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(54) **Title**: THE METHOD AND SYSTEM OF MONITORING THE LV (LOW VOLTAGE) ELECTRICITY INFRASTRUCTURE USING GSM COMMUNICATION TECHNOLOGY AND TAKING PRECAUTIONARY MEASURES

(57) **Abstract**: The invention shares the alarms generated by failures or interruptions due to the infrastructure of the electricity distribution network of the GSM network with the electric network distributors at an appropriate interface. It increases electrical failure sampling emission points. According to the present state it is a method and system of monitoring the LV (Low Voltage) electricity infrastructure that uses GSM communication technology and taking precautionary measures which aims to reach a more stable and high efficiency electricity infrastructure.

Description

Title of Invention: The Method and System of Monitoring the LV (Low Voltage) Electricity Infrastructure Using GSM Communication Technology and Taking Precautionary Measures

[0001] The invention shares the alarms generated by failures or interruptions due to the infrastructure of the electricity distribution network of the GSM network with the electric network distributors at an appropriate interface. It increases electrical failure sampling emission points. According to the present state it is a method and system of monitoring the LV (Low Voltage) electricity infrastructure that uses GSM communication technology and taking precautionary measures which aims to reach a more stable and high efficiency electricity infrastructure.

Present Technique

[0002] In the currently used methods and systems, electrical network distributors are able to determine faults, which occur during use, only by customer / user feedback. In this case, when the malfunction feedback of customers /users is delayed, the process of resolving the fault or problem is also delayed. At the same time, the malfunction feedback of customers /users does not provide clear location information about where exactly the fault occurs.

[0003] In the currently used GSM technology, each base station has its own electricity meter, where it gets its mains energy, and therefore these meters have subscriptions. By using the subscriber no. and counter no., it is crucial for the electricity network providers, to show which transferee service this counter receives. Therefore, the information that the subscriber no. and counter no. of each base station addresses a traffix of EDAŞ (electricity distribution companies) should be known at the beginning.

[0004] Each GSM base station is monitored 24/7 by GSM operators who own base stations. These monitors are the identification and monitoring of different types of alarms on each base station. These alarms are constantly monitored by the employees of the operators' network control centres. When any alarm occurs in a base station, GSM operators open a Work Order (WO) to their own crew to solve the problem based on this alarm.

[0005] There are two types of alarms that are important to our invention:

- Mains Alarm (If there is an interruption of the mains power, the generated alarm will indicate that the mains power is off at the moment)
- Under Voltage Alarm (This alarm type includes drops in the mains voltage, current values and phase measurement values).

Definition and Functions of the Invention

[0006] For each base station, a base station no., coordinate information, a subscriber no., a counter no., and Mains / Under Voltage alarm, which are taken from the GSM operator, are received as one format and transmitted to the server of the invention. By using the relevant subscriber no. and counter no. of these base stations, it is consolidated to which transformer in the EDAŞ area they are determined. At that very moment the software of the invention works for this consolidation process. It then creates polygons for each transformer zone. That is, within the scope of the invention, it is possible to define more than one signal and emission point in a transformer zone.

[0007] As a result, the platform defines more than one signal that arrives at a transformer zone as the service area of that transformer zone.

[0008] Incoming alarms start to be processed and if in a transformer zone, for example service is received from 10 points and an energy cut alarm is received from all of these 10 points, the system identifies it as a transformer failure and displays it in red on the map and/or EDAŞ's GIS (Geographic Information System) to address that the problem is on the transformer and opens a trouble ticket (error reporting) for the repair crew.

Aim and Benefits of the Invention

[0009] Within the scope of this invention, it is planned to increase the monitoring, control and availability of electricity distribution networks by covering the information and requirements of two major engineering fields (Electronic Engineering and Electrical Engineering).These benefits include reducing of operator availability and back-up investments, a more stable energy network and management due to increasing availability by EDAŞs, faster failure resolution and customer satisfaction, and replying more positively to the regulatory agency's expectations and KPIs, and when evaluated on the basis of users, preventing victimization that may be experienced due to energy cuts.

Detailed Explanation of the Invention

[0010] Data 1(For each base station base station no., coordinate information, subscriber no., counter no. and Mains / Under Voltage alarm information are taken from GSM operators,)

[0011] Data 2 (Transformer definition information received from EDAŞ by using subscriber number and counter no information of the base station)

[0012] For each base station, a base station no., coordinate information, a subscriber no., a counter no. and Mains / Under Voltage alarms (data1), taken from the GSM operator, are received in a format and transmitted to the server of the invention. By using the relevant subscriber no. and counter no. information for these base stations, the information (data 2) is consolidated to which transformer in the EDAŞ area they are determined, and at that very moment the software of the invention works for this con-

solidation process. It then creates polygons for each transformer zone. That is, within the scope of the invention, it is possible to define more than one signal and emission point in a transformer zone.

[0013] Incoming alarms start to be processed and if in a transformer zone, for example service is received from 10 points and an energy cut alarm is received from all of these 10 points, the system identifies it as a transformer failure and displays it in red on the map and/or EDAŞ's GIS (Geographic Information System) to address that the problem is on the transformer and opens a trouble ticket (error reporting) for the repair crew.

[0014] A red alarm sign on the map clearly indicates that there is a transformer failure in the transformer. Therefore, there is no need to search for failures in an area from one building to another. It directs the field teams to solve the failure at the transformer. In this way, it is ensured that both the field teams save time and the defects are detected in a much shorter time. Thus, eliminating failures in a shorter time contributes to the increase in income due to the increase in availability.

[0015] If service is received from 10 base stations and the energy cut alarm is not received from all of these 10 base stations, the system interprets this as a branch/ an extension failure in the transformer service area and not as a transformer failure and marks the power cut points on the map with yellow alarm marks and clearly indicates where the failure points are. At this point, the following explanation would be clearer. Suppose that there are 4 consecutive samples on a branch / an extension. If there is energy in the first three of these 4 samples and no energy in the 4th, it is obvious that the problem is at a point between sample 3 and sample 4.For this reason, by exploring the field between these two points, the repair crew is able to find the failure point and interfere more quickly in a very short time. All of the above mentioned advantages also apply to this example.

[0016] In the map display, the red alarm sign is displayed as a transformer failure and the yellow alarm sign is displayed as a branch / an extension failure, and if desired, sample points can also be displayed on the map. It is also possible to display sampling (emission) points on the map to indicate where the point data is received. In order to make all these data more meaningful for the administrators, the data is processed instantaneously on the dashboard and output is obtained by running the program.

[0017] Data flow and operation in the system are as follows:

Mains information is received from a GSM operator every 486ms, under voltage and other energy information (mains current, phase, voltage) are received every 5 minutes. Acquired information comes to the server of the invention and is evaluated in two stages after consolidation and data processing.

1- Instant display on the map

2- Big data processing

[0018] Instant display on the map and trouble ticket-clear operation:

Instant display on the map is realized in two ways. This is shaped by the future demands of EDAŞ. According to this, either User Definition (user and access identification) is made over the web, and web access and dashboard access are provided to the related EDAŞ by giving an IP, or it will be displayed over SCADA (Remote Control and Observer System)of EDAŞ and its integrated GIS systems. The SCADA system, which is the basis for this display, is integrated into this system. At this point, the SCADA system of the vendor, to which it belongs, will be converted into the data format to be integrated with the OMS (interruption management system) system, if available.

[0019] Opening the Map display and Trouble ticket through the web in Phase 2 of the invention will be made available to the use of EDAŞ repair crew with an application. Thus, trouble tickets and clear (failure elimination) information, can be transmitted to the final user as a notification through the application.

[0020] Big Data Processing;

In this process, the data that is processed and sent instantaneously is logged and recorded on the server. After this, reports called the evening Z report start to recur.

[0021] Accordingly;

Daily Z Report – Interruption
Daily Z Report - Under Voltage
Weekly Report – Interruption
Weekly Report – Under Voltage
Monthly Report – Interruption
Monthly Report - Under Voltage

[0022] The report includes information such as; daily, monthly and weekly interruption and Under Voltage headings as well as address, interruption class, interruption time, start time, end time, repetition frequency.

[0023] When the rate of the network is kept by looking at the daily total number of interruptions, the duration and recurrent interruptions, Under Voltage information is also removed in a similar format and the places where problems may possibly occur are proactively highlighted. Two failure categories are defined in this part of the report. If the detected failure is a transformer failure it is defined as A-1 and if it is a branch failure, it is defined as A-2.

[0024] Daily reports are followed by weekly and monthly reports. The main approach here is to prepare a weekly total interruption and Under Voltage report to identify repetitive and possibly larger failure locations. For this reason, failure points repeated 3 or more days a week are included in the weekly report, and failures repeated for 2 weeks or more are included in the monthly report.

[0025] In addition, reports based on the logged data and recommendations according to the desired scenario are produced.

[0026] Default scenarios:

1- Producing detailed analysis requests for daily repetitive A-1 class failures

2- Proactive load control, balancing and possible failure scenarios for daily repetitive A-2 class faults

3- Screening of daily recurring UV points and creating a failure scenario

4- Suggestions for avoiding failures by combining similar solution scenarios with field solution notes processed after failure clear

5- All the first 3 specifications will be repeated in weekly and monthly reports and «weekly» and «monthly» recommendation reports will be prepared

6- Creating quarterly benchmarked recommendation reports for investment planning, load distribution and failure management

7- Reporting of breakdown-cost analyses if fault solution costs can be processed

[0027] The basic operation of the invention is as follows:

- Receiving base station no., Coordinate information, subscriber no., Counter no. and Mains / Under Voltage alarms information (data 1) in one format for each base station from GSM operators,
- Transferring the given data (data1) to the server,
- By using the relevant subscriber number and counter number information for the base stations taken from EDAŞ, information (data2),to which transformer they are determined in that EDAŞ region, is obtained,
- Consolidating the software capability data1 and data2 in the server,
- Creating polygons for each transformer zone,
- Starting to process incoming alarms,
- Defining the failures,
- Displaying the failure on map and / or related EDAŞ GIS (Geographic Information System)
- Addressing the failure to the EDAŞ failure repair crew and opening a trouble ticket (error report)
- Logging and recording instantly processed and sent data on the server,
- Reporting at desired time intervals,
- Producing recommendations according to reports and desired scenario through logged data.

Claims

[Claim 1] The invention is the method and system of monitoring the LV (Low Voltage) electricity infrastructure using GSM communication technology and taking precautionary measures whose features are as follows;
- receiving base station no., coordinate information, subscriber no., counter no. and Mains / Under Voltage alarms information (data 1) in one format for each base station from GSM operators,
- transferring the aforementioned data (data1) to the server,
- by using the relevant subscriber no. and counter no. information for the base stations taken from EDAŞ (electricity distribution companies), information (data2), to which transformer they are determined in that EDAŞ region, is obtained,
- consolidating the software capability data1 and data2 in the server,
- creating polygons for each transformer zone,
- beginning to process the incoming alarms,
- defining the error,
- displaying the error on a map and/or on a related GIS (Geographic Information System) of EDAŞ,
- addressing the error to EDAŞ fault repair crew and opening a trouble ticket (reporting error),
- keeping records of instantly processed and sent data by logging on the server,
- reporting at desired time intervals,
- producing recommendations according to reports and desired scenario through logged data.

[Claim 2] It is the invention in Claim 1 which is the method and system of monitoring the LV (Low Voltage) electricity infrastructure using GSM communication technology and taking precautionary measures and whose feature is to receive Mains alarm (alarm that is generated if there is an interruption in the mains energy on the base station) from GSM operators every 486ms, to receive Under Voltage (alarm that is generated due to drops in the mains voltage, on the base station,) and other energy data (mains current, phase, voltage) every 5 minutes.

[Claim 3] It is the invention in Claim 1 which is the method and system of monitoring the LV (Low Voltage) electricity infrastructure using GSM communication technology and taking precautionary measures and

whose feature is to provide web access and dashboard access via IP, which is given to the relevant EDAŞ by making Server A User Definition (user and access identification) over the web.

[Claim 4] It is the invention in Claim 1 which is the method and system of monitoring the LV (Low Voltage) electricity infrastructure using GSM communication technology and taking precautionary measures and whose feature is to display the SCADA (Remote Control and Observation System) of EDAŞ on its integrated GIS systems.

[Claim 5] It is the invention in Claim 1 which is the method and system of monitoring the LV (Low Voltage) electricity infrastructure using GSM communication technology and taking precautionary measures and whose feature is to open the map display and trouble ticket to the use of EDAŞ repair crew and to transmit the clear (failure elimination) notification after the elimination of the failure to the final user through an application via the web.

[Claim 6] It is the invention in Claim 1 which is the method and system of monitoring the LV (Low Voltage) electricity infrastructure using GSM communication technology and taking precautionary measures and whose feature is that the report element is daily, monthly and weekly and includes data such as, interruption and Under Voltage headings, address, interruption category, downtime, start time, end time, recurrence interval.

[Claim 7] It is the invention in Claim 1 which is the method and system of monitoring the LV (Low Voltage) electricity infrastructure using GSM communication technology and taking precautionary measures and whose feature is that if the software element receives a Mains alarm (power cut) from all of the base stations in a transformer zone, the invention will identify it as a transformer error and indicate it by a red mark on the map and / or the EDAŞ's GIS (Geographical Information System) which addresses the problem to the repair crew and opens a trouble ticket (error report).

[Claim 8] It is the invention in Claim 1 which is the method and system of monitoring the LV (Low Voltage) electricity infrastructure using GSM communication technology and taking precautionary measures and whose feature is that if the software does not receive any alarm from none of the base stations in a transformer zone, the system interprets it not as a transformer failure, but as a branch / an extension failure in the transformer service zone and energy cut points on the map are marked

yellow which clearly displays these points to the repair crew.

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L12/24 G01R19/25 H02J3/00 H04W24/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04L H02J G01R H04W

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	HAU-REN LU ET AL: "Design and Implement of Distribution Transformer Outage Detection System", INDUSTRIAL INFORMATICS, 2007 5TH IEEE INTERNATIONAL CONFERENCE ON, IEEE, PI, 1 July 2007 (2007-07-01), pages 323-328, XP031161812, ISBN: 978-1-4244-0850-4	1,2,5,6
Y	page 323 - page 327; figures 1,2,4,5	3,4,7,8

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

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PCT/TR2017/050108

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KROHNS-VALIMAKI HEIDI ET AL: "Combined electricity and mobile network situation awareness system for disturbance management", 2015 IEEE INNOVATIVE SMART GRID TECHNOLOGIES - ASIA (ISGT ASIA), IEEE, 3 November 2015 (2015-11-03), pages 1-6, XP032851173, DOI: 10.1109/ISGT-ASIA.2015.7387099 [retrieved on 2016-01-19]	3,7,8
A	page 1 - page 5; figures 1-4	1,2,4-6
Y	US 2015/006128 A1 (ENENKEL ROBERT F [CA] ET AL) 1 January 2015 (2015-01-01)	7,8
A	paragraph [0031] - paragraph [0078]; figures 1b,2-13	1-6
Y	N Giiveii ET AL: "GIS BASED OUTAGE ANALYSIS SYSTEM FOIR ELECTRIC DISTIZIBIJTHON NETWORKS", , 16 May 1996 (1996-05-16), XP055378930, Retrieved from the Internet: URL:http://ieeexplore.ieee.org/ielx3/3992/11496/00551327.pdf?tp=&arnumber=551327&isnumber=11496 [retrieved on 2017-06-07]	4
A	page 761 - page 764; figures 1-5	1-3,5-8

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/TR2017/050108

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015006128 A1	01-01-2015	US 2015006128 A1	01-01-2015
		US 2015006141 A1	01-01-2015