that tends to lead to a better supervision of the risks in the environment. This article presents a proposal for the supervision of high-risk areas, through temperature registers, manageable through the design of a software system with the implementation of mobile 4.0G LTE technologies, aimed at efficiency and effectiveness in the notification of environmental status. Finally, I conclude with a remote temperature monitoring and forecast system, using mobile technologies, with a fuzzy logic prediction system with a quadratic error not greater than 2.6%, that is, on a fuzzy algebra system whose Numerical calculation does not exceed this error value in comparison with actual values; At the same time that the future works are presented from the approach of the research that is postulated, according to the emergence of new perspectives related to this developing software system.

Keywords*: predictive system, software engineering, mobile technologies, temperature monitoring*

1. Introduction

Colombia's current situation in forestry has been booming lately, as the media are becoming more and more instantaneous in considering environmental catastrophes, but it is clear that the response times for these calamities are still inefficient in Terms of the losses produced by this catastrophe. The Figure 1 is a statistical evidence that provides the IDEAM [1]. The information provided in the graph shows the number of hectares affected together with the number of fires associated with each department of the country.

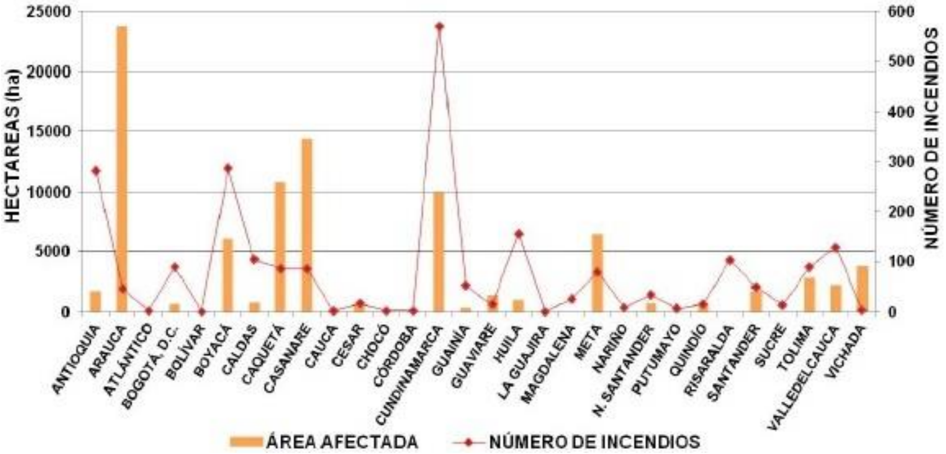

Figure 1. Fires in Colombia during 2010. Source: [1]

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A rapid assessment shows that the situation in the department of Arauca in terms of the number of fires is small, but the same amount caused great damage in terms of hectares affected; while in Cundinamarca the number of fires is high but the number of hectares affected is lower, making it possible to emphasize the urban character as an advantage to act instantaneously the fire is detected, of course, the urban character is treated from a technological perspective specifically. A more detailed assessment shows that the relationship between the number of fires and the number of hectares affected per department is closely related as each fire is causing direct damage to the hectares in risk areas, i.e. Not to prevent fires but to act when they are detected in danger category, irremediably causes damage to the hectares of the surrounding area.

In addition to the environmental damage caused by fires within the country, each of them shares the factor of detection and early prevention as a potential cause of efficient control to regulate stability in each of the possible risk environments. The key point for the analysis of the causality of these events is the reading of the temperature in the environment before, during and after the fire, because it is composed of own characteristics in contrast to the environment in stability. The gathering of these characteristics essentially allows statistical reports to be provided in order to provide information and analysis; however, bringing these research processes together with environmental processes to an alternative forest fire detection and prediction would mean a significant advance in social development and Ecological country.

The present research work is carried out with the motivation to produce the necessary social approach so that the technological resources are truly a tool of progress in the community, since to direct a software problem towards a population frame is a situation that competes to everything Professional systems engineering as it makes proposals for work landed in a context that requires an effective solution. It is important to say that the project is carried out because the evidence of a contemporary problem and with increasing expansion within a national context, and eventually international, such as forest fires, requires a discernment capable of going beyond strategic research and analysis, managing to implement a system with the necessary characteristics to transcend in the world of software bringing with it an effective solution of a problematic of great importance.

Also, the project is developed so that the present methodological proposal of development can provoke multiple effects on the society of knowledge, leading them to elaborate new proposals in front of the scenario of surveillance in zones of risk for fires, or for any scenario that requires a development Oriented software for structuring and documentation. Initially, it is important to establish the two fundamental axes of justi- fication of research: methodological justification and practical justification, since the characteristics that are worked in each section are indispensable to demonstrate the motivation and need to adopt the present project.

Arguing in terms of methodological justification, the present research project is essentially a software engineering project, based on development with nuances of quality and documentation directed to a field of action, and it is precisely this feature that makes it somewhat formal Within the scientific institution, since it is surreal to speak of a development that is built on the pillars of software engineering, without being strict with this branch of knowledge as a globally accepted science, designed, elaborated, evolved and evaluated.

However, it is not enough to mention software engineering explicitly as a form of motivation; it is still a real procedure to delimit all the techniques required for research, understanding that it is an institution that is constantly evolving within short periods of time. Time, but it is possible to establish that the main instruments are quality and software documentation, in the sense that they are the two most outstanding properties that identify the software engineering projects currently, and from these derive methodologies worked by the community of the knowledge in this context, necessary in terms of collection and successful use in each of the points of elaboration of the project.

And finally, the reasoning for practical justification becomes more understandable when interpreting that once the software is designed under the standards that are collected from the institution of software engineering, it has a pragmatic objective and is to direct its development towards a functionality That gives life, to be implemented in a context and that can evolve methodically.

The context that is being hinted at is the context of remote surveillance in areas of fire risk, something that is truly attacking a field of action within society, and whose implementation may be reflected in the results provided by immersed research Already within a workspace. Since it is being treated about an optimization process, it is emphatic how the present project intends to use all its training in software engineering to facilitate the immediate recognition of alert situations in an area of risk in order to take the necessary measures and to reduce the damage that fires cause in the environment. In this way, this research project describes its main reason of work in developing a remote surveillance system for fire risk areas through quality tools and documentation in software development, to optimize the processes of detection and prevention of fire. The fires to the context where the software is implemented.

It should be emphasized that even though the context is strongly rooted in forestry engineering, there is also a tool that must be sufficiently elaborated to meet the needs of remote surveillance and immediate alert, among other emerging requirements according to the Environment evolves. This feature is only achieved through software engineering, since it is a tool that is contemplated as a system located in a field of action waiting to evolve as its context does, therefore, it will be a tool that effectively helps The institutions responsible for environmental regulation in terms of fires in areas at risk, but also the result can be used as a teaching center for possible research projects oriented to software engineering.

2. Background

The surface area of forest forests has been changing during the last 25 years, fires, pests, indiscriminate felling or winter seasons are the main causes of their decline. According to figures from the Food and Agriculture Organization of the United Nations (FAO) in 2015, a total of 3999 million hectares of forest area were registered, a figure that in years much later was significantly higher, annually by percentage The rate of change can be represented as 0.13 decremental, which generates an alarming situation and a broad field of research to present solutions and manage to slow or at least gradually reduce that damage.

Many research and developments in different parts of the world are aimed at providing and giving significant contributions to the problem of forest fires understood as one of the worst consequences of the prevention, control and timely reaction of these natural or intentional disasters. Independent models of the technologies aim to analyze different fire elements, current environmental elements or generate knowledge bases for the creation of systems for increasingly accurate predictions and with the minimum error rate.

The use of Sensor Networks and Wireless Actors (WSANs) as shown in Figure 2 as a strategy for detecting and extinguishing fire represent a great contribution, due to its form of implementation seeking the minimum of energy consumption and obtaining Expected results [2].

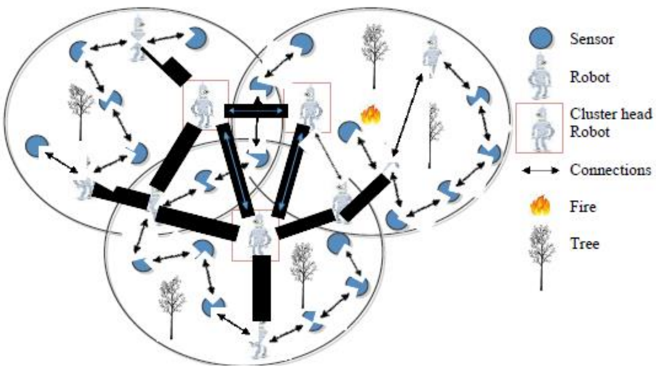

Figure 2. WSAN implementation. Source: [2]

On the other hand, the direct analysis of the smoke resulting from the first fires generates a starting point to be able to predict new possible scenarios or fire activity, to identify key factors in the smoke and to carry out a corresponding morphological processing. Then, analyzing the rate of false positives and the rate of recognition of the results of these experiments, it selects the combination of direction of motion, high frequency energy based on the wavelet transformation and compactness to constitute the final recognition vectors [3,4].

On the other hand, the construction of Unmanned Aerial Vehicles (UAVs), solves the problem of the surveillance and detection of forest fires, even when a failure occurs in one or more UAV within the perimeter of surveillance and control. Having a scenario similar to the figure 3 with a fault included and presenting the reaction of the UAVs involved in the attention of the natural disaster as shown in Figure 3 [5].

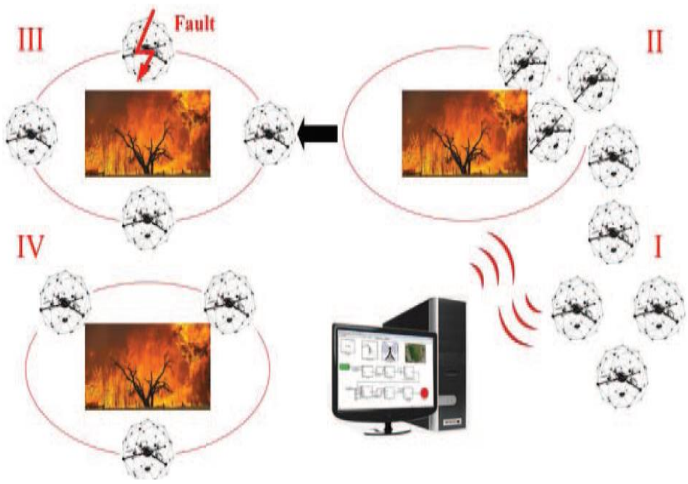

Figure 3. Forest Fire Monitoring. Source: [5]

The design of an intelligent platform developed for the recognition and response to disasters using a deep forest-based forest fire monitoring technique using images acquired from an unmanned aerial vehicle with an optical sensor. Through training for the set of images as shown in Figure 4 of past forest fires, the proposed deep learning based forest fire monitoring technique is designed to make human judgment for a new image of Entry is automatically whether the forest fire exists or not [6].

Label-2	Fire			Non-fire		
Label-6	Fire-nighttime	Fire-daytime	Smoke	Spring-fall	Summer	Winter
Training images						

Figure 4. Analysis of images of forest fires. Source: [6]

Another possibility developed and implemented, using the concept of thermal infrared channel (TIR), which contains wavelengths sensitive to the emission of heat. And taking advantage of the fact that forest fires can be characterized by peaks of intensity in TIR images. A fully automatic method of detecting forest fires from TIR satellite images based on the theory of the random field [7] is proposed as shown in Figure 5. The work developed in 'ESS-IM applied to forest fire prediction: Parameters tuning for a heterogeneous configuration' represents a study of calibration of the evolutionary-statistical system with the evolutionary parameters of the island model (Evolutionary-Statistical System with Island Model ESS -IM).

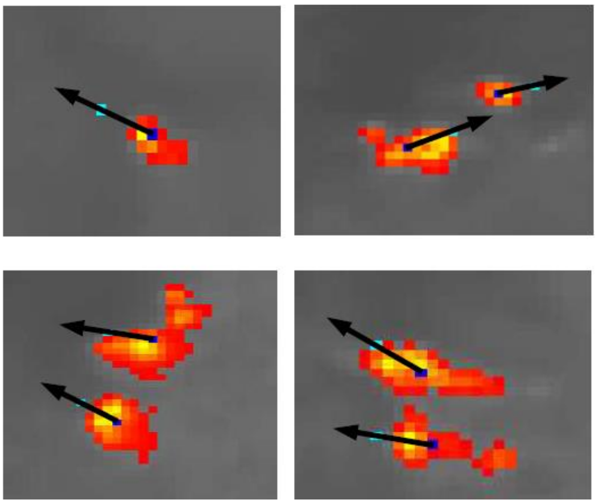

Figure 5. Detection of Forest Fire and possible propagation. Source: [7]

ESS-IM is a general-parallel uncertainty reduction method applied to the prediction of forest fire propagation as shown in Figure 6 [8].

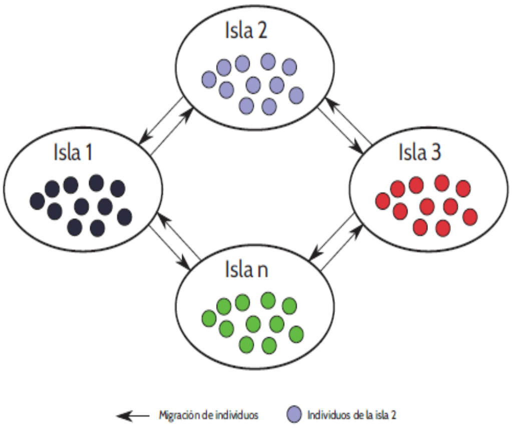

Figure 6. Island-based parallelization scheme. Source: [8]

The prevention work not only remains to be able to predict a possible fire, but on the contrary goes beyond, to the point of analyzing the possible propagations or factors that can greatly increase the current emergency, therefore, the implementation and construction of A system based on and expressed in cellular automata capable of simulating and effectively predicting the propagation tendency of the forest fire in various conditions represents a vital support for the treatment of fires already generated and at risk of propagation in the affected area [9].

Within the proposal of design and appropriation of the different existing techniques that contribute to the construction of a much more robust device, it has the work of fuzzy logic, where the possibility to predict and anticipate scenarios of forest disasters, includes the current proposal as an important and key component for greater support and better intervention in the different frameworks in which they can be presented. This is how the work developed in [10] is a great investigative and supportive contribution Where an “approach on board fuzzy logic” is presented to identify and detect active fire spots in the Brazilian Amazon forest considering the separability of the spectral characteristics of the fire considering it a valuable contribution to the current research and development of a device that includes knowledge And accurate predictions of possible forest risks.

Following the same line of research, involving and approaching artificial intelligence issues is the related work [11] where a network of wireless sensors is proposed for the reception and capture of records used in the fuzzy system, where five functions of Membership with the most relevant attributes of analysis presents the probability of fire in the areas of study and interaction that is being worked on. Having thus, another point of reference quite important and that covers many related aspects to work and to deepen.

In the search for good performance and assertive information delivery, it is extremely important to recognize the general state of the proposed structure, for example, the nodes of a network of wireless sensors feeding a fuzzy system, or perhaps the emitters of Information from the receiver of temperatures, winds and so on, all of this is addressed and routed in the work of transmission using routing and related techniques of the networks, so, at work [12] expresses an interesting effort by To recognize potential failures and errors within a network of related nodes, assigning and calculating a level of confidence to classify them under a fuzzy logic framework to later eliminate or treat those that are failing, reducing the percentage of error and increased the possibilities of an excellent operation in all the architecture of reception, analysis and control early warning of forest disasters or damage scenarios in forests and wild flora. Similarly, the work [13] is another support point for that faulty nodes search and management and does not alter the proper functioning of the system in charge of the detection, prediction and early control of forest fires or disasters.

3. Methodology

Figure 7 is the representation of the methodology that will allow the development of research, in terms of its most representative components during the management phases, and the relationships of the main components associated to the proposed system. It has an objective context, which can be understood as the plant where there will be installation of a physical assembly, which will allow to manage sensorial data flows, through a temperature sensor, to bring the notion of the state in which the environment is That you want to monitor and follow up. The system will be able to capture this data flow, and apply transformations to its input to have the prediction module based on fuzzy logic, i.e. using a predictive component, can extend the monitoring properly made from reading the flow of information, and to follow up the possible states of temperature as the system learns its data entry. With this, the system will reproduce the competent information to its telecommunication module with mobile devices, in order to send the information flow to a user, through its mobile technology, so that it can consume the information concerning the surveillance and supervision of a potential catastrophe risk area.

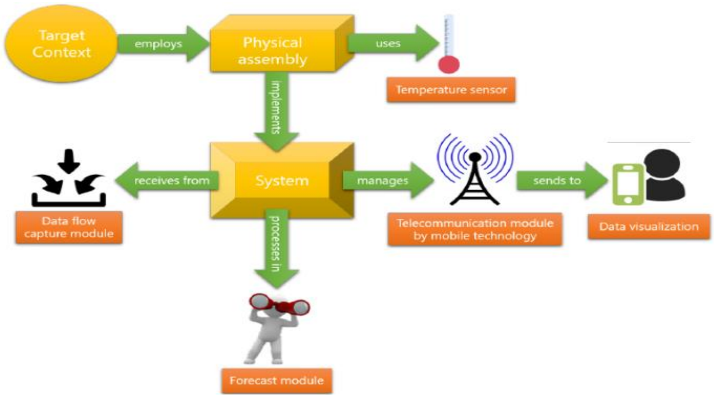

Figure 7. Illustration on Research Methodology. Source: Authors

In the Figure 8, it is possible to appreciate the methodology concerning Software Engineering that will be used for the development of the project. The use of the Scrum methodology allows the design of the project in an agile process, since this approach allows clarity on the development of the phases, and delivery of artifacts for projects that require a robust software process. From this perspective, the Scrum methodology describes a framework for working with the proposed software as it describes each of the stages of development. In this sense, it is also proposed to make a process specification, which is contained within the framework in Scrum, and is the life cycle in Cascade, for the moment of implementation, since it is expected that by that time A complete specification of requirements, and have an advantage over the progress in software development in terms of quality and documentation.

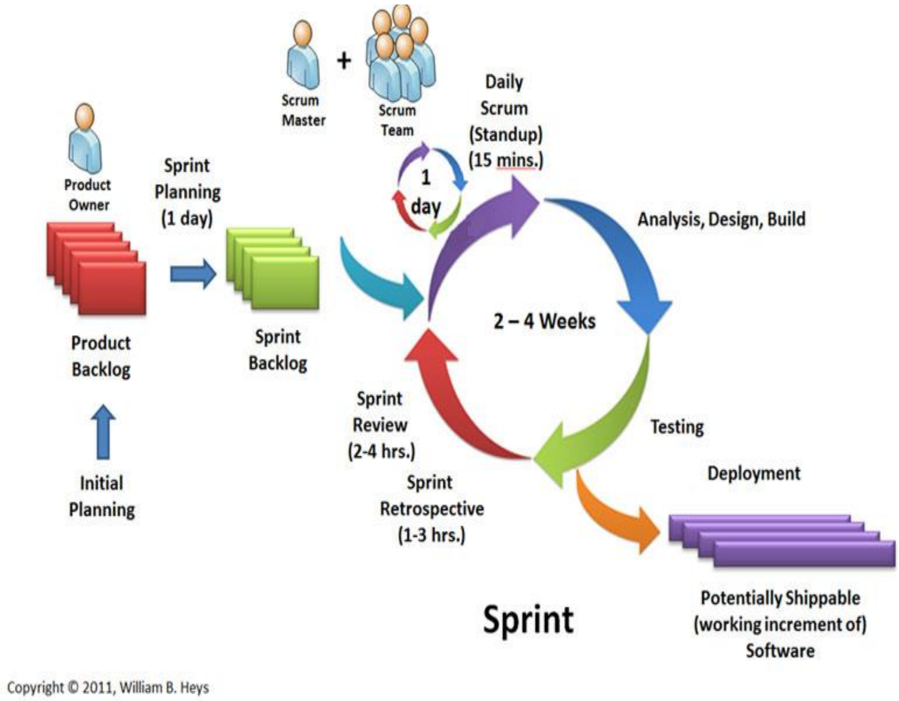

Figure 8. Illustration on SCRUM Methodology for software development. Source: [14]

In the Table 1 it is possible to appreciate the structure of the data to be handled during the experimental development of the system. This table contains specific aspects about the details that will be taken into account for the presentation of the implementation and results obtained for the eventual analysis. This information establishes how each of the methods and techniques that will allow the monitoring and monitoring of temperature through the system will be performed in the sense presented by the experimentation documented here and the process to be followed to consume the product information. It is necessary to clarify that in the data of capture pulsations, it is a configuration available for the sending of data obtained sensorially, by reason of each interval of time, so that the amount of registers exposed for the experiment covers a period of time in the That the correct analysis can be provided and thus offer the services developed in the system.

Table 1. Data structure

Description of the data		
Concept	Datatype	Units
Temperature	Numerical	Celsius Degrees [°C]
Description of the experiment		
Capture Sensor	LM35	
Technology	4.0G LTE	

Table 1. Data structure

Description of the data	
Visualization	Mobile device (Android)
Capture pulses	Ten (10) seconds (sec.)
Number of Records	One hundred (100)
Description of the experimental plant	
Dimension	13:4m3
Window	On a wall with 1:5m2
Door	On a wall with 1:5m2
City	Bogotá D.C.
Season	May 2017

4. Design
4.1. Client-Server Architecture
In the Figure 9 you can observe an architectural conception design, as it is the scenario of a traditional client-server model, and it is an appropriate design for the development of the investigation, to the extent that it allows the relation of Desired direct communication with users who wish to receive information flow, but that must be managed, and this is achieved through a server that does the management of the system, to obtain answers associated with requests.

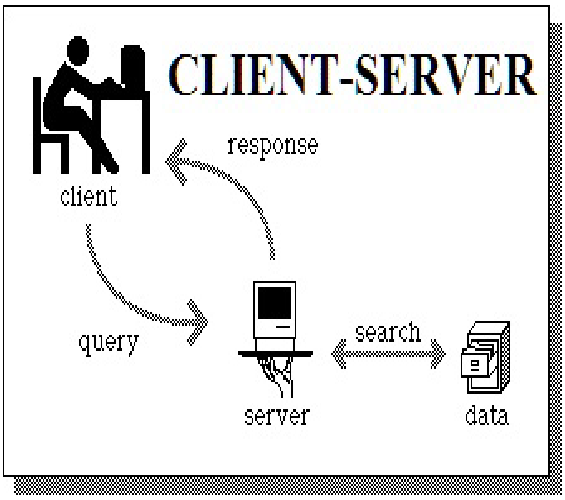

Figure 9. Traditional Client-Server Architecture. Source: [15]

4.2. Software Engineering Models
In the management of the research project, it is necessary to have sufficient documentation, insofar as it is a software for the development of a problem situation. In the following sections, I will present the design models developed under the UML standards for Software Engineering, explaining their role in the management of the research project, using a highly refined CASE tool, such as Enterprise Architect [16]. Use Case Diagram: The Figure 10 represents the abstraction of the system's functionalities, in relation to the proposed use cases, through the UML standard. In this approach, the design is provided on what will be developed, in a high level of abstraction, with the intention of defining the scope of the system to be developed.

Activity Diagram: Figure 11 presents the modeling of activities conceived in the development process. It is important to highlight the importance of decision making so that the system can identify which process to perform, depending on the capture from its installation. States Machine: Figure 12 shows the modeling of the fundamental states of the system, for the development of the project. Features similar to a previous description of activities are observed, but in this scenario the emphasis is more on the states that the system would be, as well as its guards and triggers.

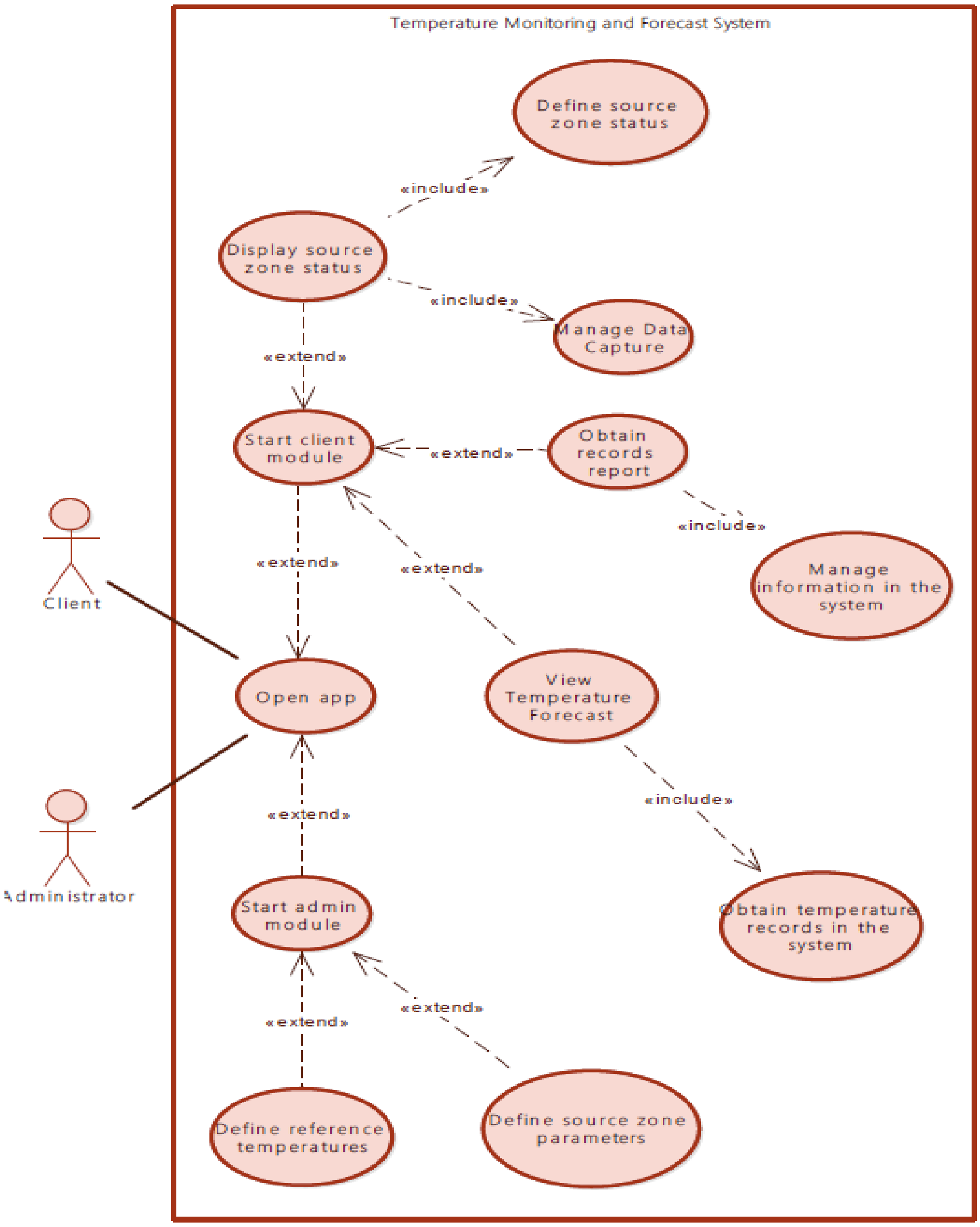

Figure 10. Use Cases for Software. Source: Authors

At this point it should be mentioned that it is already possible to identify the proposal for the states of the system, which are described below:

a. Normalized state: Occurs in the scenario where the study area is without risk, as its temperature captures are within a range acceptable to the system.
b. Warning status: When the temperature capture reaches or exceeds a reference temperature for warning (which is subject to installation conditions), the system recognizes that it must be alerted, as there is a risk that when controlled or supervised, would avoid catastrophes in The study area.
c. Alert status: When the temperature capture reaches or exceeds a reference temperature for alert (which is also subject to installation conditions), the system enters alert, and at this point there is an imminent risk on which to act immediately, already thinking about the notifications that are made from the software.

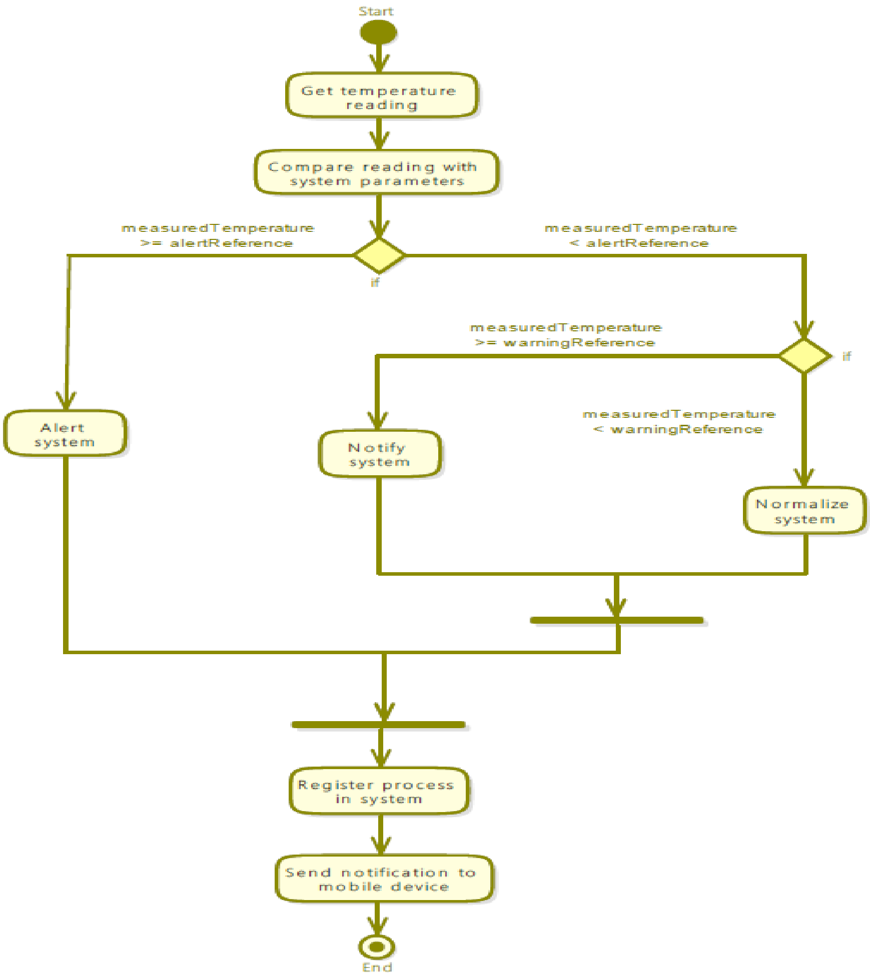

Figure 11. Modeling of project activities. Source: Authors

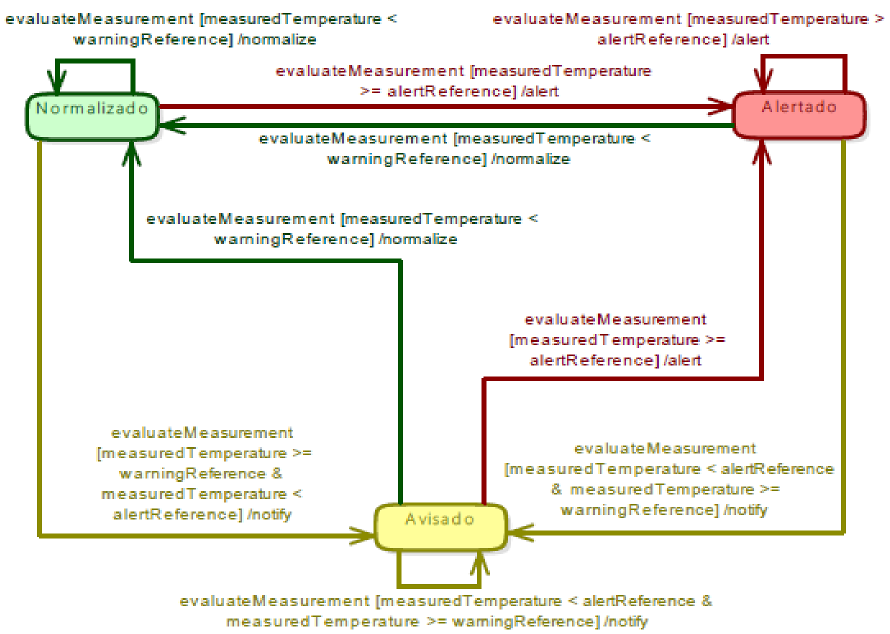

Figure 12. States machine proposal for the project. Source: Authors

5. Implantation
5.1. Deployment of the project
The deployment of the project is possible to understand it through the diagrams of nodes and artifacts, being a software system according to the standardization of documentation and the quality of development. Node Diagram: In the Figure 13 it is possible to appreciate the arrangement of nodes, as an abstraction endpoint, which is the closest thing to the implementation and installation of the software in an application environment. It should be mentioned that the communication flow between the nodes follows a sequential pattern, as the information is traveling from a server to a client, however, it is understood that there is a constant data capture from the microcontroller device, which causes The flow of communication is continuous and provides a more appropriate and sustainable use of software.

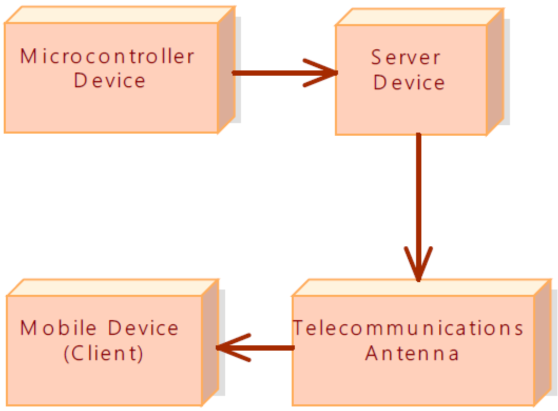

Figure 13. Deploy through the node diagram. Source: Authors

Artifact Diagram: In Figure 14 it is possible to observe a more concrete representation of the final devices that are part of the software deployment. These devices are the ones that make possible the transformation of the information through the flow of processes, to arrive from a capture in a zone of study, towards a visualization of the information.

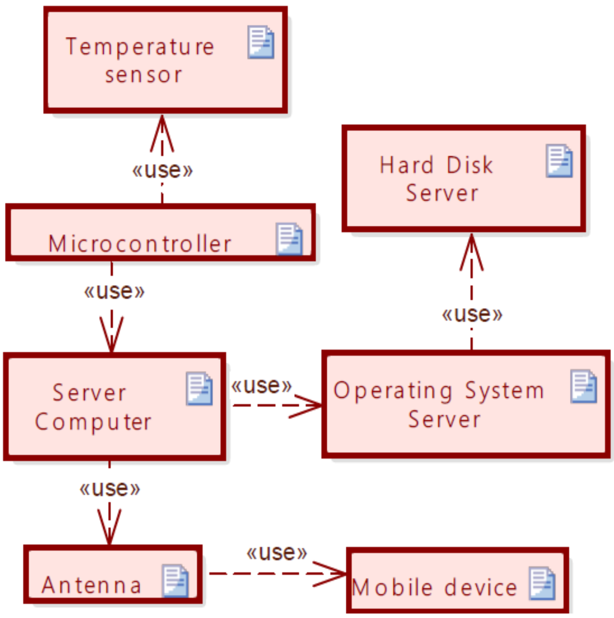

Figure 14. Deploy through the artifact diagram. Source: Authors

Application on Android: In the same order of implementation, I conceived the construction of a mechanism to achieve the emission by the software system and the reception by the Android customers, through the notifications that this operating system provides. Thus, in the Figure 15 the operation established for the creation, sending and reading of notifications is displayed, as the software system is in its monitoring and control work. Within this operation it is highlighted the assignment of a single token or identifier to each client, which is registered by the server provided on the server side of the software, which then uses the messaging service provided by Google called Firebase Cloud Messaging Who is responsible for sending the notification created from the control and monitoring proposed by the application built. Therefore, each user interested in receiving such notifi- cations complies with this procedure and is subscribed to receive notifications of the process of recording and controlling temperatures in the area that is of interest to them.

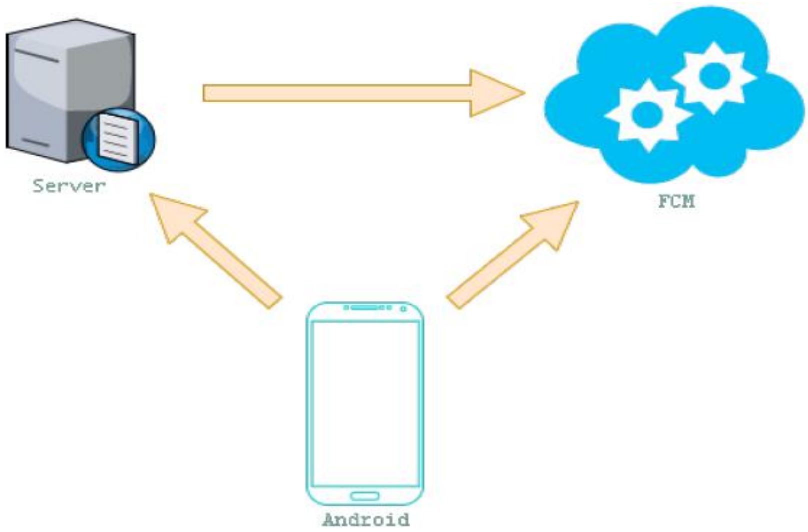

Figure 15. Mechanism and operation of the application on Android. Source: Authors

Calculations for the transmit antenna: Due to the need to transmit the information to a mobile device, it is necessary to implement an antenna with 4G technology, and for this, it is necessary to calculate some parameters in order to obtain the desired assembly. Initial Parameters: In the equations (1) and (2) the initial parameters are presented, so that it is possible to begin by indicating the desired transmission frequency, and the function associated with the transmission of the signal.

$$f = 3Ghz \tag{1}$$

$$U = cos^5(\theta) \tag{2}$$

Main Values: In the set of equation (3) and (4) the calculation for the APBW and FNPW standards is made, first with the declaration of assignments to the functions of the proposed signal in the (3); And then finding the values for 2θ in each standard in the (4).

$$cos^5(\theta) = 0 \; cos^5(\theta) = \frac{1}{\sqrt{2}} \tag{3}$$

$$2\theta = \pi \; 2\theta = 0,736098 \tag{4}$$

Radiation power: In the set of equations (5)-(7) the procedure is performed to calculate the expected radiation power for the antenna, according to the initial parameters, so that in the (5) the associated declaration is made with the equation of the radiating power [17] in the (6) the substitution is made by the initial function of the signal; And in the (7) the result associated with the radiative power is displayed, after operating on the proposed calculation.

$$Prad = 02\pi 0\pi 2\ U\sin(\theta)\ .d\theta\ .d\varphi \quad (5)$$

$$Prad = 02\pi 0\pi 2\ 5\theta\sin(\theta)\ .d\theta\ .d\varphi \quad (6)$$

$$Prad = \pi 3 \quad (7)$$

In the Figure 16 the result of the implementation on the developed system, in terms of the temperature captures in an experimental field room, located in the city of Bogota D.C., in Colombia during the present year, is exposed. In this figure the temperature values in degrees celsius [◦C] can be seen at different times, captured at ten [10] minute pulsations between registers. It is important to note that the times were taken in negative due to the use of this information as an empirical element to demonstrate the operation of the fuzzy system later.

The Figure 16 places the time variable in the iterations of the hundred records established during the data structure, to transform this region to the dimension of the temperature variable recorded during the experiment. The understanding of the values of these variables is equated between 14◦C minimum and 20◦C maximum during the collection of information within the system, and the statistical mean of these numerical values is concentrated at 17◦C. This graph interprets the scenario of the experimentation without allusion to the totality of the records and supports the comparison with the result of the fuzzy system of prediction implemented.

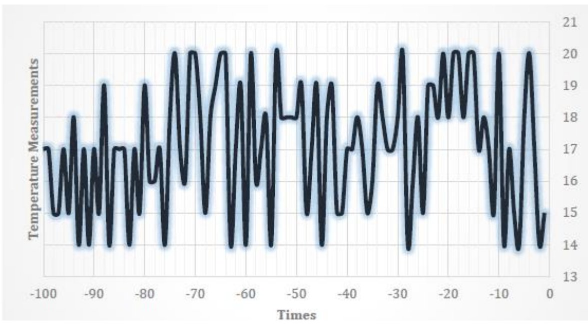

Figure 16. Experimental Temperature Records. Source: Authors

Design of the fuzzy prediction system Initially, you can think of a scheme of functions as seen in the set of equations (8)-(10), where I determine the antecedent responsibility to the equation (8); Determine the present liability to the equation (9); And determine the consequent liability to the equation (10). This proposal would be supported by the fact that the fuzzy system can be fed with the predecessor and present experimental values, so that it is possible to determine the consequent through a fuzzy logic-based procedure.

$$X(t - 1) \quad (8)$$

$$X(t) \quad (9)$$

$$X(t + 1) \quad (10)$$

Thus, the function set forth in equation (8) would have the same form as shown in Figure 16 in an experimental case, since it describes the behavior of a phenomenon measured empirically. Membership Functions: After defining the system design, I proceed to define the membership functions associated with the operation of the prediction based on fuzzy logic [18]. These membership functions allow modeling the behavior of temperature records with respect to an algebraic structure by means of fuzzy sets. In the set of equations (11) and (12) the membership functions that define the fuzzy sets for the antecedent X(t−1) in equation (11) are taught; And for the present X(t) in the equation (11). It is worth mentioning that the replacement of the x value would be performed on the registers that are loaded to the functions described above.

$$\mu_{X(t-1)} = \frac{1}{1+e^{-0.15(x-21.18)}} \quad (11)$$

$$\mu_{X(t-1)} = \frac{1}{1+e^{-0.12(x-22.69)}} \quad (12)$$

Compressor based on logical relationships: Given that a prediction system based on fuzzy logic is being treated, a compressor based on logical relations [18] can be used based on the established membership functions, to obtain the functions associated with the consequent, such that to determine the desired prediction. In the procedure included in equations (13)-(17), the value of this compressor is explained through the value of the consequent sought during the design of the prediction system, as well as the calculation to be followed according to experimental data. The factors of each addition in the compressor were obtained from adjustments from the statistical mean in the experiment previously described in Figure 16.

$$CBR = X(t+1) \quad (13)$$

$$= 7 * MIN\left[1 - \mu_{X(t-1)}, 1 - \mu_{X(t)}\right] \quad (14)$$

$$= 10 * MIN\left[\mu_{X(t-1)}, 1 - \mu_{X(t)}\right] \quad (15)$$

$$= 15 * MIN\left[1 - \mu_{X(t-1)}, \mu_{X(t)}\right] \quad (16)$$

$$= 16 * MIN\left[\mu_{X(t-1)}, \mu_{X(t-1)}\right] \quad (17)$$

Prediction results: In the same order of the above experiment, the result obtained from the prediction of the fuzzy system can be seen in the Figure 17, by means of the comparison between the functions of real value [X(t)] and value Predicted [X(t+1)] at each of the record times in the previous experiment. It is important to mention that the behavior is quite as desired, as the system is fed with empirical values, and in this way, future (or consequent) values can be offered to the temperature registers with respect to a sample of Temperature records.

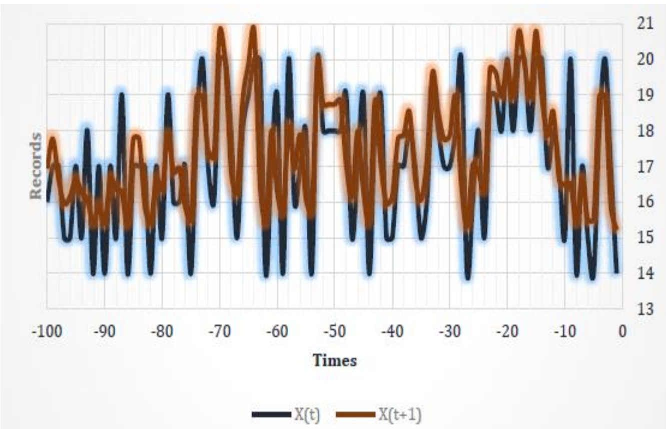

Figure 17. Comparison between actual values and predicted values. Source: Authors

In fact, the system can provide prediction values for this field experiment, as can be seen in the Table 2, where for the times t=0 and t=1, the values of X(t) and X(t+1) represent the real and future values respectively, ie, for the following positive times, after the negative empirical collection, an analogy is made to the behavior of the registers Temperature and the prediction to themselves. This supports the comparison of the performance analysis on the results of the implementation and the mismatches between the mathematical functions, depending on the behavior of the fuzzy prediction system.

Table 2. Values predicted by the system

t	X(t)	X(t + 1)
0	15:22	16:21
1	16:21	16:66

6. Results

Table 3 sets forth the result of the calculation related to the sum of the quadratic error obtained from the field test with the fuzzy logic based prediction system, rather than for service automation systems for the monitoring and supervision of Remote areas is an emerging research challenge, whether they are dealt with computational elements for the analysis of forest environments [3,5,9], or through the learning of machines using cybernetic automata [6,10,11].

Table 3. Sum of the Quadratic Error During the Experiment

E	220; 85

From the analysis related to the analysis of forest environments [3,5,9] it was able to interpret environmental variables, such as temperature, atmospheric pressure, carbon dioxide level in air; And environmental contexts of the plants on the physical assemblages, which were not parameterized for the experimentation of this research project, at the same time that this research concentrated its interest in the independence by the scenario of implementation and in the domain of the system of Software itself.

While machine-directed analysis using cybernetic automata [6,10,11] interpreted the problem from a more control approach, and certainly with a more dense mathematical rationale, In spite of the fact that in this research the value of being implemented under the ideology of software development in the provision of computer services was added on the environmental states that represent a study area that can potentially be forest or high risk relative to temperature, With the systemic implications that include more scenarios than those proposed when establishing a data plan.

In fact, in each work that is directed to the resolution of a problem with some criterion of uncertainty, it must contemplate the scenario of the tolerable error of the designed system, so that the future work is the optimization of this factor to increase the credibility of the product. In the Table 4 is possible to observe the values of the variables that can be improved under a numerical method to obtain an improvement in the index of the quadratic error, that is to say, by means of an algorithm of operational optimization based on the mathematical functions for the data used in the experiment, solved using the SOLVER mathematical module of the Microsoft Excel [19] tool, the prediction system must be able to optimize its criteria to have the correct balances when providing an appropriate monitoring and tracking service. This research challenge challenges the software system developed to adapt its processes to the realization of these refinements, depending on its continuous improvement.

The values presented here are the result of the mathematical module of the aforementioned computer aided tool, which takes as the optimization factor the sum of the quadratic error, on the calculations of the mathematical model, and allows a variation on the functions and constants that reach The best value of comparison between the predicted values and the actual measured values, such as 0.055 and 0.098 in K1 and K2 respectively, towards the dispersion values in the membership functions; And 16.98 and 21.55 in C1 and C2 respectively, towards the values of centralization in the membership functions.

Table 4. Criteria for Error Reduction

Variable	New Value
K in $ц_{X\,(t-1)}$	0:055
C in $ц_{X\,(t-1)}$	16:98
K in $ц_{X\,(t)}$	0:098
C in $ц_{X\,(t)}$	21:55
B_1 *in CBR = (t + 1)*	0:024
B_2 *in CBR = (t + 1*	0:004
B_3 *in CBR = (t + 1*	18:131
B_4 *in CBR = (t + 1*	25:076

In the Table 5 it is possible to appreciate the sum of the quadratic error related to the experiment, but applying the parameter adjustment mentioned above. It should be emphasized the great improvement that leads to the experiment, as the quadratic error has been greatly reduced. Consequently, this aspect would directly place a new milestone for the already developed monitoring and temperature monitoring system, which would increase the reliability of the information provided by all the services exposed.

Table 5. Sum of the Quadratic Error with the Parameter Setting

E	0; 13

Compared with the research of Lafarge, Descombes and Zerubia [7], both have to consider the implementations of a fuzzy system based on logical rules, but in this investigation I worked with the variation of parameters implementable from the software system, Such as those set out in the table IV, in values of the variables K1, K2, C1, C2 within the membership functions, in the values of the constants in the compressor based on logical relations, with the possibility of providing better reliability with the proposed quadratic error limit.

In relation to the research of Renubala and Dhanalakshmi [12], it is true that the implementation of fuzzy systems based on logical rules have all the guidelines of modeling and implementation, but this research does not include aspects of information security With the system itself, while in the investigation of the two authors, a section is specifically addressed to the proposal of improvement on sensors in the communications networks where they install their service of fuzzy logic, that is to say, they have a teleinformatic research project completely, but obviating aspects of improvement in the treatment of information, such as the implementations made here.

7. Conclusions

The presentation of the temperature monitoring and forecast system has defined the composition of the software development, insofar as it has solved the scope of the project with an implementation of mobile 4.0G LTE technologies for the proportion of a remote computer service; Which in turn provided a predictive analysis for system feedback with the intention of providing decision support for high-risk areas, measurable through their temperature records.

The development of the research software included in the nuances of analysis with previous research works has contributed to a system of refinement in the provision of computer services with the intention of solving a constant problem in contemporary society, to the point that A system that, under experimental conditions, has not passed a quadratic error sum at 2.6%, ie, through the experimental implementation of the monitoring and supervision system, the information management procedure has been observed To the point of changing a quadratic error sum of 2.2085% to a value of 0.0013% of the tables III and V respectively, which looks at the control of variables on the software model , Would support any practical scenario where it is installed.

These figures related to the sum of the quadratic error are intended to justify the importance of the integrity of the information provided by the system based on a predictive model from fuzzy logic, so that it is decided not to exceed a high error rate, and In addition, allow a parameter variation adjustable to multiple implementation conditions, with the idea of reducing the impact of the error under the desired prediction, as evidenced by the change from

7, 10, 14 and 16, to 0.024, 0.004, 18.131, and 25.076 in the constants B1, B2, B3 and B4, respectively, within the logic-based compressor, and set out in the Table IV.

However, the temperature monitoring and surveillance system in remote areas using mobile 4.0G LTE technologies reaches and challenges research fields with interest in improving the conditions for decision making in environments that represent a problem for a population. The methodology described above refers to the continuous improvement that is understood as the system can make a variable candidate as it requires an installation on demand in different plants, i.e. aspects such as atmospheric pressure, carbon level in the air, circulation of undulatory movements, can contribute to a more sophisticated surveillance; While introducing new variables to the fuzzy system based on logical rules could avoid the constant change of parameters necessary for error reduction, i.e., to think of a model change oriented to $X(t-1)$, $X(T)$ and $X(t+1)$.

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