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Smart Parking System using Machine Learning and Internet of Things

Rupeshwar Maheshwar Rao¹, Mishalee Lambat², Suresh Kapare³, Apurv Pradip Vidhate⁴

^{1, 2, 3, 4}Computer Science And Engineering Department Of MIT School Of Engineering, MIT ADT University, Pune, India

Abstract: *The Smart Parking System is a modern approach to resolve the parking issues in our country. This application will help all the users to find the perfect parking spot in shopping complexes or a public parking system. It has an additional feature of securing the vehicle using Face Recognition. (Abstract)*

Keywords: *Arduino, Face Recognition, Smart Parking, Internet Of Things (IOT), Smart City, Machine Learning, Statistics, Python, Ultrasonic Sensor*

I. INTRODUCTION

Have you ever struggled to find a parking spot and gone in circles around a parking lot looking for an open space to park your vehicle? [1-2]. Well our project helps enable the users to find a parking spot in the given architecture. Safety is also a concern to people, our project It ensures the safety and security of your vehicle by authentication of the user. Our project pin points to an open parking spot occupied by a vehicle. Consider the parking lot of a mall or a shopping complex, it is very hectic to find a spot in such huge architecture. Our project simplifies the work and directs the users to different locations to avoid a collision. To wrap it up, our project takes care of Business Analytics through Machine Learning. The data which the system will collect is the number of vehicles Parked in a year and revenue collected in the past year. It will all be fed to a program which will help the owners and management to understand the current scenario of their business which will help them take steps to ensure the future of their Business. in [3-7], the various data communication systems are presented. These systems can be effectively utilized for IoT enabled smart parking systems to mitigate the problems of network congestion.

II. HARDWARE COMPONENTS

A. Arduino ATmega 2560

Arduino ATmega 2560 is the microcontroller we used which has 54 digital input output pins, 16 analog pins, 4 UART pins, a USB A port, a power jack and a reset button present on the board. We can connect it to a computer with a USB cable or power it with a AC-to-DC adapter. 5volts is the operating voltage of the microcontroller. Flash Memory like 256 KB where 8 KB of flash memory is used with the help of bootloader.16 MHz Clock (CLK) speed of the microcontroller. Every pin of the Arduino has a unique function to perform and also all analog pins can be used as digital I/O pins as well.

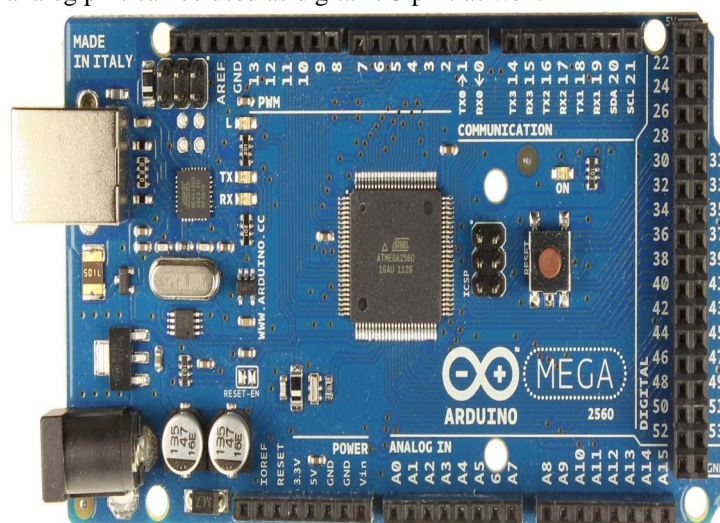


Image Credits: <https://5.imimg.com/data5/WK/KJ/MY-5859485/arduino-mega-2560-500x500.jpg>

B. Ultrasonic Sensor (HC-SR04)

The Ultrasonic Sensor HC-SR504 uses SONAR(Sound Navigation and Ranging) to calculate the distance of an object. It provides a long range and provides accurate readings with high accuracy.

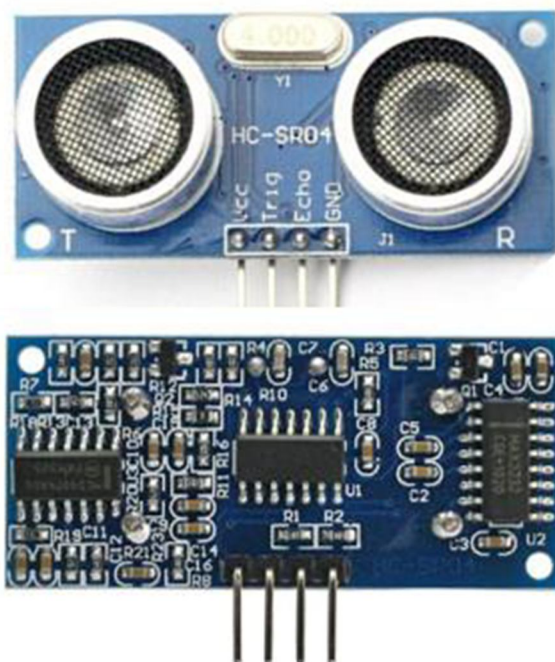


Image Credits:

https://www.tutorialspoint.com/arduino/images/ultrasonic_sensor.jpg

It consists of two modules, the 1st module is the transmitter which emits the ultrasonic waves and the 2nd is the receiver that detects the reflected waves from the object. There are 4 pins namely, VCC, TRIG, ECHO and GND.

C. Jump Wires

A jump wire (commonly known as jumper) is an electrical wire. It is a group of them in a cable, with a connector (female) or pin (male) at each end (or sometimes without them – simply "tinned"), which is normally used to join the components of a prototype or test circuit or a breadboard, internally or with other or components or equipment, without the need of soldering.

Each jump wire is fitted by inserting their "end connectors" into the slots of a breadboard, the head connector of a circuit board, or a piece of test equipment.

There are different types of jumper wires. Some with the same type of electrical connector present at both ends, while others have different connectors. Common connectors are:

- 1) *Solid Tips:* These are used to connect a breadboard or female header connector. The ease of insertion and arrangement of the elements on a breadboard helps enable us in increasing the mounting density of both components and jump wires without the fear of short-circuits. Jump wires vary in size and colour to help distinguish the different working signals.
- 2) *Crocodile Clips:* These are used, among other applications. To temporarily bridge buttons, sensors and other elements of prototypes with components or equipment that have random connectors, wires, screw terminals, etc.
- 3) *Banana Connectors:* These are frequently used on test equipment for low-frequency AC and DC signals.
- 4) *Registered jack (RJnn):* These are commonly used in computer networking (RJ45) and telephone (RJ11).
- 5) *RCA Connectors:* These are commonly used for audio, low-resolution composite video signals. They are also used for other low-frequency applications which require a shielded cable.
- 6) *RF Connectors:* These are used to carry radio frequency signals between antennas, circuits and test equipment.
- 7) *RF jumper cables:* The Jumper cables are smaller, hence more bendable type of a corrugated cable. It is frequently used to join antennas and various other components to the network cabling. Jumpers wires are often used in base stations to help connect antennas to radios. The most bendable jumper cable has a diameter of 1/2".



Image Credits:

https://cdn.shopify.com/s/files/1/0903/7990/products/jumperwire-alltypes_2048x2048.jpg?v=1593333898

III. SOFTWARE

A. Face Recognition

Face Recognition is a secure and fast method of authentication and is widely used in today's world. For example when you upload pictures to Facebook it automatically recognises the person if it is in your friend list. Face detection is a great feature for cameras. If camera captures pictures automatically then it will make sure that all pictures are focused while capturing. To recognize faces, convert images into black and white as we do not need the colored data. Then we shall take a look at each pixel in the image one by one. For every single pixel, we want to look at the pixels that directly surround it, we need to figure out how dark the current pixel is compared to the pixels directly surrounding it. Then place an arrow in the direction the image is getting darker. If you start doing this for every single pixel in the image then you shall end up with all arrows instead of pixels in the image. Arrows are called gradients which shows the direction in which image is getting darker. Now we have turned the original image into representation which captures basic features in simple way of a face.

Measurements that seem relevant to us humans (like pupil color) does not make sense to a computer looking at individual pixels in an image. Researchers say that it is very efficient that let the computer determine which factors to pick for recognition. Deep learning picks important parts of face rather than humans.

We train it to generate 128 measurements for each face.

The process of training works by looking at three face images at a time:

- 1) Upload an image of person for training process.
- 2) Upload a resembling picture of the same person.
- 3) Upload an image of another person.

A single 'triplet' training step:

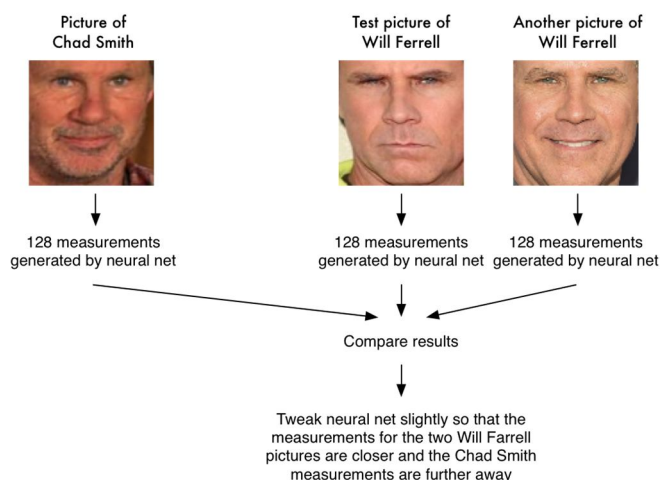


Image Credits:

https://miro.medium.com/max/1400/1*nIR8VMYDRw3RNO3JULYBpQ.png

After repeating this step for several times for many people the neural network can generate 128 measurements for each individual. Any other types of pictures of same person shall roughly give same measurements.

Embedding in Machine learning is called for these 128 measurements. The idea of reducing complicated raw data example a picture into a list of computer-generated numbers is seen a lot in Machine Learning (especially in language translation).

To process and train requires a lot of computation power so we have used the python library of OpenCV.

B. OpenCV

Open-Source Computer Vision Library (OpenCV) library is a programming way in which a use can deal with real-time computer vision algorithms. Developed by Intel, it was later supported by Willow Garage then Itseez (later acquired by Intel). It is cross-platform and under the open-source Apache 2 License is free to use. In 2011, OpenCV features GPU acceleration for real-time operations. With the help of OpenCV's cv2 library and few other python libraries (dlib, face-recognition) we were able to successfully recognise a person.

C. Firebase

Firebase is created By Google for Web Development and temporary storage of any Computing Database. We used firebase as a backend to our project. All the data which we have received through the application is sent to the firebase storage. Including user information like name, phone number, email id , car number and the picture of the user.

We chose Firebase as it is free of cost and helps create prototypes without any hassle. Firebase also provides their own authentication and hosting services which can help in expanding the scope of the project.

D. Machine Learning

Machine learning (ML) is a part of artificial Intelligence (AI) which makes the software applications accurate at predicting outcomes without being explicitly programmed. Machine learning algorithms previous data to predict the upcoming values.



Image credits:

<https://thumbs.dreamstime.com/b/machine-deep-learning-algorithms-artificial-intelligence-ai-automation-modern-technology-business-as-concept-134359416.jpg>

E. Prediction in Machine Learning

“Prediction” in Machine Learning is a way of obtaining output of an algorithm which has been trained on a previous dataset and applied to new dataset to obtain an outcome, such as whether a crop shall grow or not based on previous weather forecasts



IMAGE CREDITS:

https://www.wallpapertip.com/wmimgs/168-1688670_stock-price-prediction.jpg

F. Regression in Machine Learning

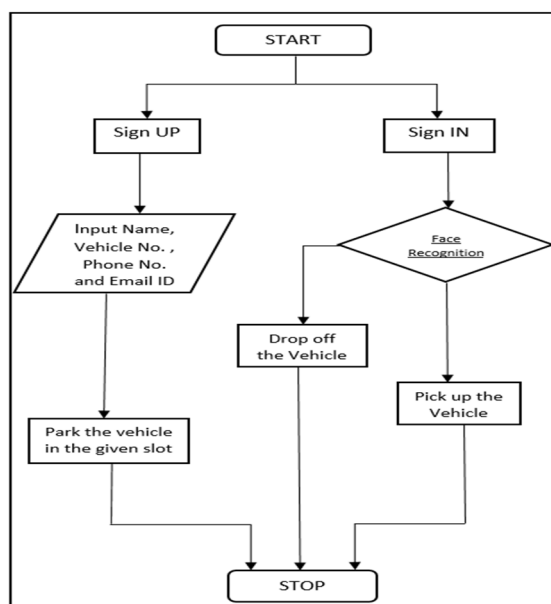
Statistics refers to a collection of tools that you simply can use to urge answers to big questions on data. You can use descriptive statistical methods to rework raw observations into information that you simply can understand and share. Statistics is usually considered a prerequisite to the sector of applied machine learning.



IMAGE CREDITS:

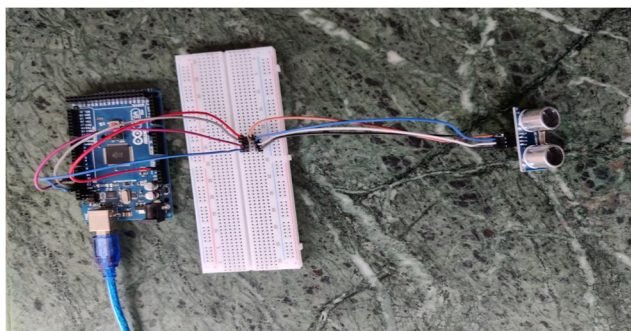
<https://towardsdatascience.com/essential-statistics-for-data-science-ml-4595ff07a1fa>

IV. PROPOSED SYSTEM



A. Configuring Arduino with Ultrasonic Sensor

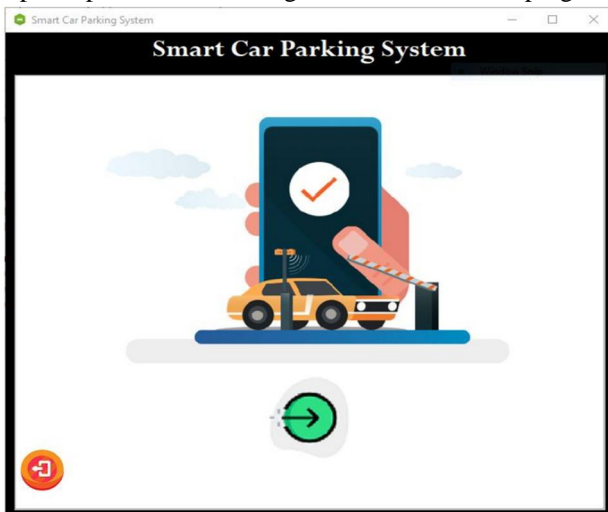
Configuring the Arduino ATmega 2560 with the help of jump wires and a breadboard, we have connected it to the ultrasonic sensor, keeping in mind the input/output pins of the Arduino.



This arrangement of the Hardware will detect the Vehicle in a radius of 0.5 meters. After it has been detected then in the Terminal it displays “Car Detected at 4.06 cm”. If the vehicle has not been detected then it displays “Car not Detected.”

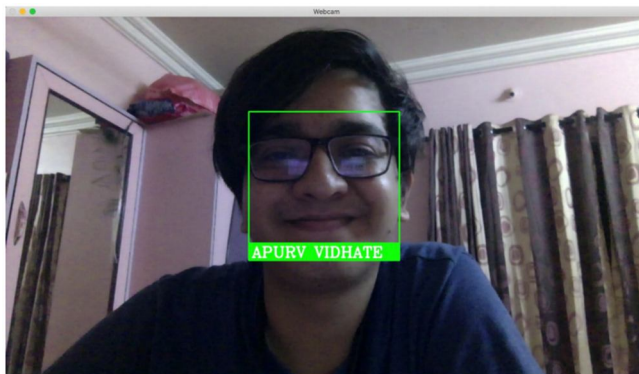
B. Executing the Program.

When we execute the command the User Interface of the program will be displayed on the screen. The user has several options to park or pick up the vehicle through the interface of the program.



C. Face Recognition

Once the face recognition is completed the user can park or pick up the vehicle which ensures the safety of the vehicle.

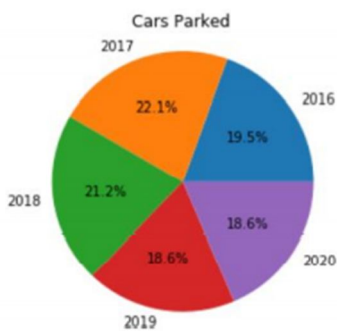


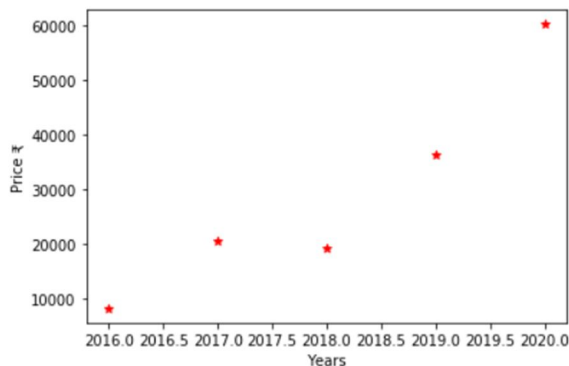
D. Statistics of Machine Learning.

Statistics in ML is a way of providing the Parking system owner to grow his business by bringing any changes which is bringing the market loss to his/her business.

The Machine Learning program predicts the future revenue generated by the Parking System under present conditions. It uses regression in single Variable to do the prediction.

Also, the program allows the owner to know the statistics of the system by having various charts on revenue and No of vehicles parked in a year.





V. ACKNOWLEDGEMENTS

We would like to express our gratitude to our teachers, Prof. Suresh Kapare, Prof. Nikhil Sardoor as well as our Principal Dr.Ravande who gave us this golden opportunity to work on this Project ‘Smart Parking System’ which has helped us in developing our skills in various fields like Arduino hardware, Machine learning and also Artificial Intelligence. Last but not the least we would like to thank our parents and our friends who helped in the development and completion of this Project.

VI. FUTURE ENHANCEMENTS

- A. In the project, the Arduino is a separate module which could not be connected to the Main program due to insufficient sensors.
- B. In future we will combine the both models i.e, Main program Module and the Arduino module by embedding the architecture into the program or will remove the Hardware model depending on the algorithm used in future.
- C. Last but not the least, Updating the Profile section will also be provided to the Existing user.

VII. CONCLUSION

The proposed framework gives an alternative way to the traditional parking management system, to deal with identification of opportunities of parking spots.

This approach comprises distinguishing empty parking spots. The framework likewise gives drivers' information assistance. This module gives a continuous refresh of parking slots to drivers through cell phone application with a specific end goal to guide them and encourage the errand of finding an accessible parking slot. The proposed system provides a vision-based approach for detecting vacancies of parking spaces.

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