Application of artificial intelligence on internet of things(IOT)

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***Abstract*—The internet of things (IOT) concept has evolved into one of pillars of the new technologies sector. Artificial intelligence is added to IOT systems because it is a best solution to manage huge data flows and storage on IOT. In IOT the data flows internets will have sensor data and user data that send and receive from workstations. Due to increase in workstations and sensors, some data may be facing problems on storage, delay, channel limitation and congestion of networks. It is overcomed by artificial intelligence which is defined for the purpose of data mining, manage and control of congestion in networks. The aim of this paper is to present the application of artificial intelligence on IOT. The importance of data mining and management will be highlighted in this paper through the application of artificial intelligence in self driving cars.**

Keywords—Internet of things, artificial intelligence, mechatronics, neural networks, fuzzy logic, self driving cars, radar and lidar sensors.

I. INTRODUCTION

The internet is a powerful tool used in all kinds of information systems. The network is available almost everywhere, at home, at work also on mobile devices (phones and watches).People start to think to connect internet to almost all the devices of everyday use, so they can communicate with each other by taking simple decisions for people and helping them in their life. Such idea is called the internet of things (IOT).

IOT is current technology to send or receive the sensors data via internet networks. It is same like normal data communication except that in IOT, sensors and microcontrollers are usually used. The sending and receiving of data do not rely on computers but relies on microcontroller and portable devices such as cell phone, communication pad or even the smart watch. With IOT most of the sensor data can be directly routed into the server. This usually is done when the microcontroller is attached to the wifi and there is connection between the microcontroller and wifi[1].

Unlike in traditional internet system, to send or receive data, the user must know the IP address and hence do the necessary setting in the network before transmission. Similarly for wifi connection, like in portable computer, the user had to do connection with wifi and ensure the service provider provides the channels, then the communication is available. In IOT the wifi connection usually is done through a programming. For example, arduino program call for ESP command to have communication links will enable the ESP wifi to make necessary connection to the networks. This can bypass a lot of steps in the internet setting. Configure the connection or setting through a program is much easier and convenient. The use of artificial intelligence on IOT can transform the normal devices to smart devices[1].

II. CONCEPT OF INTERNET OF THINGS(IOT)

The internet of things (IOT) is a system of interrelated computing devices, mechanical, digital machines, objects, vehicles, animals or peoples provided with unique identifiers (UIDs) and the ability to transfer the data over a network without requiring human-to-human or human –to-computer interactions. A thing in the internet can be a person with heart monitor implant, a farm animal with a biochip transponder, a automobile that has built-in sensor to alert the driver when tire pressure is low and any other man made object that can be assigned the IP address and is able to transfer the data over the networks[10].

The Internet of Things is a vision, in which objects become part of the Internet, where every object is uniquely identifiable and accessible on the Web. These objects may directly or indirectly collect, process or exchange data via data communications network[9]. This concept can be described by simplified equation:

physical objects +sensors and microprocessors=IOT

The concise comprehensive definition of the concept internet of things is:
"Internet of Things is a concept, where clearly identifiable and smart objects can communicate with each other in a defined environment to make autonomous decisions by analyzing and processing the data collected from the environment."
A very simple IOT system should comprise of self optimizing network and software defined networks. The self optimizing network helps to optimize the network for huge data transmission and reception.

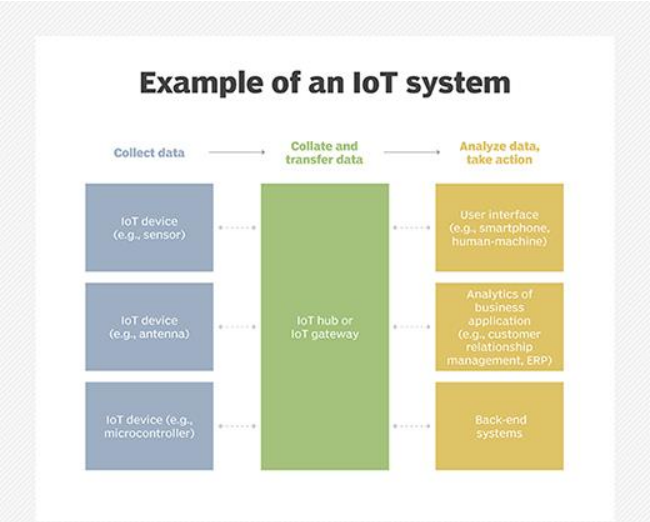

Fig. 1. IOT system

Fig.1 shows the simple example of IOT. Normally in this optimizing network, time and the free channel will be computed and assigned to the user who wants to send and receive the data.

The Self-optimizing network can be done automatically by a router and system update the router's table. The system will compute and determine the shortest path for the data to flows. In software defined networks, a specific software will be used to program the data to send and received. Arduino programming language and Python are two examples of software defined networks. Both of the compilers can instruct the data send, store and received from the receiver[1].

III. Concept of Artificial Intelligence

To apply artificial intelligence on IOT systems, certain principles of the concept should be understood. There are two commonly used techniques in artificial intelligence – Neural networks and fuzzy logic[2].

A. *Neural Networks*

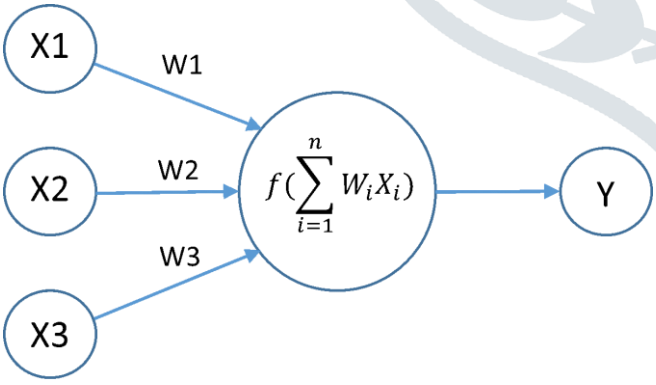

Fig. 2. Neural networks system

Fig.2. shows a neural network system, which comprises of inputs x1 to x3. All these inputs basically contain weights by themselves i.e w1, w2 and w3 as shown in the fig.2. The middle circle component is a transfer function. The transfer function will process the inputs to produce single output. The decision making is as follows[3]:

Σ xn > 1000 = 1 (1)

or

Σ xn < 1000 = 0 (2)

The output either releases 1 or 0 based on transfer function and decision making as illustrated in (1) and (2). In more advanced artificial intelligence system, weight functions may be introduced to control the inputs. These weight functions produce weight values that are part of the parameters to control the inputs. The new output is reproduced from the input plus control parameters in the transfer function. In some cases, the control parameters are adjusted so that the input signals can be trained then the next inputs will be compared with trained values. Finally the "yes" or "no" answer will appear at the output.

Take an example of Arduino voice recognition module. The module comprises a microphone and the processor. When the user wants to recognize the speech, he or she will record his or her voice into the module. The module uses an Artificial Intelligent technique to make user keep on recording the voice until the subsequence voice, one or two or three are matched with the first voice recorded. If this happens, we said that the voice is successfully trained. Once the voice is successfully trained, the user can use his or her voice to activate any devices.

In other words, all the signals coming from input must be trained before they can be used as references in the library[1].

B. *Fuzzy logic*

Another commonly used technique in the Artificial Intelligence is Fuzzy logic. Fuzzy logic uses a set of rule to determine a single output. Fuzzy different from traditional logic where digital 1 or 0 is produced. Fuzzy can analyze more detail on a certain condition and make the final decision on the output.

Let us consider air-conditioning system with 5 level fuzzy logic system as shown in fig.3. This system adjust the temperature of air conditioner by comparing the room temperature and the target temperature value. The 5 level fuzzy logic system indicates

Temperature={very -cold, cold, warm , very -warm, hot}All these conditions are represented in the table 1 below.

TABLE.1. Room temperature values versus target temperature values.

Target temperature/Room temperature	**Very cold**	**Cold**	**Warm**	**Very warm**	**hot**
Very cold	No change	Heat	Heat	Heat	heat
Cold	Cool	No change	Heat	Heat	heat
Warm	Cool	Cool	No change	Heat	Heat
Very warm	Cool	Cool	Cool	No change	Heat
Hot	Cool	Cool	Cool	Cool	No change

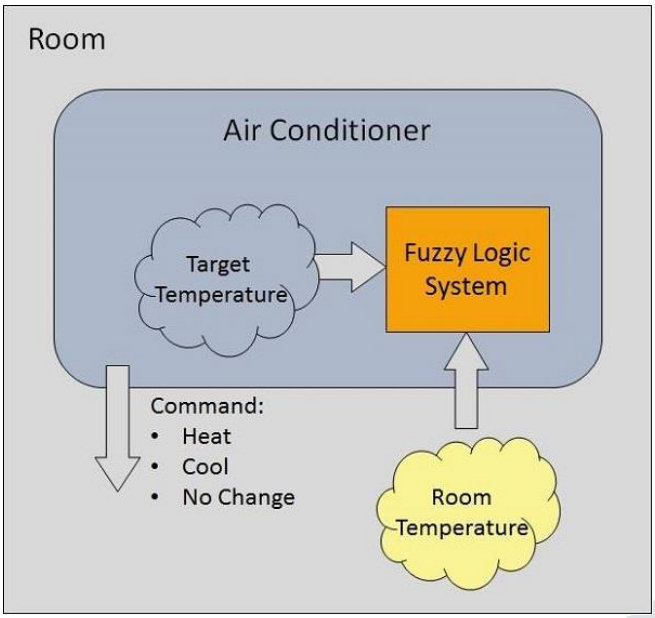

Fig.3.Fuzzy logic system

IV. SELF DRIVING CARS

A. *description of self driving cars*

Artificial intelligence plays an important role in developing vehicle technology. Vehicular automation involves the use of "**mechatronics**" and in particular AI to assist in the control of a vehicle thereby relieving responsibilities from the driver or making responsibilities more manageable. "Mechatronics" is an engineering discipline integrating the fields of mechanical engineering, electrical engineering and computer science. E.g CD players, washing machines, cars.

An autonomous car also known as robotic or formally as driverless or self-driving car, is an autonomous vehicle capable of fulfilling the human transportation capabilities of a traditional car. It is capable of sensing its environment and navigating on its own. A human may choose an destination, but is not required to perform any mechanical operations on vehicle[4] [5].

Driverless cars utilize the connectivity Of IOT when updating their algorithms based on user data. These autonomous vehicles require an enormous quantity of data collecting and processing.

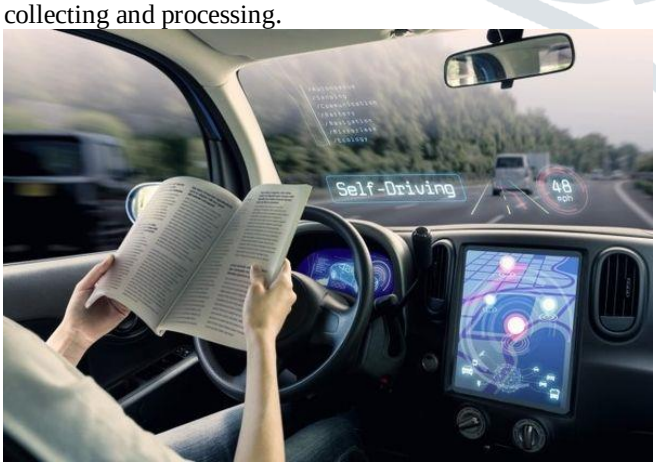

Fig.4. self driving car

In this case, through IOT driverless cars can share information. The information includes the actual path, traffic and how to navigate around the obstacles. All of this data is shared between IOT connected cars and is uploaded wirelessly to cloud system to be analyzed and put to use improving the automation.

B. *Design and methodology of implementing the self driving car*

Modular approach with fuzzy control algorithms

Modular approach help to distribute the processing power amongst its sensor, motor driver and supervisor modules for easy future enhancements in robot design.

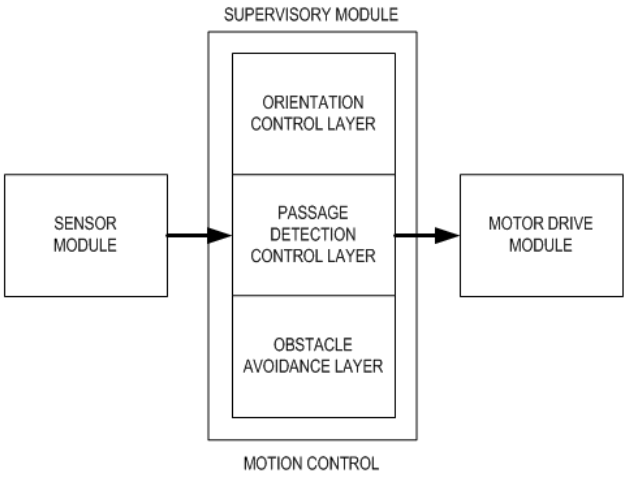

Fig.5. Block diagram for modular approach

Fig.5 describes the modular approach in detail. The sensor module will sense all the obstacles in the path of the robot and if find any obstruction it will compute the distance between them i.e, the obstacles and the robot and notifies it to the motion controller to manage. The motor driver module maintains all the information needed to travel from source to destination distance travelled and also take care of movement of robot in specific direction. The decision making part of the robot is handled by supervisor module , which instructs the sensor module regarding the sensor sequence to be fired and commands the motor driver module to move in a particular direction along with direction to turn if there is an obstacle. It also sets the speed with which the robot should move. The navigation decisions are made utilizing a control algorithm of supervisor module[6].

The supervisor module control algorithms are of fuzzy logic. Fuzzy logic has been extended to handle the concept of partial truth. The truth value ranges between completely true to completely false.

The IOT system in driverless cars consists of many devices which make the car "smart" like humans those are:

1) Radar sensors dotted around the car monitor the position of vehicles nearby.

2) Video cameras detect traffic lights, read road signs and keep track of other vehicles, while also looking out for pedestrians and other obstacles.

3) Lidar sensors help to detect the edges of roads and identify lane markings by bouncing pulses of lights off the car's surroundings.

4) The software is able to identify recognize the traffic signs and store them in a common database using Google Maps and GPS.

Fig.6. IOT system of self driving car with artificial intelligence

As shown in fig.6, the use of AI in self driving cars can associate many devices smartly and can make the car intelligent.

The introduction of driverless cars could produce several direct advantages like fewer crashes, reduce oil consumption and air pollution, elimination of redundant passengers, etc[6]. One intriguing aspect of driverless car is that commutes no longer have to be wasted time. People on their way to the office or a meeting can get some extra work done during drive-time instead of driving . This adds extra time to one's day to be more productive. Another thing is that computer don't get distracted as easily as people and not to mention, computer don't drive drunk either[7].

V. CONCLUSION

From a computer science perspective unmanned vehicle serve as a research platforms for progress in a variety of fields as machine learning, computer vision, fusion of sensor data, path planning, decision making, control architectures and intelligent autonomous behavior[6]. In automotive industry, AI approaches in smarter vehicle could help make transportation safer and more efficient. Cars would drive closer to each other making better use of the 80% to 90% of free spaces on the roads. They would react faster than humans to avoid accidents, potentially saving thousands of lives. Vehicle would become a shared resource, a service that people would use when needed. You'd just tap on your smart phone and the autonomous car would show up where you are, ready to drive you anywhere. You would just sit and relax or do any work. This is one way we see in the future this technology can actually make transportation better, make it more efficient.

VI. FUTURE SCOPE

According to tesla CEO Elon Musk who claims that we are two years away from "sleeping in cars"[8]. Companies in those sector have more to lose than to gain in autonomy, but society is a big winner. We will benefit from fewer traffic accidents, reduced reliance on fossil fuels, more affordable transportation options and more free time.

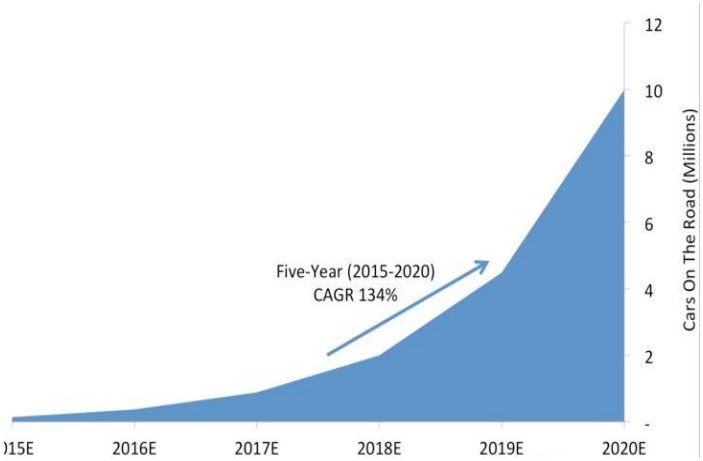

Fig.7. graph on increase in the number of cars on road (millions) in the upcoming years.

From the above fig.7 the quantity of cars in the market will be rapidly increased in the upcoming years therefore, in 2020 onwards driving on roads will be just like surfing on web. There will be traffic congestions but no injuries or fatalities. Advanced driver assistant systems and new sensing technologies can be highly beneficial along with large body of work on automated vehicles. Level 5 driverless cars are well on their way, but we still might have to wait a decade or more.

VII. REFERENCES

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