Remote Access Digital Notice Board for Hazard Alert

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Abstract- Designing a digital notice board for remote access requires high reliability count. More so when that display board is used for hazard alert and possible information on escape route, then the reliability of the system has to be well accounted for taking into account all the factors involved otherwise the system constitute a hazard itself. In this work first off, a microcontroller and a GSM modem had been used to develop a digital notice board which can be accessed remotely by SMS. A method to account for the reliability of such system was also proposed and live test were conducted to determine the reliability of the system. A reliability test performed on the system based on the two reliability measures considered "efficiency and reliability" and the result of the two devices used (SIM 300 and GSM Modem) shows that both can be used to implement the system for remote access but SIM 300 with 79% efficiency Score was preferable for the implementation of the system against mobile phone with 72% efficiency, but the efficiency and certainty of both can be improved with a better signal quality.

Indexed Terms- GSM, Efficiency, Certainty, Signal Strength, Modem.

I. INTRODUCTION

Large digital displays are now commonly seen in our everyday lives [1] and the new age of technology has redefined communication. A real time display board is a notice board that displays information to a particular group of people from any remote location in real time in such a way that the information can be accessed and acted upon timely to avoid an impending hazard, danger etc. With increasing need for information in modern times, Noticeboards provides an easy way to share important information across a group of people and ensure that it's red. Deployment of notice boards in rural communities comes with some challenges because of poor network coverage, which can undermine the effectiveness of the messages and the value of the board itself. Reliability analysis determines how effective the board will be to the people especially when it is deployed for hazard warning or alerts. Various works had been done on real time notice boards in recent past but most of these works had been geared towards design of such systems. This paper thus, explores a way to account for reliability of a real time public display board in such community to determine its effectiveness. The challenge which this paper seeks to address is on improving the latency and accessibility of public display that delivers information, visibly clear, relevant and clear on action using Global Systems for Mobile Communication Technology with a Microcontroller chip as the control hub of the display, Liquid crystal display (LCDs) is used in the prototype implementation as the main display board and after the prototype implementation, a comprehensive reliability test is performed on the system to determine is effectiveness for real time information update in rural communities

II. REVIEW

The idea of using SMS to establish routes in commination networks between transmitters and receivers for the purposes of safety and guaranty of services is not new, but design method, the application, and reliability of the system varies, F. H. Fahmy el talin [2] presented and designed a textual display system, based on a light emitting diode (LED) dot matrix array powered by solar energy, A web based technology is deployed in [3] for the control of notice board. The works in [4], [5], [6], and [7] were all based on use of wireless sensor networks to control a public display board. Wireless Sensor Networks (WSN) is formed by a large number of networked sensing nodes. The main goal of a WSN is to produce meaningful information from raw local data collected by individual sensors. A similar work of WSN is the work in [8] in which proposed model consists of two modules; one or more Transmitter and one Receiver module. The transmitter module consists of interfacing computer through serial interface to the Zigbee module. The receiver module placed at the remote end consists of Zigbee module interfaced with a microcontroller for displaying messages on LCD. All the works so far has been mainly focused on proffering methods on the design of a real time display board with little consideration of the reliability study. This work proposes the design of a real time display and in depth study of the effectiveness and reliability of such systems in rural areas.

III. MATERIALS AND METHODS

The reliability of the system is monitored by observing the latency between sending a message to the board and the display of the message. A message is sent to the system and time of display is recorded this is achieved by adding the time for message reception and, the same message is sent for 5 iterations and the average is taken. Different signal levels were achieved by moving the system around till steady signal strength was recorded for at least a minute. However some signal levels couldn't be steady as a result of network inconsistencies in the area. AT Command, AT+CMGL="REC UNREAD" [8] shows the user number, date and time of the received message reception. By interfacing the system to oscilloscope probes, the message signal is seen on the screen for any new message being displayed. The oscilloscope displays on the computer screen; the message signal, the delay time in milliseconds (ms) and the voltage in volts (v). The oscilloscope probes are connected to P3.0 & P3.1 which are internally connected to the Transmit and Receive lines of the microcontroller, the test is performed differently for SIM 300 and GSM phone to ascertain the viability of using both devices for system implementation.

IV. RELIABILITY ANALYSIS

Reliability denotes the ability of a system to consistently provide service with certain performance characteristics, even in the presence of stressful [9] conditions that may threaten to disrupt the offered service It may take several forms and includes notions such as high availability, resiliency, fault tolerance, and even security, depending on the context In this work, The first task is to establish a baseline characterization of the reliability for the system. The basic question governing the reliability measure is "did the display board work on the day of the live exercise?

Two key factors define the reliability of the system under study;

1. The ability to display messages from a remote location,
2. The ability to display messages within the benchmark time.

The reliability study will be performed in two ways, first is to determine the system reliability in receiving and display of messages and second is to perform data authentication test on GSM services in message transmission to the system.

V. MEASUREMENT OF THE RELIABILITY OF THE DISPLAY PROCESS

The reliability of the display board can be measured in two aspects; Certainty and Efficiency.

I. Certainty, Rc, is the operational state of the device on the day of the exercise while
II. Efficiency, Re, is the time taken before the message becomes valueless.

The reliability, of a system is the probability that no fault of the class F occurs (i.e. system works
From equations (2) and (5) of section 4.2, the overall reliability of the system is computed as a function of certainty and efficiency where

$$R = R_c \times R_e \text{ ----------------- } (1)$$

VI. MEASUREMENT OF CERTAINTY OF MESSAGE RECEIPT

The no of bars is used to measure the certainty of the board to display messages at various times and this shows the variability between mobile phone device and GSM modem device in the notice board implementation. Wireless signal is usually measured as a function of the power of the signal in decibels (dB) then referenced to 1mill watt (dBm). All the devices used in the prototype system display their signal strength. The device can have ymax bars when the signal is strongest, where y, is the number of bars, thus for any location the device can have $y \leq y_{max}$ number of bars where y is a real number. The five barsTe represent various signal strengths in decibel, A GSM mobile phone can function on -104 to -47 dBm range, various dbm ranges for the GSM modem are used to represent different number of bars as shown in the table. The minimum number of bars for the message reception depends on the service provider which can be Ymin. The device is given a score based on the signal strength indicated by the bars by applying the following formula:

$$RC = \begin{cases} \frac{1}{(e^{Ymin-y}) + 1}, & y \geq Ymin \text{ [10] --------- (2)} \\ 0, & y \leq Ymin, \text{ for } Ymin = 2 \text{ and } (Y = I, 2, 3, 4, 5) \end{cases}$$

The exponential function will give a score between 0 and 1, when y = Ymin, the score will be 0.5 depending on the Ymin, Ymin varies for different service providers. 0.5 Score shows that there is only a 50% chance that the message can get to the system, the score tends to 1 as Ymin increases from the table, for the prototype system Ymin is taken as two bars. The equation was sufficient for the certainty test.

VII. MEASUREMENT OF MEAN TIME TO FAILURE (MTTF)

MTTF is a measure of expected time which the process must be completed otherwise failure occurs;

$$Re = 1 - (MTTF) \text{ ------- (3)}$$

Where; $MTTF = \left(\frac{(Tx+Td) - Te}{Tz}\right)$-------------- (4)

Thus, $Re = 1 - \left(\frac{Ty}{Tz}\right)$ or $\left(\frac{Tz - Ty}{Tz}\right)$----- (5)

where

Ty = this is the total time it took from the sending of the message to the display of the message.

Tx = the time taken for the message transmission between the user and the system

Td = this is the delay time between message reception and message display.

Te = the expected time for message transmission, (assumption based on observed time difference between sending and message display)

Tz = the time at which the message will be valueless if it is not displayed by the board, 15s is chosen but subsequent values for other test can be chosen depending on the environment and the purpose of the display board.

VIII. RESULT AND DISCUSSION

The result shows that as the latency of the message display increases, the reliability of the system drops for both devices, but it can be seen overall that SIM 300 performed better than the mobile phone, this can be attributed to the fact that SIM 300 module displays the received message faster than the mobile phone thus has more efficiency than the mobile phone as shown in the curve in fig 1 and fig 2.

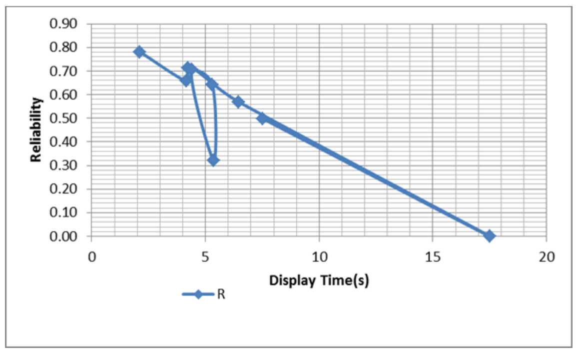

Fig 1: system reliability curve for Modem

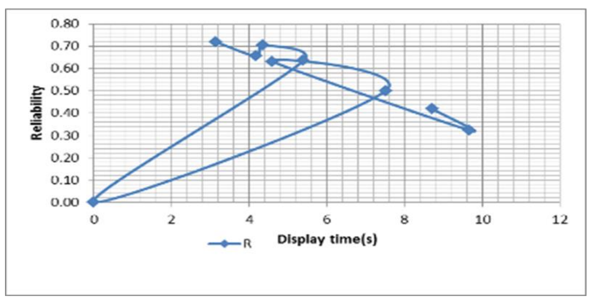

Fig 2: system reliability curve for GSM phone

Reliability in SIM 300 dropped low at point 0.32 as a result of the reception time Tx been highest there thus it the not only the signal strength of the area but the quality of the signal is also important for high reliability of alert messages in public display board. SIM 300 has its lowest score zero even when the message being received, this is because the message this is because the message reception time has passed the bench mark time Tz refer to condition ii in equation 11. The highest reliability score in SIM 300 is 78% which was better than the mobile phone with highest value of 72%. The mobile phone scored lowest value of zero when the received signal strength was -91dbm which represents 1 bar unlike in SIM 300 module where 1 bar was enough to receive the message. Overall the two devices performed well considering the poor signal quality of the area under test. However SIM 300 is used in place of the mobile phone device in the prototype system implementation because the mobile phone has high component count thus prone to failure unlike the SIM 300 modem, more so the difficulties of charging it all the time and makes it unfit to use and monitor especially when the system is deployed in a place where high system reliability is demanded, then finally the ease of construction makes SIM 300 modem the best fit for the prototype system unlike the mobile phone where the phone needs to be disrupted before interfacing to the device microcontroller which requires a very high technicality.

CONCLUSION

This work has developed an improve public display system that scales optimally leveraging on existing systems. The unpredictability of GSM services and network providers makes it impossible for the system to achieve a reliability of 100% thus, for the system to be deployed for terrorist or hazard alert warnings, good data authentication test must first be performed on such area to determine the suitability of GSM channel as a communication medium for such purpose as a result of these it is recommended that until the signal coverage on such place is ascertained the system should be first be deployed in an environment where timely information is highly important but not fail hazard e.g. train stations or airports, offices ,hospitals etc.

REFERENCES

[1] Miaosen Wang " The Proxemic Peddler Framework: Designing a Public Display that Captures and Preserves the Attention of a Passerby" M.Sc thesis, April 2012.

[2] F. H. Fahmy, S. M. Sadek, N. M. Ahamed, M. B. Zahran, and Abd El-Shafy A. Nafeh: "*Microcontroller-based moving message display powered by photovoltaic Energy"*, International Conference on Renewable Energies and Power Quality (ICREPQ'10) Granada (Spain), 23rd to 25th March, 2010.

[3] Wei C. and Bui. P. (2008) *"Implementing a Web-Based Remote Control System for Led Dot Matrix Display".* Department of Electrical Engineering Southern Taiwan University.

[4] Hara .M. Williams, *"Community Based Digital Bulletin Boards and Mobile Phone Interaction"*. Electrical Engineering and computer Science, Massachusetts Institute of technology (2009).

[5] Huthaifa Luay M, *"Design and implementation of wireless bulletin boards"*, Institute of graduate and research studies, department of Computer Engineering, July, 2012.

[6] HANSAL SHAH, ZARNA PAREKH, AKSHAY SAWANT, SHIVANI BHATTACHARJEE " *Wireless Display Using Zigbee*" Electronics and Telecommunication Department, DJSCOE, Vile-Parle (W), Mumbai, Maharashtra, India International Journal of Electronics and Communication Engineering (IJECE) Vol. 2, Issue 4, Sep 2013, 49-58

[7] Ajinkya Gaikwad, Tej Kapadia, Manan Lakhani & Deepak Karia *"Wireless Electronics Notice Board",* Department of Electronics and Telecommunication Sardar Patel Institute of Technology, Mumbai 400058, India, , India International Journal of Electronics and Communication Engineering (IJECE), 2319 – 2526, Volume-2, Issue-3, 2013.

[8] Telit Wireless Solution, "AT Command reference guide", 2001.

[9] Björn Franke "*Reliability and Fault tolerance*". Department of Informatics, University of Edinburgh, 2010

[10] Nuwan Waidyanatha, D. Dias, and H. Purasinghe, "*Challenges of Optimizing Common Alerting Protocol for SMS based GSM Devices in Last-Mile Hazard Warnings in Sri Lanka*" 2010.