# Multi-storey car parking


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# Outline

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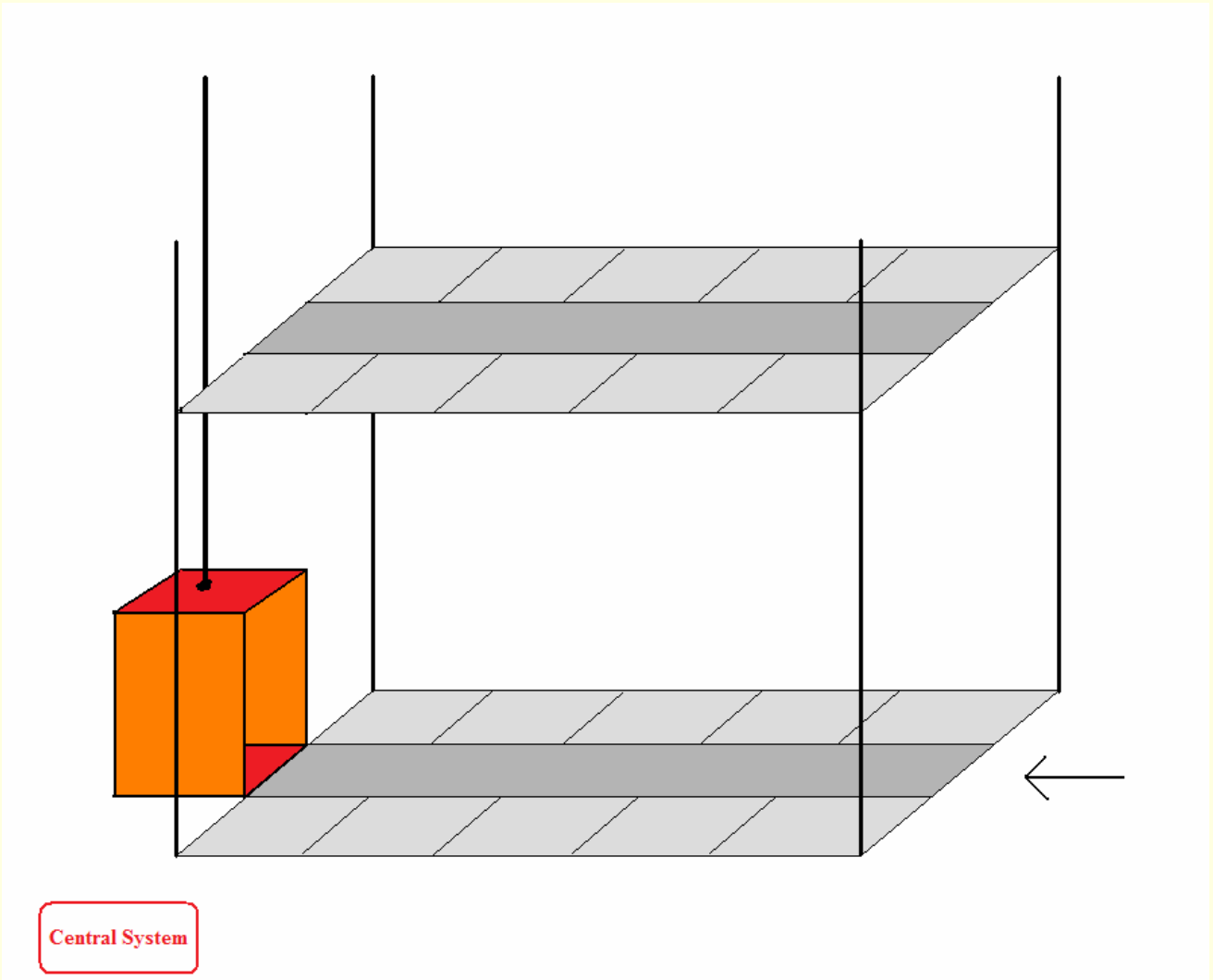
# Introduction

- A prototype of automated multi-storey car parking
- An idea for space conservation
- A learning process thereby
- It currently supports ground + one level parking
- Has 6 slots per level and an elevator for commutation
- Firebird IV used as an automated vehicle
- Firebird IV also serves as an elevator controller and a central coordinator


Central System

# Algorithm

Car enters the parking space and checks for vacant slot

↓ Slot found

Enters ground level and searches for empty slot → Slot found → Self parks

↓ No slot on ground level

Reaches the end, senses white line, stops, communicates and waits for the lift → No lift → Wait

↓ Lift arrived

Enters into elevator, communicates, reaches first level, turns by 180 degrees, self parks

# Hardware requirements

- Self parking: Front, Left and Right IR sensors
- Ground level edge detection: Three white line sensors
- Stop after entry into elevator: Front IR sensor
- Lifting mechanism: Existing Firebird IV DC geared motors
- Coordinator – car communication: 802.15.4 zigbee communication module

# Software requirements

- Complete implementation in µC/OS real time kernel
- IDE WinAVR for generation of the required executables
- Avrdude for loading the code in Firebird IV

- Light weight implementation in Esterel
  - Including self parking, lifting
- firebird_gen and Kontrollerlab for compilation and loading

# Communication protocol

- Please see comm_prot.jpeg

# Design steps and implementation

- Identifying the requirements for implementation of multi-storey car parking
  - Use of automated car parking vehicle
  - Use of central coordinator for bookkeeping
  - Lifting mechanism
- Realizing the requirements
  - Firebird IV has been used both for lifting mechanism and as an automated vehicle
- Code
  - µC/OS : Sensor, distance, velocity control and wireless tasks
  - Esterel: Single module to take care of all these functionalities

# Code structure

- Tasks for Car.c
  - SensorTask, that makes use of IR sensors for sensing various obstacles
  - DistanceTask, which keeps track of the empty distance for identifying the empty slot
  - VelocityControlTask, which assigns the appropriate velocity and direction of the vehicle motion, for moving forward, taking 90 degrees right turn, etc.
  - WirelessTask, for communication with the controller
- Tasks for Controller.c
  - MainTask which performs the task of controlling the lift and bookkeeping, along with communication with the automated vehicle

# Constraints and challenges

- Design challenges
  - Hardware: Lift mechanism
  - Software: Division of the required functionalities into appropriate subtasks and assigning priorities to these
  - Priority order: Sensing (highest), velocity control, distance and wireless tasks
- Design constraints
  - White line occurrence anywhere other than the end of the ground level is not allowed
  - Lift mechanism needs human assistance

# Scope

- Space conservation
  - Easily extendible to more levels with few modifications
  - Better bookkeeping
- Functionality add on
  - Un parking mechanism
  - Sophistication

# Acknowledgement


- Saurabh Bengali
- Raviraj
- Vaibhav
- Sachitanand Malewar
- Amey Apte
- Aniket

Thank you