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Automotive smart parking system

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ABSTRACT

We will look into the design, construction and testing of a prototype of an automated parking system. The prototype carries cars from the second floor to the empty spaces on the second and fourth floors using motors, and this can save time for drivers and provide more safety for cars.

The arduino mega 2560 micro supervises the operation of various hardware parts such as: stepper motors, two module relays, a keyboard, a stepper motor.

The Arduino Mega 2560 will be programmed using the Arduino language. And then create the prototype and when designing, we will make many modifications to improve performance and remove the malfunctions that we will encounter during the design in Project 2.

1 CHAPTER 1. INTRODUCTION

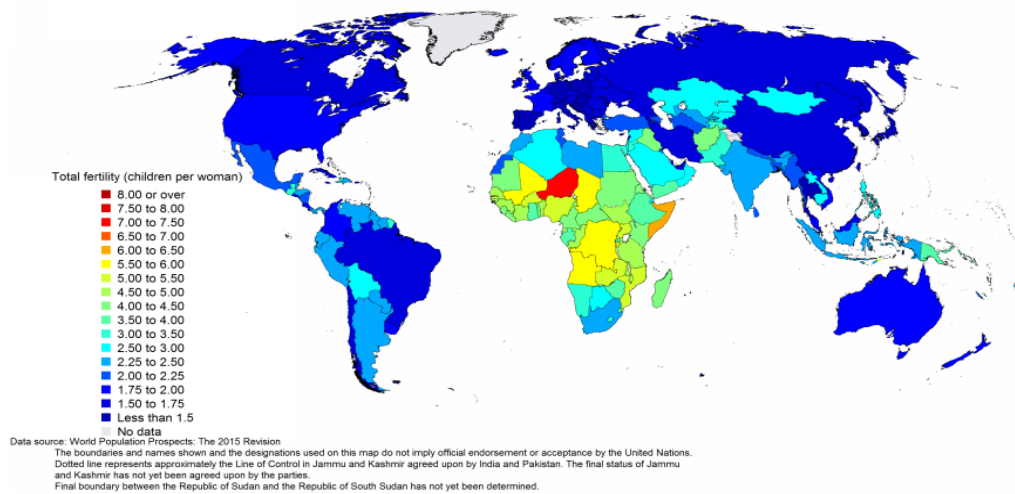
1.1 OVERVIEW

An automated (car) parking system (APS) is a mechanical system designed to minimize the area and/or volume required for parking cars. Like a multi-story parking garage, an APS provides parking for cars on multiple levels stacked vertically to maximize the number of parking spaces while minimizing land usage. The APS, however, utilizes a mechanical system to transport cars to and from parking spaces (rather than the driver) in order to eliminate much of the space wasted in a multi-story parking garage. While a multi-story parking garage is similar to multiple parking lots stacked vertically, an APS is more similar to an automated storage and retrieval system for cars.

1.2 EXISTING PROBLEMS

According to the United Nations, world population reached 7 Billion on October 31, 2011. The US Census Bureau made a lower estimate, for which the 7 billion mark was only reached on March 12, 2012. For the huge increasing in population around all over the world, and the big problem in places and ground limited, we need a very efficient and economical solution to make more places available. Concentrated population places, especially with cars need a creative solution to solve the problem of finite spaces, and wasting time to find a park. See Fig.1.3 below.

Total fertility, medium projection, 2015-2020



- **SPACE SAVING**

All APS take advantage of a common concept to decrease the area of parking spaces - removing the driver and passengers from the car before it is parked. With either fully automated or semi-automated APS, the car is driven up to an entry point to the APS and the driver and passengers exit the car. The car is then moved automatically or semi-automatically (with some attendant action required) to its parking space.



A Large Fully Automated Parking System

The space-saving provided by the APS, compared to the multi-story parking garage, is derived primarily from a significant reduction in space not directly related to the parking of the car:

- Parking space width and depth (and distances between parking spaces) are dramatically reduced since no allowance need be made for driving the car into the parking space or for the opening of car doors (for drivers and passengers)
- No driving lanes or ramps are needed to drive the car to/from the entrance/exit to a parking space
- Ceiling height is minimized since there is no pedestrian traffic (drivers and passengers) in the parking area, and
- No walkways, stairways or elevators are needed to accommodate pedestrians in the parking area.

With the elimination of ramps, driving lanes, pedestrians and the reduction in ceiling heights, the APS requires substantially less structural material than the multi-story parking garage. Many APS utilize a steel framework (some use thin concrete slabs) rather than the monolithic concrete design of the multi-story parking garage. These factors contribute to an overall volume reduction and further space savings for the APS.

Other considerations:

In addition to the space saving, many APS designs provide a number of secondary benefits:

- The parked cars and their contents are more secure since there is no public access to parked cars.
- Minor parking lot damage such as scrapes and dents are eliminated
- Drivers and passengers are safer not having to walk through parking lots or garages.
- Driving around in search of a parking space is eliminated, thereby reducing engine emissions.
- Only minimal ventilation and lighting systems are needed.
- Handicap access is improved.
- The volume and visual impact of the parking structure is minimized.
- Shorter construction time.

1.3 AIMS AND OBJECTIVES

Our project objectives can be summarized as:

1. Security from Theft and car damage, No vandalism or accidental damage eliminated and no danger of violence.
2. Save time , no need to waste time searching for empty car spaces to park the car.
3. Save spaces, the parking will hold a large number of cars, so much spaces will be saved.

1.4 SCOPE OF THE WORK

1.4.1 GENERAL OVERVIEW

A cylindrical structure containing 4 tiers on each floor and each tier containing a sensor that gives a signal when the car enters the tier that the place is full

The customer sends the order via a message using the mobile phone and specifies the number of the liquidator he wants

When the message is received, the DC Motor No. 1 works and pulls the car from the table that is located at the door of the parking lot, then the stepper motor works and raises the car to the required floor, then the DC Motor No. 2 works, which is responsible for the rotation process, and it rolls the car towards the desired parking lot, and through the existing sensor it senses place and stands in front of him

As for the power source, this project is entirely low voltage and with all its sources, and we can use power supply or batteries to operate it.

1.4.2 THE PRINCIPLE OF OPERATION

First the customer get his car and park it on the crane on the base floor, then he get out from the car and go to the keypad to enter the slot he want to park in .

We have two level each level has 4 slots to park in so when the customer choose from the keypad which slot he want the dc motor start to move to left the car from the base floor in to the chosen slot, for the first floor which have 4 park we defined the first 4 keys in the keypad for the first floor and the next 4 for the second floor .

Now for the chosen slot if he choose 1, then dc start to move to left the crane to the first floor then when the crane reach the first floor the dc stopped, then the second dc motor rotate to get the car in the right position for the slot so that the third dc motor start to get the car in slot, then the first dc motor rotate in reverse to get the car on its wheel on the chosen slot, then the third dc motor rotate at reverse and then the second and the first motor reversed at selected time to get back to the first position to take another car .

Each slot have its special sequence so at first we have a memory called EEPROM at this memory we save the operation so after we press 1 and the motor work and then get back to normal position it saves that the park 1 is full so not available shown in the LCD and for the second press in 1 it have its special code to get the car back and that's on for the rest of slots and for the two levels of the park .

Sum up:

When we press number in keypad the dc motor start to operate to left the crane then stop at the level which is fixed before for the chosen slot then the second motor which is placed at the base to rotate the crane in to the right angle for the chosen slot then stop to start the third motor which is fixed beneath the crane to move the car to its slot then stop to start the first motor for a small delay to get the car into its wheel on the slot then stop and the third motor now rotate at reverse and then the second and the first motor to get back to the original position for other order.

1.4.3 HARDWARE OVERVIEW

- Arduino
- Memory
- Two module relay
- Two dc motor
- Stepper motor
- Stepper motor drive
- Power supply or battery
- Keypad
- Hard disk drive

- Bearing

1.4.4 SOFTWARE OVERVIEW

This project can execute commands via Arduino as they are issued from the mobile software.

So Arduino is an object oriented programming language which means real time tasks of sequential reading and sending of each communication with the motor controls.

While Arduino can be opened from a laptop and controlled using some software such as ARDUINO-1.8.16 that gives access to it from a laptop.

Also, there are general software explanations found later in this report to get to the final project of a smart car park model.

1.5 IMPORTANCE OF THE WORK

The importance of this project lies in the large population density and traffic congestion in some areas as a result of the lack of parking lots, as this research provides parking lots in large numbers without the need for large spaces and at the lowest costs, as it saves time and effort on the population and leaves a positive idea about the country among visitors and tourists

2 CHAPTER2. *Theoretical Background and Previous Work*

Inspiration for this project came from insights into technology, economics, and the environment. In our project, we studied as many projects as possible about smart parking lots, from manual-controlled projects to automatic-controlled projects, but we chose to have our idea in a different way in order to address some of the problems that our colleagues faced in previous projects and work on developing and improving them Better .

For example: the problem of space, instead of needing more than one land, it is possible to add more than one floor for a larger number of cars with the same possible space. Also , the protection and security system available to us a project to reduce cases of theft and non-occurrence of crimes.

In addition to saving time and effort for the customer through the possibility of pre-booking so that he does not take time to search for parking for his car.

3.1 SOFTWARE IMPLEMENTATION

It required a Programming Tools of mobile application & C++ Language to build the project.

3.1.1 ARDUINO LANGUAGE

Arduino programming language can be divided in three main parts: functions, values (variables and constants), and structure.

Functions: For controlling the Arduino board and performing computations.

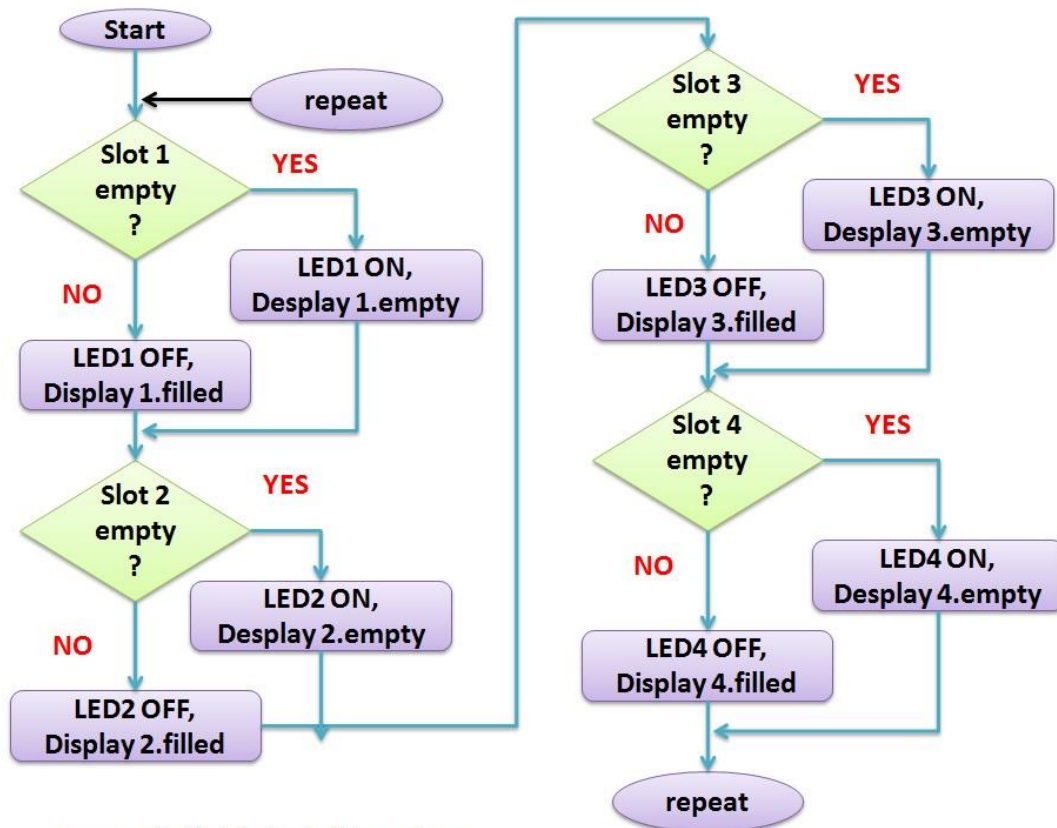
Variables: Arduino data types and constants.

Structure: The elements of Arduino (C++) code.

3.1.2 C++ language

Arduino code is written in C++ with special methods and functions added. C++ is a human readable programming language. When you create a "sketch" (the name given to Arduino code files), it is processed and translated into machine language.

3.2 SOFTWARE DESIGN



www.embedded-electronics.blogspot.com

3.3 HARDWARE DESIGN

3.3.1 Arduino mega 2560

The **Arduino Mega 2560** is a microcontroller board based on the **ATmega2560**. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Mega 2560 board is compatible with most shields designed for the Uno and the former boards Duemilanove or Diecimila.



3.3.2 Memory

The ATmega2560 has 256 KB of flash memory for storing code (of which 8 KB is used for the bootloader), 8 KB of SRAM and 4 KB of EEPROM (which can be read and written with the **EEPROM library**)

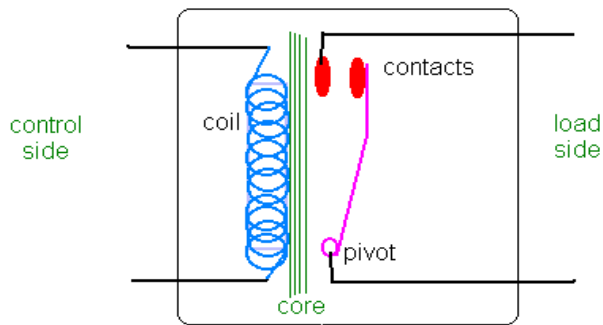
3.3.3 Two module relay

A relay is an electrically operated switch, many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays.



Relay

Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.



INSIDE A SPST RELAY

pic r-1a

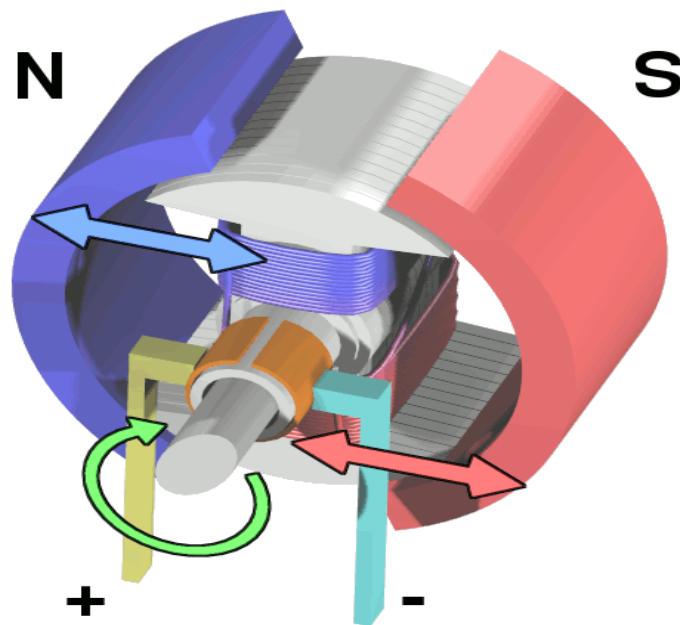
Inside a relay

A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protective relays".

3.3.4 Two dc motor

A **DC motor** is any of a class of rotary electrical motors that converts direct current (DC) electrical energy into mechanical energy. The most common types rely on the forces produced by induced magnetic fields due to flowing current in the coil. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor.

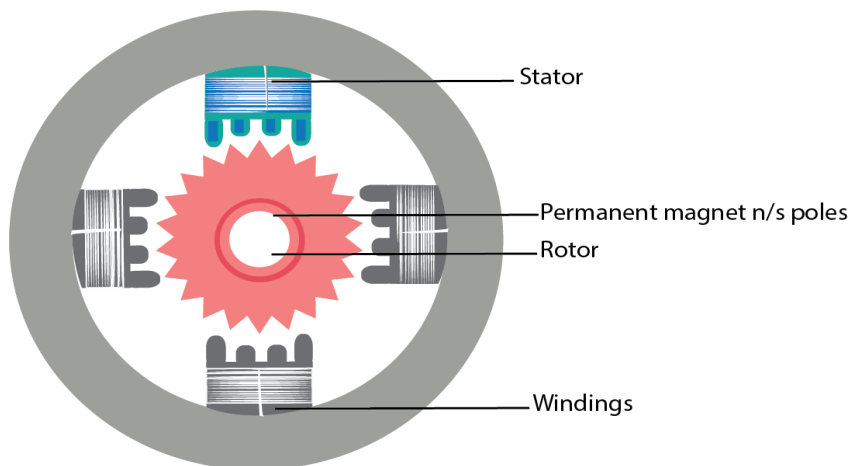
DC motors were the first form of motors widely used, as they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor, a lightweight brushed motor used for portable power tools and appliances can operate on direct current and alternating current. Larger DC motors are currently used in propulsion of electric vehicles, elevator and hoists, and in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.



3.3.5 STEPPER MOTOR

A stepper motor or step motor or stepping motor is a brushless DC electric motor that divides a full rotation into a number of equal steps. The motor's position can then be commanded to move and hold at one of these steps without any position sensor for feedback (an open-loop controller), as long as the motor is carefully sized to the application in respect to torque and speed.

Switched reluctance motors are very large stepping motors with a reduced pole count, and generally are closed-loop commutated.



3.3.6 STEPPER MOTOR DRIVES

A **stepper motor drive** is a circuit which is used to drive or run a stepper motor. It is often called a stepper motor driver. A **stepper motor drive** usually consists of a controller, a driver and the connections to the motor.

The stepper motor drive is a dumb piece of electronics unless and until you program the microcontroller to give signals correctly to the stepper motor via the driver. A stepper motor can operate in many modes like full step, wave drive or half stepping . Hence, we must make the driver interactive enough to be able to take command from the user and do the required kind of stepping. Also, we must control the speed of rotation. A start/stop command must start or stop the motor rotation. To accomplish the above functions, we need to use additional pins on the micro-controller. Two pins are required to select the kind of stepping and to start or stop the motor. One pin is required to connect a pot which will act as a speed controller. The ADC inside the micro-controller will be used to control the speed of rotation.

- **ESSENTIAL COMPONENTS OF STEPPER MOTOR DRIVE**

1. Controller (Essentially a micontroller or a microprocessor)
2. A driver IC to handle the motor current
3. A power supply unit

- MISCELLANEOUS COMPONENTS

1. Switches, Potentiometers
2. Heat sink
3. Connecting wires

- CONTROLLER OF STEPPER MOTOR DRIVE

Selection of a controller is the first step to building a driver. It must have a minimum of 4 output pins for the stepper. Apart from this, additionally it must contain timers, ADC, serial port etc. depending on the application in which the driver will be used.

- POWER SUPPLY FOR STEPPER MOTOR DRIVE

A stepper motor may run at voltages varying from 5 V to 12 V and similarly the current draw will be somewhere in the range of 100 mA to 400 mA. It is important that the power must be regulated so that fluctuations in speed and torque can be avoided.



Stepper Motor Drive

3.3.7 POWER SUPPLY OR BATTERY

A power supply is an electrical device that supplies electric power to an electrical load. The primary function of a power supply is to convert electric current from a source to the correct voltage, current, and frequency to power the load. As a result, power supplies are sometimes referred to as electric power converters. Some power supplies are separate standalone pieces of equipment, while others are built into the load appliances that they power. Examples of the latter include power supplies found in desktop computers and consumer electronics devices. Other functions that power supplies may perform include limiting the current drawn by the load to safe levels, shutting off the current in the event of an electrical fault, power conditioning to prevent electronic noise or voltage surges on the input from reaching the load, power-factor correction, and storing energy so it can continue to power the load in the event of a temporary interruption in the source power (uninterruptible power supply).

All power supplies have a power input connection, which receives energy in the form of electric current from a source, and one or more power output connections that deliver current to the load. The source power may come from the electric power grid, such as an electrical outlet, energy storage devices such as batteries or fuel cells, generators or alternators, solar power converters, or another power supply. The input and output are usually hardwired circuit connections, though some power supplies employ wireless energy transfer to power their loads without wired connections. Some power supplies have other types of inputs and outputs as well, for functions such as external monitoring and control .



Power Supply.

3.3.8 KEYPAD

A keypad is a set of buttons arranged in a block or "pad" which bear digits, symbols or alphabetical letters. Pads mostly containing numbers are called a numeric keypad. Numeric keypads are found on alphanumeric keyboards and on other devices which require mainly numeric input such as calculators, push-button telephones, vending machines, ATMs, Point of Sale devices, combination locks, and digital door locks.



Keypad

3.3.9 HARD DISK DRIVE

A hard disk drive (HDD), hard disk, hard drive or fixed disk^[b] is an electromechanical data storage device that uses magnetic storage to store and retrieve digital information using one or more rigid rapidly rotating disks (platters) coated with magnetic material. The platters are paired with magnetic heads, usually arranged on a moving actuator arm, which read and write data to the platter surfaces.^[2] Data is accessed in a random-access manner, meaning that individual blocks of data can be stored or retrieved in any order and not only sequentially. HDDs are a type of non-volatile storage, retaining stored data even when powered off.



3.3.10 BEARING

Bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. Most bearings facilitate the desired motion by minimizing friction. Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts.

Rotary bearings hold rotating components such as shafts or axles within mechanical systems, and transfer axial and radial loads from the source of the load to the structure supporting it. The simplest form of bearing, the plain bearing, consists of a shaft rotating in a hole. Lubrication is often used to reduce friction. In the ball bearing and roller bearing, to prevent sliding friction, rolling elements such as rollers or balls with a circular cross-section are located between the races or journals of the bearing assembly. A wide variety of bearing designs exists to allow the demands of the application to be correctly met for maximum efficiency, reliability, durability and performance.



Bearing

4 CHAPTER RESULTS AND CONCLUSION

4.1 ISSUES AND LIMITATIONS

- Think of how to make the crane stable.
- Thinking about the best way to make the quad move 360 degrees, in addition to determining the appropriate place for the stepper motor responsible for doing this process.
- Determine the mechanical parts that achieve the best desired results from the project, and these parts are easy to obtain.

4.2 SECURITY

This project is almost fully secured, since it sends a protection password when the car arrives at its place in the parking lot, and when it is retrieved, the password must be entered again, and when attempting theft, the program sends a confirmation message to the customer to confirm whether it is him, and then a different password is sent to the customer to keep his car safe .

4.3 CONCLUSION

Obtaining a preliminary conception of what needs to be implemented in Project No. 2, in order to achieve the best expected results from the project. With the possibility of modification when designing in case of finding a better alternative or an optimal way to design the project

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