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Motion Detection and Prediction Using Machine Learning Algorithm

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Abstract:*Machine learning is a branch of Artificial Intelligence which is gaining importance in the 21st century with increasing processing speeds and miniaturization of sensors, the applications of Artificial Intelligence and cognitive technologies are growing rapidly. An array of ultrasonic sensors i.e., HCSR-04 is placed at different directions, collecting data for a particularinterval of a period during a particular day. The acquired sensor values are subjected to pre-processing, data analytics, and visualization. The prepared data is now split into test and train. A prediction model is designed using logistic regression and linear regression and checked for accuracy, F1 score, and precision compared.*

Keywords*: Machine Learning, Logistic Regression F1 score*

I. Introduction

Machine learning is a field of Artificial Intelligence which is gaining importance in the 21st century with increasing processing speeds and miniaturization of sensors, the applications of Artificial Intelligence and cognitive technologies are growing rapidly. An array of ultrasonic sensors is placed at various locations, collecting data for a particular interval of a period during a particular day. The acquired sensor values are subjected to pre-processing, data analytics, and visualization. The prepared data is now split into test and train. A prediction model is designed using logistic regression and linear regression and checked for accuracy, F1 score, and precision.An array of ultrasonic sensors i.e., HCSR-04 is placed at different orientations, collecting data for a particular interval of time during a particular day. The acquired sensor values are subjected to pre-processing, data analytics, and visualization. The prepared data is now split into test and train. A prediction model is designed using logistic regression and linear regression and checked for accuracy, F1 score, and precision.Motion detection of objects or living beings might be interesting in many domains, such as security devices, radars, the positioning of industrial robots, and auto-guidance systems. Most of these applications need the detection system to be non-invasive and not disturb the normal work environment, devices, or living beings inthe region of detection. This involves the choice of discrete vectors for information transport, with high immunity to all other factors unless the state of motion.

II. Methodology

In this methodology, we are going to collect the data from the sensor. The sensor is going to acquire the data by finding the distance between the target object. The acquired data will be fed into the system as an input. Data acquisition is done from the array of sensors and storing the database. Further, data will be pre-processed thereby it removes noise and unwanted values. The pre-processed data now it is eligible for data visualization and data analytics. thereby it hence the process of AI. For the knowledge of correlation, heatmap analysis is done. The data

will be split into train and test based on particular randomness 'X'. A predictive model is designed by using logistic regression. In verification, we verify its accuracy, f1 score, and precession.

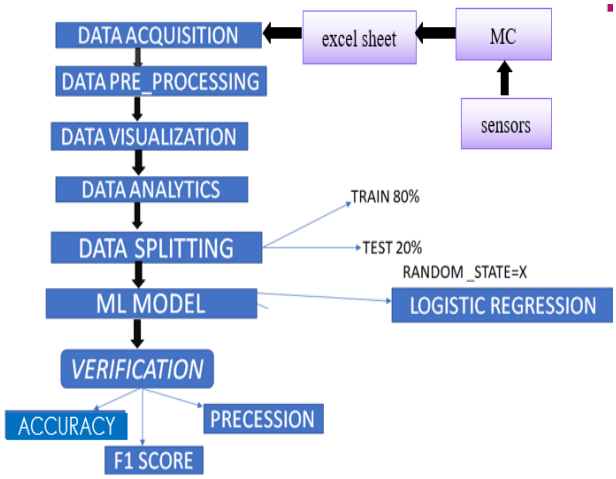

Fig.1.Flow Diagram

Make the initial state as the current state after evaluating the initial state. Run the loop until there is no features present. Select a feature that has not been yet applied to the current state and apply it to produce a new state.The flow goes as form data acquisition, pre-processing, visualization and analytics, data splitting (in this data splitting it undergoes test, train, randomness), after all this it starts with machine learning algorithms finally it gives accuracy, precision.

Data acquisition:

In Data acquisition we gonna acquire the data from the ultrasonic sensors,that is HCSR-04.the presented data that is sensed by the sensors which will be followed by the process of stored the data in the excel sheet of PLX-DAC.these collected data can be used to get the high efficiency,reliability.The data sets we collected includes the parameters like age,gender,blood pressure rate,fasting blood sugar levels,etc.

Data pre-processing

Data Pre-processing is the process where if any unwanted values or data like any noice contains in environment that will be removed by this process.Data that we need not process may not be from a single source sometimes it can be from different sources we do not integrate them it may be a problem while processing Reduction - When we work on data it may be complex and it may be difficult to understand sometimes so to make them understandable to the system, we will reduce them so that we can achieve good results.

Data visualization and analysis

Data Visualization and Analytics are sometimes are interchangeable. Data visualization is the process where the process of data will be presented that can be stored according to the sensors collection of the data.the data that will be visualized according to the process of graphical method it can be variable according to the collection of the data.analytics is the process of considering the graphical method to obtain the certain method of data values to be considered.

Data splitting

In Machine Learning, we have to split data into train and test sets. When we are working on a model and want to train it,according to the machine learning we have to test and train the data,80% of data is to be trained and 20% of data to be tested.

Logistic regression

Logistic regression is used to predict the probability of binary response based on one or more independent variables.The dependent variable is always binary in logistic regression. It is used for calculating the probability of success. It says the condition as 0 and 1. Logistic regression is a linear algorithm. Logistic regression takes different attributes from theprovided database here and provides output in 0 and 1 that is true or false condition. Data transform of your input variables that better expose this linear relationship can result in a more accurate model. It computes the probability of an event occurrence.

Verification principle:

The implemented model and the data are verified by used the logistic regression algorithm and high accuracy, precision, and F1 score is obtained.

III. Implementation

This section describes the implementation of the proposed work

BLOCK DIAGRAM

The block diagram consists of hardware and software components such as 4 HC-SR04 ultrasonic sensors, Arduino mega 2560 microcontroller board, jumper wires, USB cable, laptop/PC, Arduino IDE software, PLX-DAQ tool, Microsoft excel sheet, and a jupyter notebook. In the above block diagram, the sensors connected to the Arduino board microcontroller is placed at the center of a fixed boundary. Say fixed distance is 200cm or 2m in all 4 directions. As the object enters the fixed boundary, the sensors sense the object and calculate the distance of the object, and stores the data into the excel sheet with the help of the PLX-DAQ tool.

If the object is detected in the direction A, sensor1 will be activated and detects the object and measure the distance of the object at each real-time value and if the object takes the direction B, sensor2 will detect the object and measure the distance and will store in the excel sheet with the help of PLX-DAQ tool.

The same process will be followed by all the sensors in all 4 directions. The distance is calculated by the given formula

$D = (T/2) * S$

Where, D – distance

T – time

S – speed

The speed of sound is constant and it is equal to 343m/s.

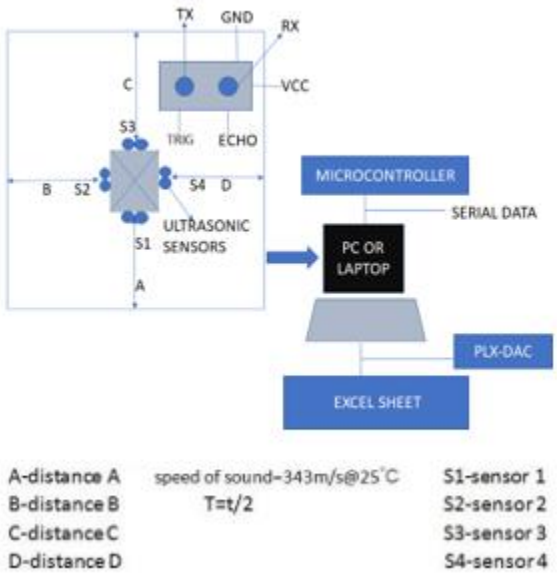

Fig.2.Block Diagram

Data were analyzed using SPSS version 20 (SPSS Inc., Chicago, IL). The student's *t*-test was used to ascertain the significance of differences between mean values of two continuous variables and confirmed by the nonparametric Mann-Whitney test. Also, a paired *t*-test was used to determine the difference between baseline and 2

years after regarding biochemistry parameters, and this was confirmed by the Wilcoxon test which wasa nonparametric test that compares two paired groups. Chi-square and Fisher exact tests were performed to test for differences in proportions of categorical variables between two or more groups. The level $P < 0.05$ was considered as the cutoff value or significance.

III. Result

The model is implemented in the main road circle which consists of 4 roads in 4 directions. The model is kept at the center of the road. A fixed distance is implemented, say 200cm. There are some assumptions made for the object to move in a circle:

1. The object should follow the clockwise direction only.
2. The object should not stay in the same position for a longer duration of time.
3. The object should not take a U-turn.
4. The sensors will detect objects like vehicles. Animals are not detected by the sensor.

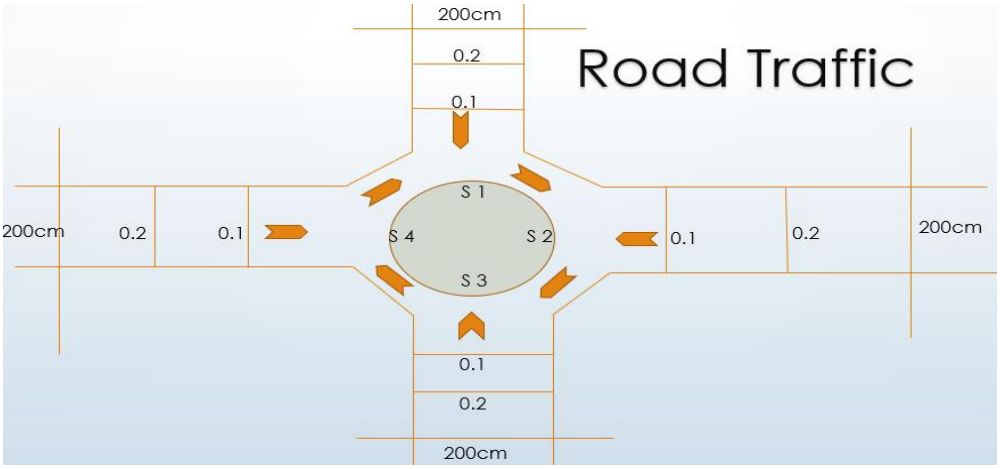

Fig3. Implementation of the model in the main road

Schematic Diagram

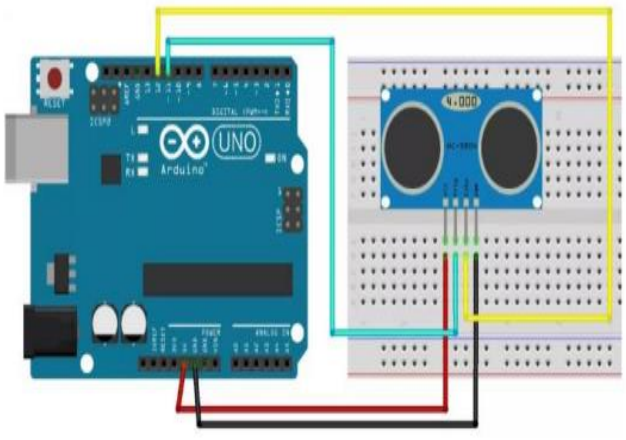

Fig.4.Schematic Diagram

The above fig shows that the sensors connected to the Arduino Mega 2560 microcontroller board. The connections are as follows:

1. VCC pin of sensor is given +5V of the microcontroller.
2. GND pin of the sensor is given to the GND pin of the microcontroller.
3. TRIG pin of the sensor is given to pin no.11 of the microcontrollers.
4. ECHO pin of the sensor is given to pin no.12 of the microcontrollers.

Sensor Working

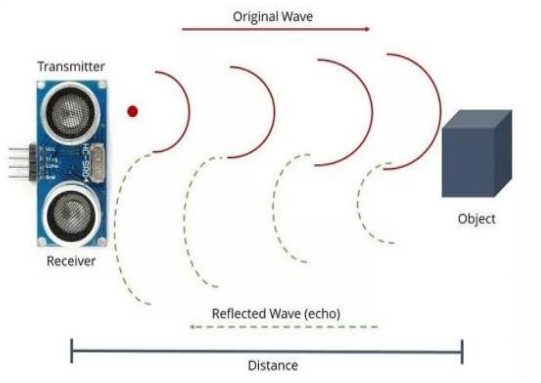

Fig.5.Sensor Diagram

Pins
1. VCC: +5VDC
2. Trig: Trigger (INPUT)
3. Echo: Echo (OUTPUT)
4. GND: GND
distance = (travel time/2) x speed of sound
The speed of sound is: 343m/s
The sensor has two eyes
1. Transmitter.
2. Receiver.
The sensor works with the simple formula
Distance =speed * time.
The transmitter transmits an ultrasonic wave and this wave travels in the air and when it gets objected by any object it gets reflected towards the sensor. This reflected wave reaches the ultrasonic receiver module as shown.

PLX-DAQ

PLX-DAQ is a Parallax microcontroller data acquisition add-on tool for Microsoft Excel. Any of our microcontrollers connected to any sensor and the serial port of a PC can now send data directly into Excel. PLX-DAQ has the following features: Plot or graph data as it arrives in real-time using Microsoft Excel.

Fig6.PLX-DAQ

	Distance in cm	distaA in cm	formatA	format	fuzzA	fuzz
Distance in cm	1.000000	-0.018671	0.028335	-0.978855	0.023904	-0.360664
distaA in cm	-0.018671	1.000000	-0.570074	0.018835	-0.382703	0.020258
formatA	0.028335	-0.570074	1.000000	-0.032605	0.709676	0.001149
format	-0.978855	0.018835	-0.032605	1.000000	-0.034827	0.501482
fuzzA	0.023904	-0.382703	0.709676	-0.034827	1.000000	-0.021508
fuzz	-0.360664	0.020258	0.001149	0.501482	-0.021508	1.000000

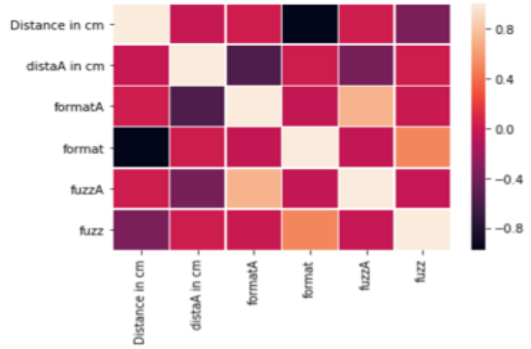

Fig.7.Correlation and Prediction

Prototype Model

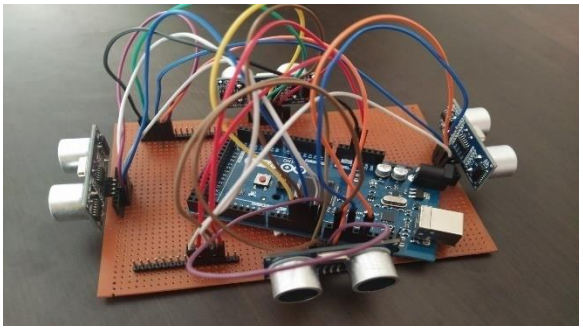

Fig.8.Prototype.

Fig.9.Reduced Traffic Density

IV. Conclusion

Motion detection is very simple work because of the improvement in sensor technology and with ever-increasing accuracy of the same. This can be done by Machine Learning algorithms which allow the machines to learn on their own. Ultrasonic sensors were mounted at different orientations, continuously gathering data of the ether.

The data acquired is then analyzed, visualized, and used for future predictions. We have proposed a low-cost, low power, and a simple system for distance measurement.

The sensor HC - SR04 Arduino with 2560 microcontroller. We can easily know the sensor position, aiming to exactly know the place where an object is detected. The model was able to measure distance up to 400cm without human help in activity with an absolute accuracy of 99%. The circuit was tested for the measurement of various distances in different atmospheric conditions. It has a quick and fast response. This can be used in various applications such as autonomous driving cars, avoiding obstacles and collisions between vehicles.

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