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A Novel Approach in Restaurant Management with Adaptive Channel Hopping Technique

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ABSTRACT: The pragmatic automation techniques are very much in need for present day restaurant environments. This project deals with automation of restaurant ensuring customer satisfaction with commercial elements .As soon as the customer presence is detected through an IR sensor the Voice playback and LCD gets activated ushering in the customer along with led lights giving him a candle light experience. Once the customer sends his request, it immediately gets transferred to cooking section and order will be confirmed by cooking department by sending an acknowledgment of total bill which can be payable through smart card. Here the table is interfaced with MSP-EXP430G2, CC2500 (RF Transceiver 2.4 GHz), Smartcard reader, (APR9600) voice playback module, serial switching circuit (SN74LS244 & MAX232). MSPEXP430F5438, CC2500, HC05 (Bluetooth to receive data from user) will be interfaced at cooking section. This project is designed and implemented by avoiding interference problems of ISM band and demonstrated in few restaurants which hustled a positive response .This design is practical in most of modern restaurants.

KEYWORDS: RF Mode communication, adaptive channel hopping, Bluetooth, smart card system.

I. INTRODUCTION

The Amelioration In Information And Communication Fields Had Greatly Influenced The Automation Field, With The Adaptation Of Wireless Networks And Development Of Mobile Devices Had Impelled The Growth In Automation, The Hospitality Industry Has No Exception From This. Restaurant Being One Of Our Favourite Premises Has To Be Upgraded To Present Day Trend For Robust, Customer Friendly Environment By Reducing The Human Effort While Taking Order And To Defray The Bill. The Conventional Method Followed Now Is A Manual Process Where Waiter Needs To Attend The Customer And Collect Order From Them, Transfer Them To Kitchen, Serve The Respective Items, Finally Prepare The Bill, Which Is Prone To Human Errors In Delaying The Process Which Leads To Customer Dissatisfaction [1][2].

A. Technical Background

The computer based networks which run on the scheme of client/ server communication are proposed in [2] [3] [4], Bluetooth and Zigbee based ordering system was developed for the purpose of automation in [5] [6].The works done or proposed till now facilitates only the food ordering system and lacks efficient hardware mechanism. Though [7] has implemented touch screen based wireless data transfer for ordering system it doesn't facilitate the defrayment of bill.

The ultimate challenge faced by using [2], [3], [4], [5] is in avoiding heavy data transfer traffic during the times of rush in restaurants. Proposed previous automation techniques failed in giving solution this problem and for the payment of bill the previous manual process is to be implemented if we use the previous techniques, being concentrated entirely on the automation process they have not involved the fact that the customer needs to be given a proper idea on what he is ordering, like cost of the item and amount of nutrition indulged in it. Customer satisfaction is given least preference as they failed in developing an acknowledgement system from ordering department, hardware efficiency, power consumption and cost factor are never discussed in previous works.

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B. Proposed solution

The Key idea of this project lies in giving a robust solution to the above mentioned problems by developing a hardware efficient Bluetooth algorithm to avoid interference problem (SECTION II), along with additional features of attracting customer which proved pragmatic in approach. As said earlier this project focuses in designing hardware with low power consumption which is done through using Texas Instruments components. The usage of android application for purpose of displaying menu is just an additional asset to this project which even enabled us for proclamation of commercials (SECTION III) with built-in kid's zone for the purpose of customer satisfaction.

The paper is machinated as follows Section II deals with proposed algorithm .Section III consists of implementation of hardware (PCB design, interfacing of peripherals etc..,), Software part (flow chart), Android app Development, results, conclusion and appendices.

II. RELATED WORK

Being a practical automation project, keeping in mind the customer satisfaction the components and devices used in such way and the algorithm is efficient enough to avoid the interference between multiple Bluetooth which operate in 2.4 GHz using channel hoping technique.

A. INTRODUCTION

The focus of Bluetooth is ad-hoc interoperability between cell phones, headsets, and PDA's [9]. Most Bluetooth devices are recharged regularly. Connected Bluetooth devices are grouped into networks called piconets; each piconet contains One master and up to seven active slaves. The channel hopping sequence of each piconet is derived from the master's clock. All slave devices must remain synchronized with this clock, which requires periodic beacon packets. In Bluetooth, interference from other Bluetooth piconets is minimal, because each piconet uses its own pseudo-random frequency-hopping pattern. If two co-located piconets are active the probability of a collision is 1.3%. The probability of a collision increases to 20% with ten active networks and 60% with 37 co-located active networks [10]. Bluetooth originally relied on its frequency-hopping algorithm to handle interference, but people have realized that a single active Wi-Fi network can cause heavy interference on up to 25% of the Bluetooth channels [8].

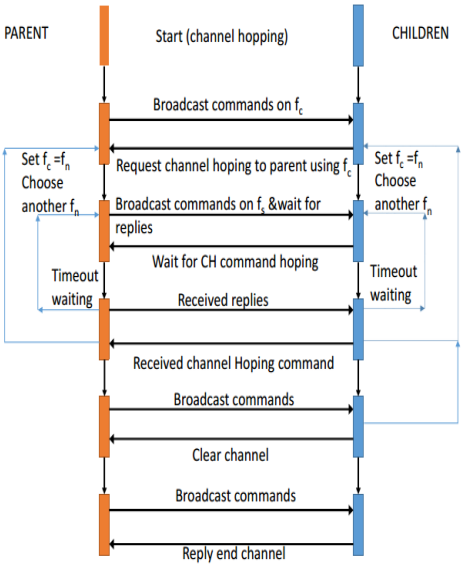

Fig1 channel hoping flow representation

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III. PROPOSED ALGORITHM

B. CHANNEL HOPING ALGORITHM

The proposed Channel hoping algorithm utilizes a channel hopping sequence for coordination between the parent and child nodes of each group. The channel hopping sequence is periodically generated every $T_{LQIreport}$ seconds by the parent node and distributed to all children. Parents generate this sequence first by gathering a Link Quality Information (LQI) map from each child which describes the current state of all N available channels. The complete LQI map gathered at the parent contains LQI values represented as LQI_{ki}, where i and k are the channel and node IDs, respectively. For the current operating frequency, the LQI information can be estimated based on the Signal-to-Noise (SNR) ratio for recently received packets. For the remaining $N-1$ channels, nodes can act as energy detectors and estimate the current noise floor. To improve the accuracy of these readings, children scan the N channels m times every $T_{LQIreport}$ seconds. An additional weighting factor, W_k, can be defined for each node k. If all nodes have the same priority, the weight can be set as $W_k = 1, \ \forall k$. W_k can also be chosen proportional to the traffic carried by a node k, i.e., W_k = number of leaf nodes. Nodes with a large W_k will have a greater effect on the aggregate LQI (ALQI) calculation. The ALQI for each channel can be calculated as shown in Equation 1.

$$ALQI_i = \frac{\sum_{k=1}^{K} LQIWk}{\sum_{k=1}^{K} Wk} \quad (1)$$

Where $i \in N$, K is the total number of group members. The channel hopping set is a list of available channels, sorted by the calculated ALQI values. The channel with the highest ALQI value is first in the channel hopping sequence.

C. Channel Hoping algorithms

Parents utilizing ACH are assumed to have complete knowledge of their children. Coordination between the parent and children is handled through a set of control messages as
Defined below:

1) *Channel Hopping Command (CHC)* used by parents to:
- Announce their existence on the operating channel.
- Send directives to change the operating channel.
- Send directives to confirm a clear operating channel.

2) *Channel Hopping Reply (CHR)* used by children to:
- Request channel hopping.
- Respond to the hopping command with the channel Availability for the group, et al [11].

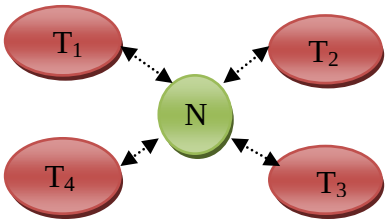

Fig 2 Network Topology

Where T_1, T2, T3, T4are children nodes (table), N is the parent (central node) and from central node the order will be placed to kitchen.

IV. IMPLEMENTATION

A. Hardware Implementation

The hardware section here is developed into two sections namely a) Transmitter section and b) Receiver section.

a) Transmitter section

As discussed this project aims to design a complete automated menu display and billing system, keeping in the consumer satisfaction at most importance without losing the essence of restaurants. Each table acts as a children node point from where the order can be placed, the system developed is a type of acknowledgement system where the receiver section

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immediately after receiving the data from the table (children node) transmits an acknowledgment of total bill payable through smart card, and same will be displayed in the android application. Step wise hardware design:

i) The power supply section for driving multiple loads of different voltages (5V & 3.3V) which is designed through a reference design generated through WEBENCH.(UA7805 for 5v and LM3489 for 3.3 V which are from Texas Instruments)

ii) The launch pad at transmitter section being provided with only one UART port ,but our design is having multiple devices which transfer the data serially ,to avoid this complexity we used multiplexer(74LS244),MAX232 naming SERIALSWITCHING CIRCUIT (from Texas Instruments)

iii) To persevere the restaurant touch, we designed an LED board with 5x5 (led) to give customer the feel of candle light experience (glows only at presence of customer), which is again designed through TI's WEBENCH LED architect.

iv) An alternate solution to drive led board is done through designing an inverter circuit with LP395 inverter circuit for which the input is taken from sensor (which returns high value for object detection) and positive terminal is given to a source with output connected to negative terminal with a common ground.

v) Switch board circuit is designed at every table for the purpose of facilitating the customer to intimate the management that he is ready to defray the bill which gets transmitted to kitchen there by generating an acknowledgment of total items ordered in application itself (android).

b) Receiver section

Respective hardware setup at receiver section are MSP 430 F series Experimenter board with built in GLCD which enabled us to display images, depending on the request given by customer respective acknowledge is generated and transmitted to children node(table) with CC2500 .Bluetooth module HC05 (interfaced with TTL to Serial convertor). Serial switching circuit is again designed here to multiplex two serial devices HC05 and CC2500.

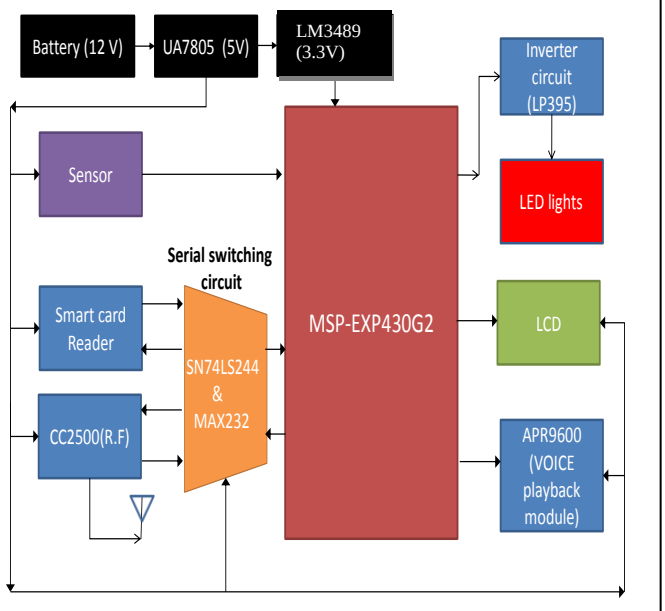

Fig 3 Block diagram of transmitter

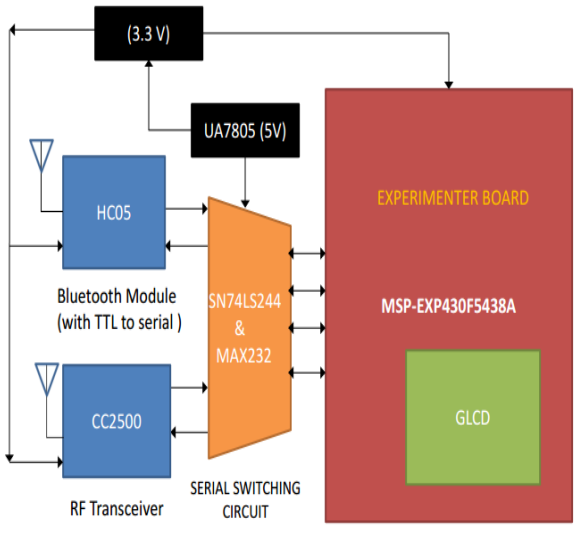

Fig 4 Block diagram of Receiver section

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Design of Android application

The android application designed, is just an asset to the project. It is an interface between customer and designed hardware. This is designed using an open source web application MIT app inventor which enabled us to indulge commercial elements into the application. Through which order can be placed by knowing proper cost and nutritional values and it has kid zone designed for entertainment purpose, for every 10sec of non-activity the proclamation of commercials can be done until next activity. This app found pragmatic in real time interfacing.

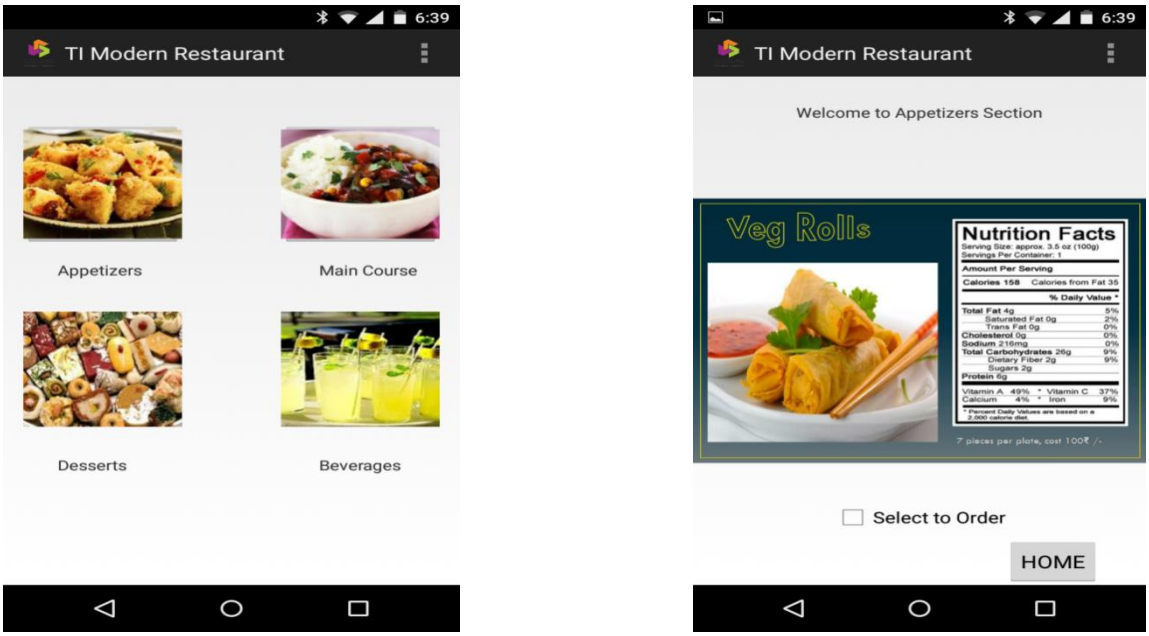

Fig 5 Snap shot of android interface of displaying items

The final layout of android application with display of menu and its respective nutritional values ,this app also features the online payment depending upon the customer's interest .

IV. PSEUDO CODE

Step 1: Let C_1, C2… Cn Be the N Number of Customers Seated At T_1, T2…T_n I.E... N Respective Tables.
Step 2: The Led Lights And Voice Gets Activated Welcoming The Customer At Each Children Node.
Step 3: Customer Can Place His Order Though a Tab Placed At Table
Step 4: Once the Customer Is Done With Order, Immediately It Gets Transferred To Receiver Section There By Displaying the Image on GLCD
Step5: The Appropriate Acknowledgement Is Sent Through RF
Step 6: Received Acknowledgment Consists Of Bill Of The Ordered Item Which Is Stored In Temporary Variable I.E. To Say That We Are Stopping Compiler at Smart Card until the Confirmation of Bill Comes From the Customer
Step 7: Now The Customer Can Be Able To Defray The Total Bill Using Smart Card.

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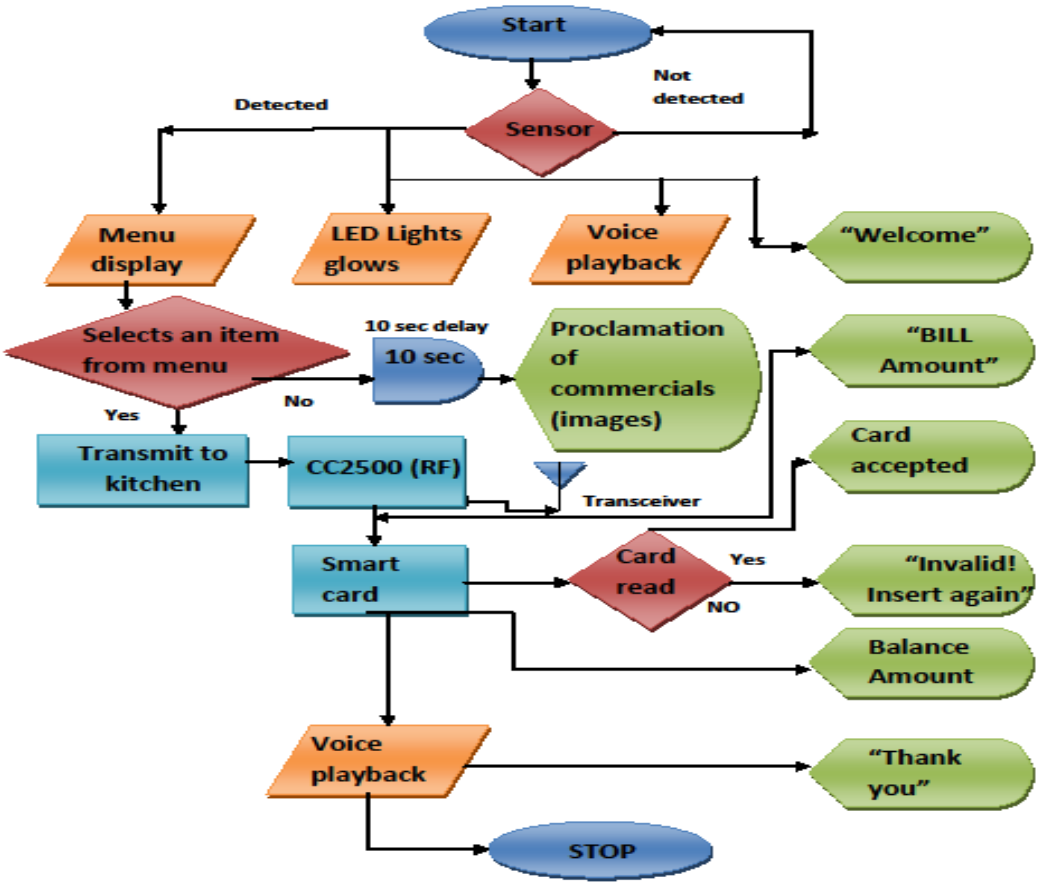

Fig 6 Flow chart

VI. RESULTS

Designed power supply section is capable of driving multiple loads of 3.3V which is implemented using WEBENCH software

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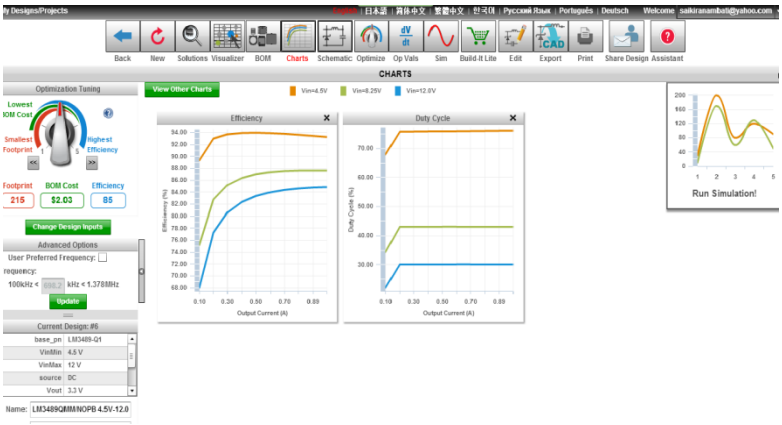
Result 1:

Result 1: Efficiency v/s voltage plot

This is the efficiency v/s voltage plot,intuitively we state that efficiency is inversely proportional to input voltage at a constant current supply



The LED architect of 5x5 is designed based on a reference design which is generated through WEBENCH with 90% efficiency.

Analysis: Efficiency v/s current plot for different i/p voltages are (taking current constant)

S.no	i/p voltage	Current	efficiency
1	4.5 V	0.8 Amp	91 %
2	8.25 V	0.8 Amp	88 %
3	12 V	0.8Amp	83 %

The above analysis into account, we have designed a circuit to drive multiple loads of 3.3V with input as 5V with 90.2 % of efficiency.

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VII. CONCLUSION AND FUTURE WORK

The wireless technologies are becoming more practical in application because of its low cost and ease of use. The restaurant automation in future may take drastic changes in terms of technologies used, to give customer a greater satisfaction this leads to increase in revenue. The idea of interfacing smart card system will indeed enhance the billing system making a transparent payment. Proclamation of commercials can be possible through this software which is beneficial to claim new products. Though it makes ordering easier and effective it lacks the human feel of welcoming customers. The restaurants need to be updated with trending technologies to ensure customer satisfaction, this indeed changes the way we dine in future.

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BIOGRAPHY

Saikiran Ambati is currently pursuing his graduation from **BVRIT** affiliated to **JNTUH**, simultaneously working as student researcher for the VLSI and NETWORKING LAB, his research includes **implicit communication** between mobile robots for its behavioural control.