

---

---

**DESIGN OF MICROCONTROLLER-BASED ENHANCED PATIENT CALLING SYSTEM FOR UNIVERSITY OF MAIDUGURI CLINIC**

---

---

By

***Abdulfattah A. Aboaba<sup>1</sup>, Dodo M. Tukur, Umar Y. Bintu Samuel Victoria, Amaza Stephen***

Computer Engineering Department,  
Faculty of Engineering,  
University of Maiduguri, Nigeria.  
abdulfattahaa@gmail.com<sup>1</sup>

---

---

**ABSTRACT:**

*The solution to the short-comings of both traditional and modern queue management systems is presented here and named "The Enhanced Patient Calling System" which is a microcontroller-based queue management system designed with the ability to handle absent patients from the queue in the form of a 'slot-back'. The setting of the design is the University of Maiduguri clinic which operates on the traditional system of queuing whereby patients sit in chronological order and then shift forward as early comers go in to consult with the doctor. The system is stressful and can be disorganized when a queuee leaves the queue for any reason including exigencies. The design presented in this paper is made up of three microcontrollers, each connected to screens that display patient number when it is the turn of the patient to consult with the doctor or see the pharmacist, as the case may be. More so, it uses a mathematical model to slot-back an absent patient into the queue.*

**INTRODUCTION**

Time is a quantity that is non-renewable and continuous. Any process that save time and space is considered vital in many applications because it is an important quantity that has to be efficiently managed. Wastage of time and energy in queuing is always inevitable and it is in this that the presence of a microcomputer- based enhanced patient calling system finds its importance. In daily life, patients face the problem of lengthy queues and unpredictable waiting time, causing tension and stress among both patients and doctors, resulting in efficiency decline.

In the present system in use in the University of Maiduguri clinic, patients have to sit in a queue in chronological order. As one patient is attended to, the patients shift in their seats till it's their turn to meet the doctor. As they go in to consult with the

doctor, their file is withdrawn from storage and brought into the doctors' office.

In an advanced situation, there is an electronic calling system where patients are tallied and the tally number is displayed on a screen when the patients turn reached to consult with the doctor. However, files are collected manually at the record office and then arranged before the doctor.

In more advanced systems of queue management, the queue is still managed using electronic calling systems but the system has a computerized database as well. This way, the files do not have to be manually arranged before the doctor and any changes in the files can be instantly documented and shared amongst the necessary departments; as the Pharmacy.

One major limitation of the systems described above is the lack of a feature to allow patients go for

pressing matters and still not lost out in case they return after their must have been skipped. Patients might need to use the toilet facilities, get snacks or even food and in their absence, their turn might be reached. When they get back, they might have to start at the end of the queue again, or at best seek the assistance of nurses in order to be able to see the doctor.

The solution is to the short comings in the systems is the design of a microcontroller-based patient calling system with slot-back capability. It enables coordination of patients to avoid end to end sitting in waiting. It will allow patients to go and undertake necessary activities like visiting the toilet or getting snacks yet be put back in the queue automatically by the slot-back feature in situation where the patient has been called during his period of absent without the need for assistance. A review of exiting work is here presented.

Basil, R. and Aswin V. (2013) presented a Novel Intelligent System for Efficient Queue Management. The aim was to design a low power, low cost, AVR microcontroller based design that could replace existing arrangement of queue management system, so as to efficiently manage crowd in Public Place, and also to increase discipline & order. The proposed system was tested and it was proved to drastically improve the efficiency of crowd management in public places, increasing discipline and order, resulting in improved customer services and convenience for the people. However, the system was unable to automatically call out token numbers using loudspeaker and it could only handle 100 customers. Hossain, B., Hossain, N., Hossain, M., and Rahman, H. (2011) designed and developed a Microcontroller Based Electronic Queue Control System which was aimed at maintaining a queue with order and efficiency, using a low - cost and portable

microcontroller based queuing controller. The system has been tested under different conditions to evaluate its performance of which it drastically improved the efficiency of crowd management. But the set-back observed was that the system makes it tedious to keep track of the token numbers being served as the waiting customers have to continuously monitor each of the four counter displays. Also there is no provision to pass any information to the waiting customers and selectively call any token number in case any emergencies. The work of Arun, R. and Priyesh, P. P. (2013) was termed Smart Queue Management System Using GSM Technology. The main objective was to design a system to maintain a queue with order and efficiency, through GSM Technology, so as to manage time in Hospital Queuing System using GSM Technology. The designed system has been evaluated successfully, the only set-back seen was that the system could not obtain the patients' location and also could not calculate the distance between the service area and the patient. Megalingam R. K., Sreenath P. S., Soman D., Jessin P. A. and Srikanth S. (2009), presented a work called 'Low Power Microcontroller Based Simple Smart Token Number Display System'. It was aimed at designing a system that will control queue system with order and efficiency, thereby increasing performance and time management, using a 4x4 matrix keypad. The designed system has been evaluated successfully and the results obtained showed that only one counter could be implemented, thus adversely affecting the capability of the system. The system also lacks the features of real time information delivery system.

The goal in the work of Mamun, M., Karim, A. H., and Mahbub, M. I. (2011), was to design a system that will control queue system with order and efficiency, using LCD display and speaker to call token numbers.

The designed system has been evaluated successfully and the results obtained revealed that only one counter was setup, which limits the number of customers that could be served per time. A system using two microcontrollers and two sets of Seven Segment display to control queue system with order and efficiency for time management and increased discipline in queuing control was reported in Htwe, S. S. Oo, M. T. and Win, H. N. (2008), The evaluation the system shows that lacks speaker for calling out the number on the token ring, so as to get the attention of the customers.

The solution is to design a microcontroller based enhanced patient calling system presented in this paper. It enables coordination of patients to avoid end to end sitting in waiting. It will allow patients to go and undertake necessary activities like visiting the toilet or getting food and water because of a slot back feature that will put the patient back in the queue if he/she misses his/her queue position for up to three times.

## **METHODOLOGY**

Owing to the novel approach of the design, that is, the capability of the enhanced queue management system proposed to slot-back absent patient, it is necessary to determine the exigent needs that could make a patient to temporarily leave the queue, and then parameterize those needs into quantifiable units of action. Our initial investigation and discussion among friends and colleagues revealed that actions such as snacking, and attending to call-of-nature (visiting conveniences) are things that patients do while waiting for their turns on the queue. Furthermore, since the design is based on University of Maiduguri (UNIMAID) clinic, our team of researchers was at the clinic for several days studying the queue and the clinic environment.

This gave rise to the methodology adopted for of this work which is a combination of field work, survey, data collection and analysis, mathematical model development, development of circuit layout based on the result of data analysis, design algorithm, and flowcharting.

### ***Field work***

Having studied the clinic environment, the research team realized two things namely; need to know the average consultation time per patient, the availability of conveniences within the clinic, and the length of time to and fro the nearest snacking point to the clinic owing to absence of one in the clinic premises. In order to achieve these, members of the research team spent several days recording the time spent by individual patient with the doctor (consultation time), and at end, the average consultation time (ACT) per patient was determined. In addition to this, members of the research team and some volunteers took turn to take 'gentle trek' (depicting when someone is sick) to and fro the nearest snacking point to the clinic. More so, since the conveniences in the clinic is expected to function adequately and efficiently, the research team considered the time to trek these conveniences negligible.

### ***Survey***

In order to determine the time taken by individual to complete those activities deemed expedient while on queue, questionnaires were distributed among students and staff whose primary health care facility is the University clinic, that is, those residents on campus. Questionnaires were given out for a survey to find out the average time people spend taking snacks and using the toilet facilities, and further investigate if people take more

time than the usual for the above activities when sick.

**Summary of Field Work Results and Data Analysis**

In this section, a summary of major indices in all data analyzed are presented in tabular form in table

1. Seventy eight percent (78%) of questionnaires distributed was returned. The received questionnaires were then analyzed and the average time it takes to complete any of the three (snacking, urinating, excreting) activities when sick was determined.

**Table 1:** Data Analysis Summary

SN	ACTIVITY	TIME in Minutes
1	Average Time for Snacking (ATS)	15
2	Average Time for Urinating (ATU)	7.5
3	Average Time for Excreting (ATE)	12.5
4	Average Time Taken to and fro Snacking point (ATTS)	09
5	Average Consultation Time (ACT)	03

Based on the assumption that an absented patient must have gone for the activity that takes the longest time of the three. The average of the individual treks was found and added to the average time taken to snack. At the end, the longest average time of absence (LATA) of the patient; Longest Average Time of Absence

$$(LATA) = ATS + ATTS$$

**Development of Model Equations**

Based on the activities and time taken in table 1, a model equation was derived from the data analysis. The model equation was use to calculate after what time interval should an absent patient be slot back into the queue from

the time his/her token number was displayed.

$$y = Ax \dots \dots (i)$$

$$A = \frac{LATA}{ACT} \dots \dots (ii)$$

Where *y* represents the number of patients to be attended to before an absent patient will be called again, *x* is the number of doctors on duty, LATA is the longest average time of absence, and ACT is the average consultation time. It should be noted that the number of doctors on duty a may vary from time to time even within a day.

**Design Algorithm**

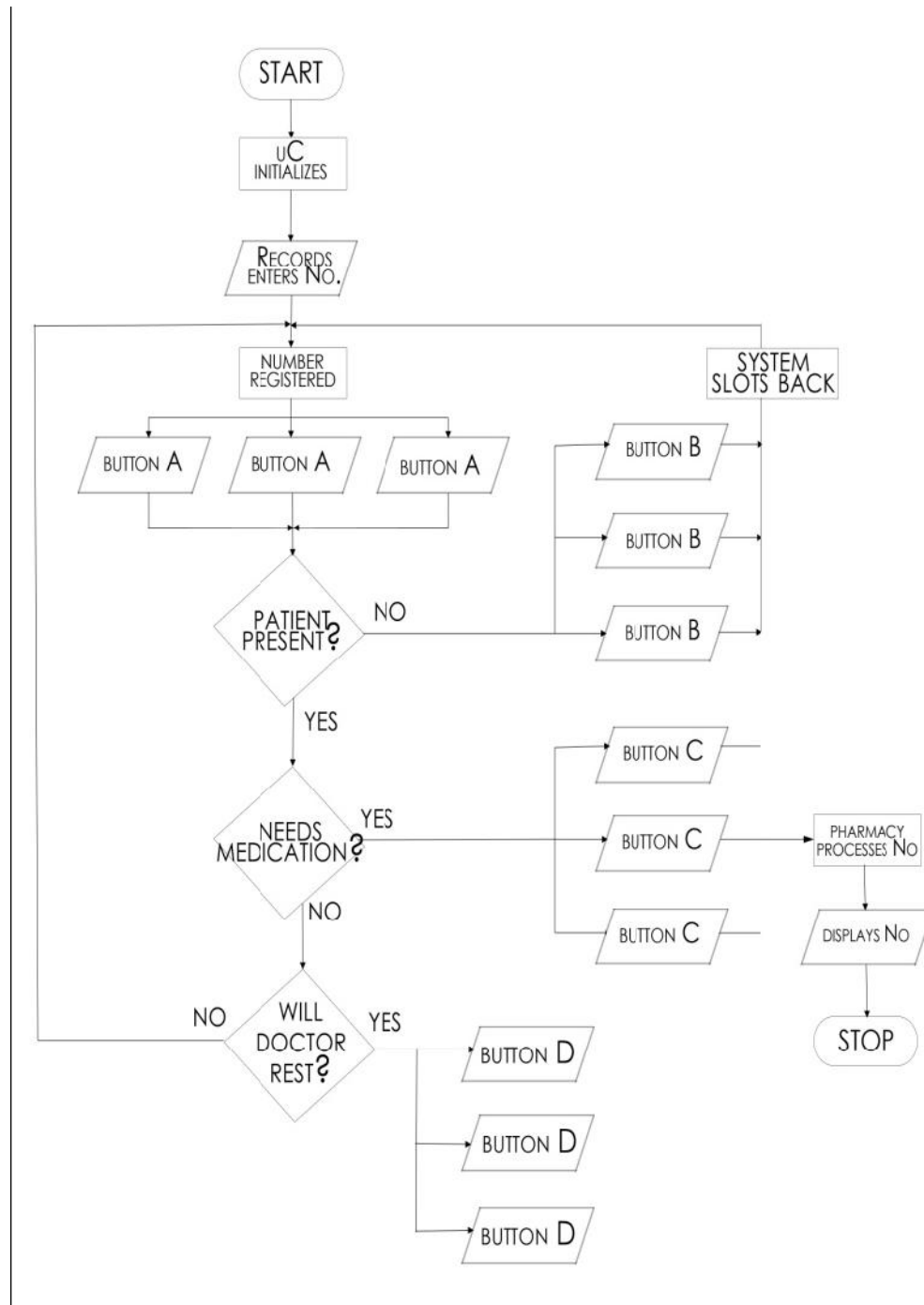
1. Start.
2. Microcontroller initializing.
3. Tally number is generated for each patient at the medical record point.
4. Doctors microcontroller is notified of waiting patients

5. Doctor(s) presses button A to call next patients.
6. The respective doctor's LCD displays the tally number of the next patient with green light.
7. If the tally owner is absent, the doctor depress button B after 30 seconds
8. The microcontroller inserts the tally number in the queue based on equation (i), and it is noted as first absence.
9. Else, patient is attended to
10. If the patient does not need medication, go to 4.
11. Else press button C which sends the patient to the pharmacy
12. Pharmacy's microcontroller is notified of waiting patient(s)
13. Go to 4.
14. If the doctor needs a break, button D depressed.
15. The particular doctor LCD displays the message "Doctor is Busy"
16. Else go to 4.
17. If the turn of the absent patient is reached for the third (final) time, the red light is ON indicating the last chance. And if the patient does not respond with a given time (15 seconds) to warrant the doctor to press button B twice with 3 seconds, the patient is consider gone and the tally number is automatically deleted from the queue.
18. Pharmacy presses button E to call next patient
19. Pharmacy's LCD displays patient's tally number
20. Go to 1

### ***Flowchart of the design***

The flowchart design for the algorithm design in section 2.5 is presented in figure 1, it is

a diagrammatic depiction of the sequence of operation of the whole system, and particularly code programmed into the microcontrollers.

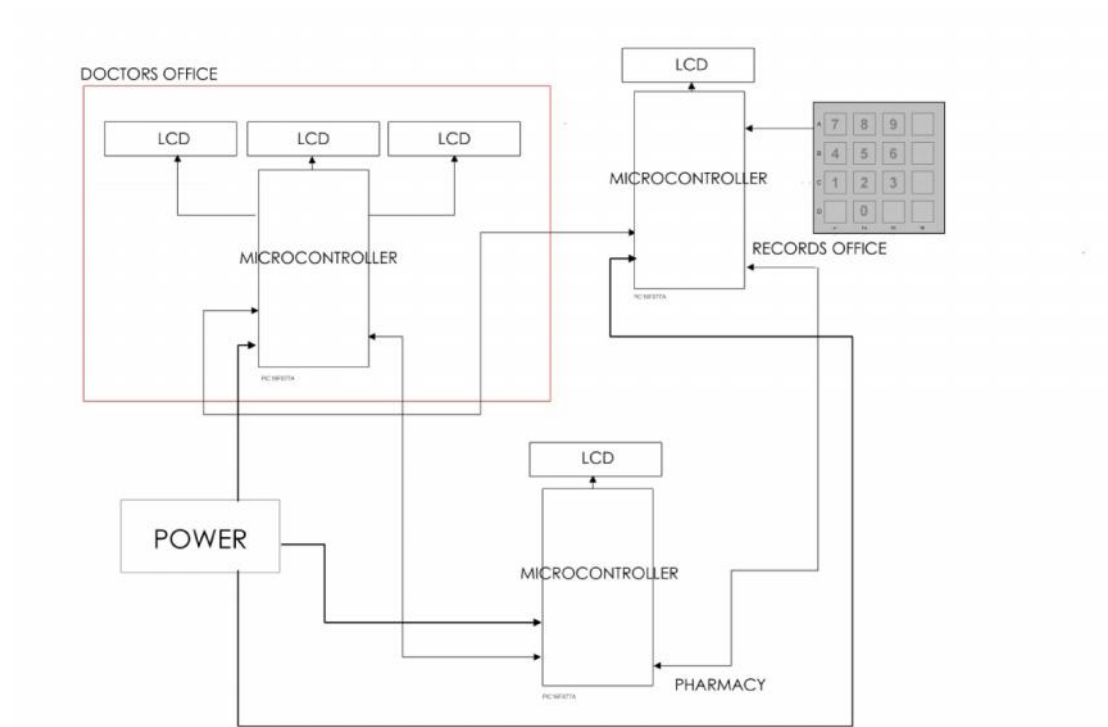


**Figure 1:** Flowchart diagram of the design

**Circuit Layout**

The design employs the use of three microcontrollers one each for the medical record, consulting rooms, and the pharmacy, and each one with liquid crystal display (LCD). The

microprocessor for the medical record is connected with keypad for generation tally/token for the patient. The circuit layout is shown in figure 2.

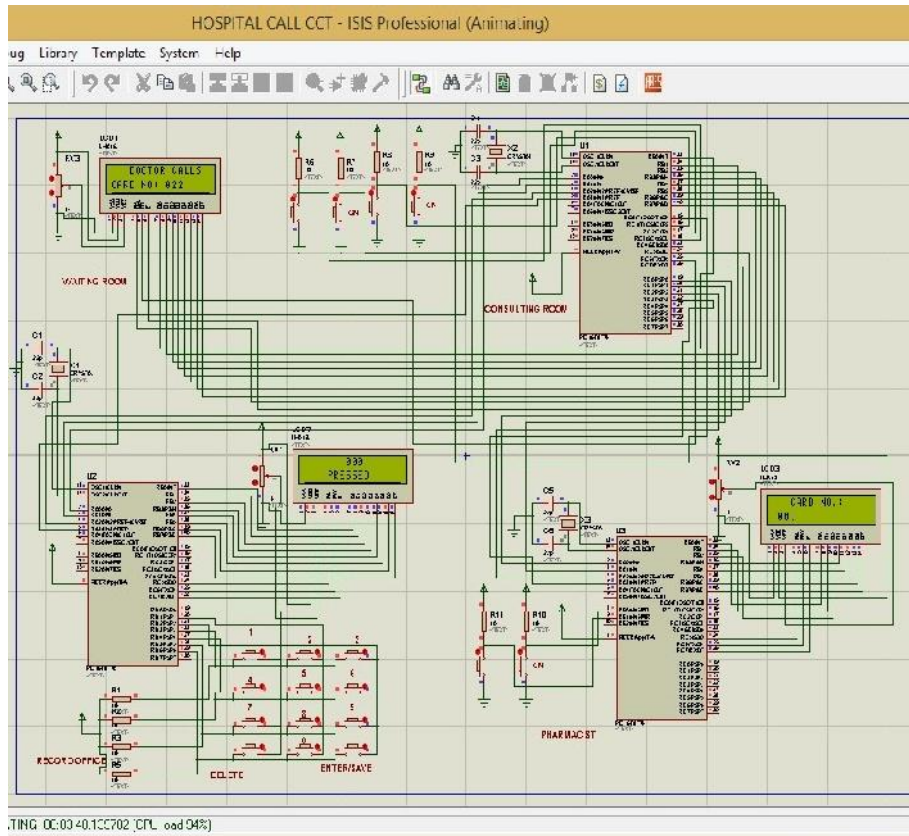


**Figure 2:** Circuit Layout of the Design

### IMPLEMENTATION AND TESTING

Following the algorithm design and the flowchart, and using a programmable microcontroller IC (PIC16F877A), the source code was compiled using micro C COMPILER. Proper consideration was given to the code during compilation in order to avoid any logical errors. The test-run was done using interactive electronic simulation software called Proteus 7. The hex file was then generated

and transferred to the PIC16F877A microcontroller with the aid of a USB programmer. The design was simulated on a computer to study and analyze the behavior of each stage before physical implementation was carried out. As shown in figures 2 and 3, the implementation was finally assembled on Vero board after its initial assembly on Bread board and tested.



When the system is ON it will initialize, then the clinic record office enters a tally numbers for the patients on the system's number keyboard connected to the microcontroller dedicated to the clinic's record office as shown in figure 1. The number is registered and sent to the Doctors' microcontroller. At the Doctors' side, four switches were provided labeled (A, B, C, and D) in which all the switches have specific functions to perform. The doctors switch on their stations devices when ready, and press the switch A to call the next patient. If the patient is absent switch B is depressed to slot the patient back into the queue based on equation 1. If the patient needs medication, switch C is pressed to send his number to the pharmacy, and if the Doctor is busy switch D is pressed which indicates 'Doctor Busy' on the screen outside the particular consulting room. The pharmacy's microcontroller

has a station device that has only one switch for calling patient and is in the form of first in first out (FIFO).

**CONCLUSION**

In conclusion, the sole aim of carrying out the design and construction of an Enhanced Patient Calling System has been achieved. The aim was to develop an efficient and reliable enhanced patient calling system, which was successfully realized at the end of the design and construction process. One factor that accounts for the reliability of the product is the ability to slot back an absent patient and it uses battery power. This ensures that the system keeps working in the event of a power outage. The system was tested and found to be working to specifications and predictions. A cheap and reliable way of regulating queue in the university Medical Centre



has been successfully developed and the benefits of having this enhance patient calling system cannot be overemphasized.

## RECOMMENDATION

Although the aim and objectives of this project have been accomplished, there is still room for improvement on the work done. First of all, provision could be made for a GSM modem which could immediately send an SMS to alert an absent patient and inform him of the estimated time he would be called again. Secondly, a database system could be added to future systems to improve the performance of the system, also the number of patient to be attended can be increase to above one thousand in the case of a bigger hospital where ten or more doctors are working simultaneously. This use of such enhance patient calling system should be encouraged in our hospitals to increase performance and eliminate the traditional queuing system.

## REFERENCES

- Arun, R. and Priyesh, P. P. (2013), Smart Queue Management System Using GSM Technology. *Advanced in Electronic and Electric Engineering*. Vol. 3(8) pp. 941 – 950. Research Indian Publications, India.
- Basil R. and Aswin, V. (2013), A Novel Intelligent System for Efficient Queue Management. *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*. Vol. 2 pp. 1737 – 1742. Research Indian Publications, India.
- Hossain, B., Hossain, N., Hossen M. and Rahman H. (2011), Design and Development of Microcontroller Based Electronic Queue Control Systems. *Proceedings of the 2011 IEEE Student's Technology Symposium*. pp. 48 – 52. IIT Kharagpur, India.
- Htwe, S. S., Oo, M. T. and Win, H. N. (2008), Remote Token Display System using Microcontroller. *Work Academy of Science, Engineering and Technology*, pp. 134 – 140.
- Mamun, M., Karim, A. H. M. Z. and Mahbub, M. I. (2011), Low Power Microcontroller Based Intelligent Token Number Speaker and Display System. *IACSIT International Journal of Engineering and Technology* Vol. 3(2), pp. 199 – 202.
- Megalingam, R. K., Sreenath, P. S., Soman, D., Jessin, P. A. and Srikanth, S. (2009), *Low Power microcontroller Based Simple Smart Token Number Display System*. In Proceedings 5<sup>th</sup> IEEE International Conference on MEMS NAND and Smart Systems, pp. 171 – 175.
- Wong, C. Y. (2008), *Portable Electronic Queue Control System*. A project submitted to the department of electrical and electronic engineering, university of Pahang, Malaysia in partial fulfillment for the requirement of B.Eng. unpublished.