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Vehicle Parking Management Using Embedded System

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Abstract-- The motive of this paper is to find out appropriate solution of parking related issues in different aspects which are suitable for Indian environment. Real time embedded controlled parking system can provide full or partial solution for building or multi-storey based parking. The proposed smart system use RC-5 (IR), CAN bus protocol play crucial role to share information between central control and parking area. The propose System can be use to manage vehicle entry-exit database, driving path guidance, billing accounting, security etc…

Key words: **Controller Area Network (CAN), RC-5 Infra Red (IR) protocol, Parking System, Embedded System.**

I. INTRODUCTION

Personal vehicles usage is increased with increasing the population in India which creates serious problem of parking place at danced market area, shopping mall, public places. As per as survey carried out in India it is roughly estimated that out of 8760 hours in year the car runs for an average for only 400 hours leaving 8360 hours in parked condition. Increasing concentration of human activity on limited land both in terms of residential activity and commercial activity causes the parking problem. Every car owner would wish to park the car as closely as possible to his destination so as to minimize his walking distance [1]. Leading to congestion of On-street spaces in official neighborhoods may give rise to inappropriate parking area in office and shopping mall complex during the peak time of official transactions [2]. The demand also leads to economic, social and environmental losses and with increase in population the problem becomes more critical [4]. As such parking spaces optimization and control has become a real challenge for city transport planners and traffic authority. By comparing various automatic cars parking systems and proposes the characteristics required by an automatic multi-storey car parking system suitable for Indian environment. These characteristics form the basis for designing Automatic car parking system for cinema theaters, malls, hotels and offices in India[3].These multi-storey parking system requires proper management with context to traffic management, allotted parking lot direction indication, vehicle identity, driver identity, vehicle safety, parking charges as per time duration, maintain data log etc… Embedded system can provide quality efficient, cost effective solution to manage multi-storey parking requirements. Proposed system can provide solution to manage multi-storey car parking system.
Multi-storey parking system requires boom barrier, direction indicator, webcam, etc… devices connected in control manner. These devices are controlled by microcontroller based embedded systems which work on different electrical signal levels, plus they also require communication link without electrical connection, and Infrared (IR) based communication system is best solution for this. This is the reason that we have incorporated RC-5 protocol based communication system and CAN Bus network.

II. DETAILS OF PROTOCOL

A. RC-5 protocol

Rc-5 protocol was developed by Philips Company for IR communication.Rc-5 protocol is 14 bit software based protocol. Out of 14 bits of RC-5 protocol: first two bits are used for bit synchronization, next one bit is used to recognize same code is repeated or new code is generated, next five bits are used for device address and last six bits are used for commands[5]-[6]. Address field and data field encoding and decoding are different as per system requirements. In our proposed system we interpret first 3-bits from address field for message type and rest of 2-address bits are combining with 6-command bits which can be use as data field.

B. CAN bus protocol

CAN bus protocol contain 4-different type of frames; (I) remote frame, (II) data frame, (III) error frame & (IV) overload frame. CAN works on multi master event based message addressing serial communication bus with different bit rates up to 1 mbps data rate. For the proposed system Data frame is more useful to transfer information as per system requirements.

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CAN protocol data frame contains seven different fields; (I) start field of frame for indication about message coming to device, (II) arbitrary field is used to select message priority, (III) control field indicates data length, (IV) data field contain 8-byte maximum, (V) CRC field for error checking, (VI) ACK field to send acknowledge, & (VII) end of frame indicates ending of message.

III. PROPORSED SYSTEM

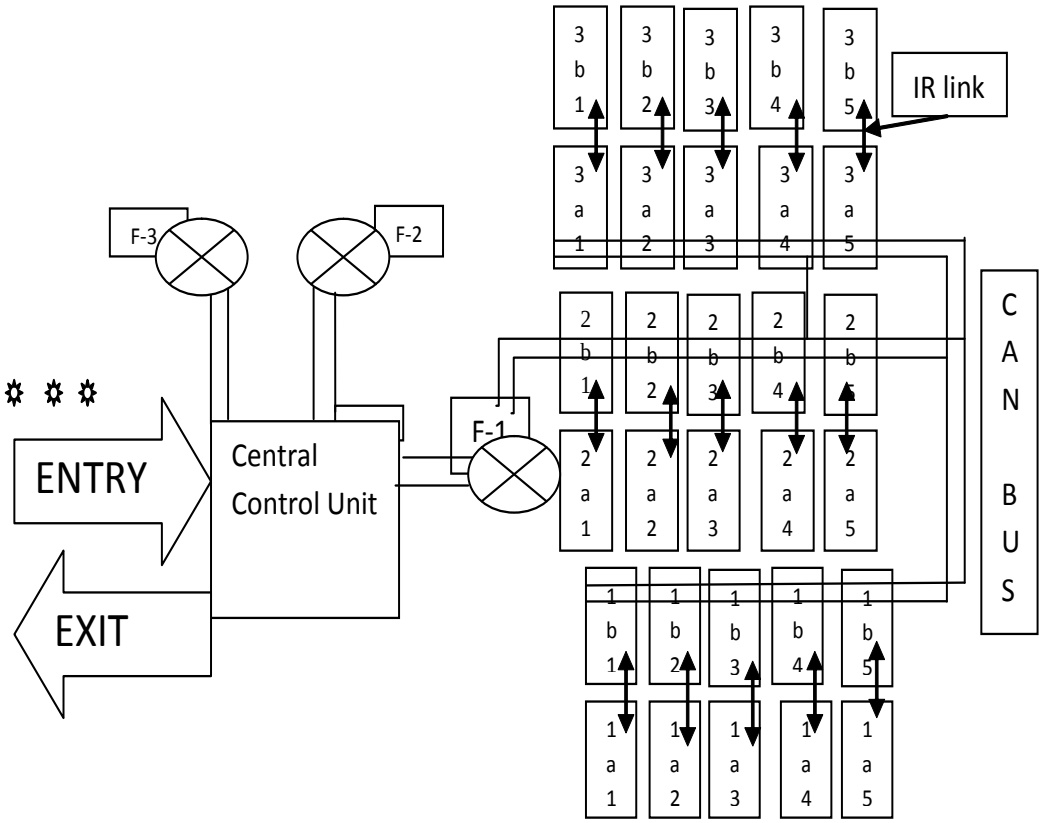

Fig. I Proposed Smart Parking System

Detail architecture of Proposed smart parking system is shown in Fig-I. At the entry of the parking system vehicle type is identified by measuring vehicle length using different IR LEDs. Based on vehicle type and category, Central Control Unit will provide token number to vehicle and will send token message to parking slot unit by using Controller Area Network. Ideally CAN bus can handle infinite no of nodes but practically 2047 nodes are possible. CAN bus is working based on multi master concept but there is no slave address in the data frame i.e. Master broadcasting message for all nodes and receiver nodes are accepting broadcasted message according to filter setting. Single filter setting can be done in receiver node, so that only single message acceptance is possible by matching identifier field , if more than one message acceptance is require then different filter setup will be required. If single message filter set on individual node then message identifier can be used as an individual device address. Standard CAN bus can support 11-bit message identifier so CAN bus system can handle maximum 2047 slots. System bus lengths, time delay, busy bus for a long time are the limitation with CAN. To overcome these limitations system need to reduce bus load, data traffic, time delay, etc… Also RC-5 IR protocol based wireless communication system interconnected with back to back parking slots. Out of which, any one of them can communicate on CAN bus can be another option for better system efficiency. At Parking slot, Device-B connected with Device-A in Back to Back position and Device-B is connected with CAN bus. Device-B interprets the received message and transfer necessary control information to Device-A through IR communication Link if required. Electrical circuits and equipments are controlled by electronics circuits. Due to power handling limitation of electronic devices, electronics circuit requires physical separation from electrical circuits for protection against high voltage electrical signal and electrical spike. Infrared (IR) based communication system fulfill the protection requirement and also use to establish wireless communication link for data or command transfer purpose between circuits or remote control system

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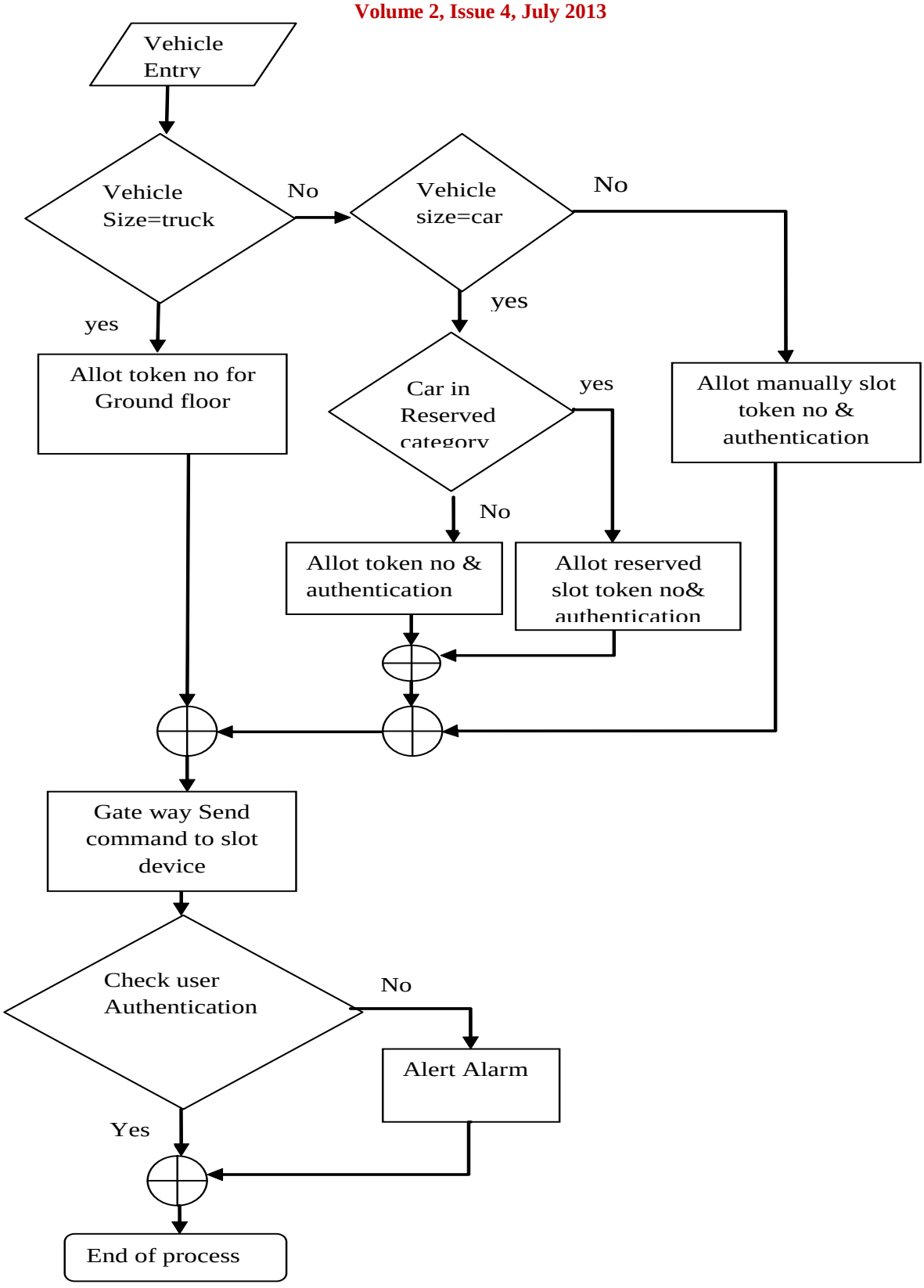

Fig. II Flow chart of parking management system

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A. For vehicle entry process:

As shown in Fig-II, token no is allotted as per vehicle types and categories. At the entry point, the system will check, whether vehicle is under reserved category or not? If it will then assign token no. as per the vehicle type. Reserved category vehicles having parking lots at ground floor will include vehicle types like VIP vehicles, staff vehicles, ambulance and heavy vehicles like truck having pre purchased/contracted slot allotment.
Non-reserved vehicles will be given token allotment, starting from 2nd floor to top floor. Once token no has been allotted, password entry will be made by driver for authentication purpose. Then System will upload password and token number in system database and forward password information and slot related message to particular slot control device through CAN bus. The parking related information like allotted slot parking lane, floor no., etc. included in token which is given to the driver. After vehicle parked on proper slot driver has again require to insert password at spot terminal device for cross verification with earlier system allotted password. If authentication is successful then boom bar is get down otherwise it generate alarm for wrong parking so that driver can park vehicle appropriate place

B. Logic Of Control System:

Central Control unit will send Token number information to the slot terminal in data frame up to 8-byte length. Out of which, First byte Token no. information is carrying floor number, second byte carrying lane number, third byte carrying lane subtype 'a' or 'b', fourth & fifth byte carrying slot number, next two bytes are used for password which is BCD (Binary Coded Decimal) coded, next single byte is used for command to control boom bar operation, slot allotment, system alerts, etc… After receiving frame, from third byte content slot terminal information is required to transfer to sub-lane terminal or keep itself. If message for sub-lane device then communication is establish between CAN connected Device and Sub-lane Device with the help of RC-5 protocol based IR System. RC-5 protocol frame is divided bit-by-bit from address filed, first 3-bits indicate message type as per Table-I, and next 8-bits contain data or information which is useful for parking management. As a example first three bits of address field are 000 means message code for password transfer then sub-lane device interpret next 8-bit is BCD code of password & wait for next 8-bit BCD password message. If first three bits of address field are 111 means admin wants to reset alarm or alert signals and rest of eight bits data are 0x00.

Table I. Message Type code and Meanings

Message Code	Meaning	Message Code	Meaning
000	Password transfer	100	Time out for parking
001	Password matched	101	Password mismatch
010	Vehicle parked	110	Alert for Security issue
011	Vehicle exit from slot	111	Reset alert or alarm

C. For Vehicle Exit Process:

First driver will require inserting password at spot terminal which will be matched with system allotted password for boom bar lead to raise the boom for exit. At parking exit point at ground floor according to token no's entry time and exit time billing amount will be calculated and the user will be charged accordingly.

IV. IMPLEMENTATION METHODOLOGY

Proposed system need to fulfill time bound management requirement. We develop software for RC-5 protocol receiver module on NXP-p89lpc932 microcontroller based hardware and for CAN bus communication; Freescale-9s08dz60 based development board is used. IR based communication is successful up to 35 to 40 feats and check CAN bus data transfer in Loopback self test mode. Software is developed using C-language which is very important for Prototype. Whole module is divided in different functions including some interrupt service routines, timer interrupt service routine, etc. As shown in code snippet Main program controls all operation to initialize & requires internal device setup for different interrupt, timer, communication peripherals like UART, etc… After proper initialization, when interrupt sensed on INTR pin timer device start timer to check bit timing

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and program works in polling mode and continually checks for receive process complete or not. After completion of RC-5 code receiving process, data is decoded as per message type and message at uc_main() program and execute application as per message command interpretation. If command is to get password content then password () function invoked, which checks entry time password and password entered at slot terminal, for authentication. After successful authentication, car parking process get finish and boom bar close operation done successfully. The same authentication check process required at exit time. If authentication process criteria success then boom bar got open, otherwise generate alarm for security and alerts the administrator for unauthenticated exit/theft.

```
void main()
{ Static int pass_status=0,pass_word[2], ent_pass[i],alarm, pass_comp, Pass_suc=0 ,i=0,j=0;
Init_uC();
UART_init();
while(1){           uCmain();          //rc-5 logic programme
          Password();}}     //password checking programme

Void Password()
{
If(pass_press=1 & pass_comp=1)
          {
          pass_press=0 ;
          If(Pass_word[0]==ent_pass[0])
          {
          if (pass_word[1]= ent_pass[1])
          {          Pass_suc=1;}
          else
          {          pass_suc=0}}
          If(pass_suc=1)
          { Pass_suc=0;
          pass _exit=~pass_exit;
          if(pass_exit=0)
          { P0.2 =0;
          Pass_comp=0; pass_word[0]=0; pass_word[1]=0;}
          else
          { P0.2=1;}
          else{alarm=1;}
          else
          {
          alarm =1;}
          ent_pass[0]=0;ent_pass[1]=0;
          }
          }
/*Ucmain programme is use to decode rc-5 code received from perantal device*/
void uCmain()
{char data, comd;
if(rcrcv)
{          rcrcv = 0;
          data = (char)(ircode);
          comd = (char)(ircode & 0x07);
          ircode = 0;
          switch(Comd)
          {
          case 0x00:
          if(pass_status =0)
          {Pass_word [pass_status]=data;
           pass_status=1}
          else
```

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```
        {Pass_word [pass_status]=data;
        pass_status=0
        pass_comp=1}
        break;
        case 0x07:
        alarm=0;
        break;
}
        EKBI = 1;}
return;}
```

V. CONCLUSION

In this paper we have proposed a model for the parking management system. The model has been tested using simulator and emulator with IR based communication system. The result of simulator and emulator are matching satisfactorily. In future we are planning to extend our work to make full-fledged parking system prototype model with more different categories of vehicle with networking capability and flexibility of control system for the cost effectiveness and market application foreground.

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S. No.	Title with page nos.	Journal
I.	***"Wireless Embedded control system for green house automation."*** Volume No. 1, Issue-2 Page No 205 to 208. Jul-Dec. (2009)	VNSGU Journal of Science and Technology
II	***"RC-5 based embedded control system for home security."*** Volume No 2, Number-2 Page No 169-175. December, (2009)	National Journal of System and Information Technology
III	**"Automatic aquaculture environment management using embedded system"**,	International conference proceeding ISWET-2012

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