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Home Automation using Machine Learning for Television

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Abstract: **Home automation is building a smart home which will monitor different attributes like light, temperature, appliances, entertainment unit and many more. This paper describes about home automation specialized in the field of the entertainment unit that is television. Our primary purpose here is that when a person comes in front of the television, the television should be switched on and the desired channel which most probably the person would watch at that time will be displayed.**

So, when a person comes in front of the television at a set distance the Passive Infrared (PIR) sensor which is used to detect motion detects the motion of the person and Pi camera recognizes the person's face using computer vision, which is integrated with raspberry pi, and according to the algorithm used, the television is switched on and the preferred channel will be displayed on the television screen. The proposed system uses only PIR sensor, Pi camera and raspberry pi hence it is low cost. The proposed system mostly comes in handy to old and disabled people as they can just come in front of the television to watch their favourite show instead of doing everything manually.

Keywords: **Home automation, Machine Learning, Computer Vision , Television, PIR sensor, Pi Camera, Raspberry Pi.**

I. INTRODUCTION

This paper aims at minimising the relative effort of an individual in suggesting relevant television channels through the optimal use of Internet of Things and ML techniques. The suggestion employs the use of PIR sensor which is used to detect the presence of a human being, PI camera which is a basic camera module attached to Raspberry PI which is used to identify the person and his/her motion and Raspberry PI which is used to control the state of television to accomplish task. The proposed solution could find its valuable application in a number of use cases, the most prominent of which would be its use to aid especially abled individuals in helping them view/have access to television at limited physical hassle.

II. RELATED WORK

[1] John Jaihar, Neehal Lingayat, Patel Sapan, Vijaybhai, Gautam Venkatesh, K. P. Upla use CNN, Fischer Face Classifier, SVM give an insight about how to go about bringing in ML algorithms with IoT.

[2] Vishwajeet Hari Bhide, Dr, Sanjeev Wagh use Naïve Bayes and points out the perspective of disabled/handicap people. Use of household data and activity to incorporate the algorithm.

[3] L. Mary Gladence,V. Maria Anu, R. Rathna, E. Brumancia use NLP, Logistic Regression, Bayes Classifier, API Protocols Uses NLP. They speak about the connection & need for automation system. Preference of cyber physical system, advancements and different technologies used.

[4] Harsh Kumar Singh, Saurabh Verma, Shashank Pal, Kavita Pandey gives information about the end devices used and their technology.

[5] Vishwakarma, S. K., Upadhyaya, P., Kumari, B., & Mishra, A. K talk about IoT applications, the system design. provides workflow chart, provides a way to use low power consuming devices.

[6] Suraj, Kool, I., Kumar, D., & Barma, S talk about turning the switch on and off., how to detect objects and functionality of various components.

[7] Popa, D., Pop, F., Serbanescu, C., & Castiglione, A. use ZigBee and Z-Wave technology. They give a total insight and details to use DNN, flowcharts, devices, connections.

[8] Himani Singh Dhami, Nidhi Chandra, Nishank Srivastava, Avanish Pandey provide details as how the android application can be used in order to connect with Raspberry Pi..

[9] Iftikhar Alam, Shah Khusro, Mohammad Naeem gives a review of the various genearations and future of Televisions.

[10] Dinesh Kumar Vishwakarma, Rajiv Kapoor provides a system using hand gesture recognizer where results show up even in low lighting conditions and uses few rules so that the design is robust.

[11] Vamsikrishna Patchava, Hari Babu Kandala, P Ravi Babu use Bluetooth technology to give clear and thorough knowledge about smart city, its working, implementation and usage.

[12] Tanweer Alam, Abdulrahman A, Salem. Ahmad O, Alsharif. Abdulaziz M. Alhujaili make use of sensors and Arduino along with Bluetooth technology to gives every inch of detail to implement a smart home and how to use the mobile app to greater effect.

[13] Yash Mittal, Paridhi Toshniwal, Sonal Sharma, Deepika Singhal, Ruchi Gupta, V. K. Mittal use voice recognition modules to talk about how to build a voice recognizer in order to identify people which can be a vital part in recognizing who is trying to communicate.

[14] Kaylee Moser, Jesse Harder, Simon G. M. Koo use IoT devices to give insight about various models of home automation, web connectivity models, existing system, ways to reduce energy consumption.

[15] Rita Yi Man Li,Herru Ching Yu Li, Cho Kei Mak, Tony Beiqi Tang speak in detail about the use of big data tools in order to increase efficiency and make the system more efficient.

[16] Song Yao, Wenbo Wang, Yuxin Chen use Naïve Bayes, Search algorithms, Pattern Finder to give information in order to efficiently utilize the commercials time to a greater extent.

[17] A.Alheraish uses GSM cellular communication network to implement remote control system using M2M design

[18] Manikandan J. has considered different technologies like Ethernet-based, IR-based, Bluetooth-based, RF-based, GSM-based and voice-based home-automation systems in his paper

[19] Vaishnavi S. Gunge and Pratibha S. Yalagiused smart task scheduling with a heuristic for the Resource-constrained-scheduling problem in their home automation.

[20] Bhaumik Vaidya,Ankit Patel,Anand Panchal ,Rangat Mehta ,Krish Mehta ,ParthVaghasiya proposed a system that has a unique door monitoring system based on face detection and recognition algorithms .

[21] Edwin O. Heierman, III Diane J. Cook proposed a framework based on a novel data-mining algorithm ED (Episode Discovery) that discovers behavior patterns within a sequential data stream. The pattern knowledge and corresponding filtered data can be provided to a prediction algorithm or decision learner to improve home automation. In addition, the framework processes the interactions incrementally and can be used in a real-time system.

[22] Tui-Yi Yang,Chu Sing Yang,Tien Wein proposes ACS DDEM algorithm to design an intelligent distribution power management system to make sure ongoing power supply of home sensor network.

[23] Manouchehr Ghahramanian Golzar, Hamid Reza Tajozzakerin used a PIR sensor to detect the moving person who wants to come inside with no prepermissions. After he came into the PIR's sight area, this sensor reports this situation

[24] G.Morganti, A. M. Perdon, G. Conte and D. Scaradozzi,A. Brintrup compared the performance of three optimisation algorithms: Tabu Search, Single Objective Genetic Algorithm and Multi-objective Genetic Algorithm. The Single and Multi-objective Genetic Algorithm were similar in their convergence performance, although Multi-objective Genetic Algorithm provided a more diverse set of solutions and allowed us to explore parameter interaction.

[25] Sehoon Yang, Sangjoon Lee, Yungcheol Byun Used with some predefined motions or gestures using a sensor devices can be controlled by gesture recognition, transfer learning, CNN, Algorithms, For gesture recognition they used transfer learning with Inception V3 which is CNN model which is developed by Google using 1000 categories of massive images from ImageNet. Converted images used for training and testing.

[26] Brundha S.M., Lakshmi P. and Santhanalakshmi S. developed Home Automation System along with security using low cost Wi-Fi modulesArduino interacts with the Matlab, Access NodeMcu via NOIP or DNSThe PIR sensor detects the user presence. Socorrespondinglythe webcam gets activated via Matlab.

[27] Freilinch, Saul Meyor The step system a unique Low-cost Tv Automation system which is designed to automate the panic period that is switching during breaks. The Step memory a flexible pinboard memory with pre-programming capabilities is used.

[28] NinadKheratkar, Ashwini Jarali, Aboli Pathak, ShreyashKumbharUsed CNN neural networking algorithm for classification of images of each gesture.

[29] Manjunath. M, Venkatesha G, Dinesh S Raspberry Pi based Anti-Theft-Security System using home automation for multi-level Authentication once the person enters the building the lights will be turned on automatically and used face recognition systems which detects the liveliness of the person for authorization.

[30] Mark Hall make enhancements to the Naïve Bayes and Decision Tree algorithm and have been proposed to help mitigate its primary weakness—the assumption that attributes are independent given the class. All of them improve the performance of naive Bayes at the expense (to a greater or lesser degree) of execution time and/or simplicity of the final model.

III. COMPONENTS

1. Television(TV): This is the core of the model and it is used for viewing purpose.
2. Set-Up Box: This is used to make the channel switch or change.
3. Raspberry Pi: This is used to control the state(ON or OFF) of the TV, Set-Up Box, act as a mediator to collect inputs from sensors and give to the PC, accept the decision made by the Decision Tree Classifier.
4. PIR Sensor: It is used to detect the presence of human being.
5. Pi Camera: It is the most basic camera module that can be attached to the Raspberry Pi and it is used to identify the person, check if he is in the viewing range and also can be used to identify the channel that is being watched by making use of Computer Vision.

IV. FLOW CHART

The following figure shows the flow chart of the proposed model.

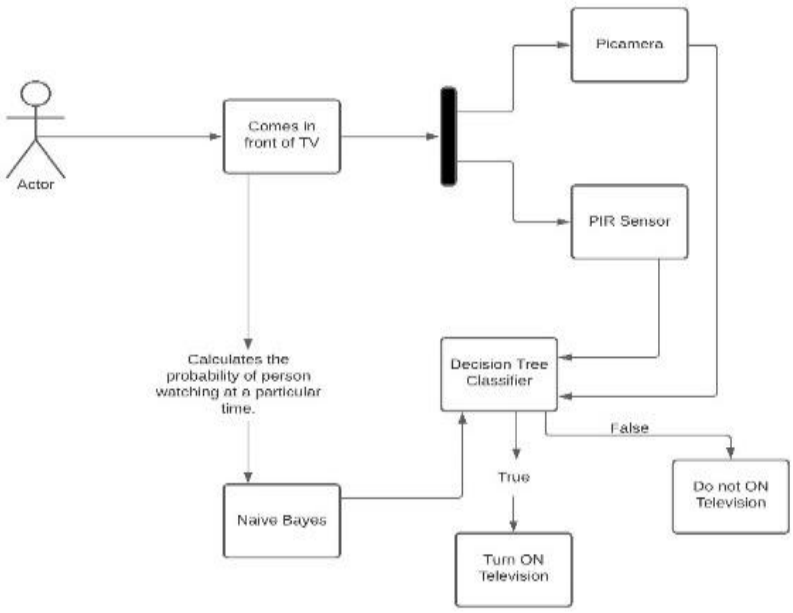

Fig. 1

First, the person comes in front of the TV. During this process, the PIR sensor captures the presence of a person and the Pi Camera does the job of authentication of the person with the help of Computer Vision and also detects if the person is in the viewing range.

Parallelly, as the person comes in front of the TV, the Naïve Bayes Classifier computes the probability of the person watching a show at that particular instance of time.

The output from Naïve Bayes Classifier, PIR Sensor, Pi Camera is all fed to the Decision Tree Classifier where the decision is being made about the person watching the TV show at that instance of time.

It is then sent to the Raspberry Pi to turn ON the TV and Set-Up Box and make the channel switch. The above process will be discussed in detail in the upcoming section.

Note: We are making a theoretical model of the proposed idea. The research is made based on certain aspects. Firstly we are making use of remotely controlled automation. Which means we are making use of devices present inside the home and are locally accessible. This is just a basic model and does not involve any cloud architecture. It would require a Personal Computer or a Desktop to store, process the algorithm.

V. WORKING

The following figure shows the flowchart of the proposed paper. We will divide these into the following phases:

Phase 1: Collection of raw data.

Phase 2: Data Pre-Processing.

Phase 3: Algorithms.

Phase 4: Raspberry Pi and Channel Switch.

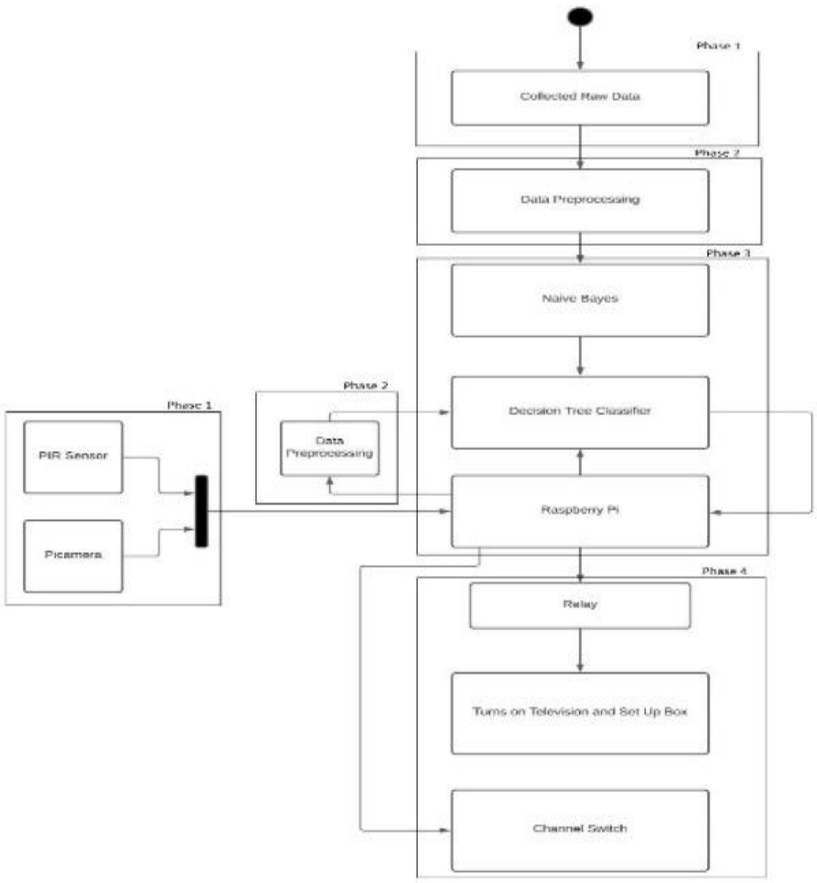

Fig. 2

Phase 1: Collection of raw data:

This is a very vital phase. As we are using supervised learning algorithms, it is necessary to train the algorithm. We can divide this into 2 divisions:

1.1 Collection of real-world data.

1.2 Collection of data from sensors.

1.1 Collection of real-world data.

We need to collect the data from the real world first. Collection of data can be possible through tracking the person and the channel through Object Identifier through Computer Vision. The other way could be like a person watching a programme during a certain time should enter it on the device manually for a few days until the threshold value is reached. For the purpose of our survey paper, we had deployed a Google Form where people could enter the channel they watched and the time.

1.2 Collection of data from sensors.

Let us first analyse the need for sensors here. Suppose we have scenarios like the person isn't at home or is unable to watch a show due to some other work, we wouldn't want the TV to turn and play the show for any non-existent creature. Likewise, also there are chances that the person might be present at home but is not willing to watch the TV, but just wants to do some other work, we wouldn't want the TV to turn ON for him. In order to overcome these problems that were identified, we make use of sensors.

The 2 sensors we would propose to use is a PIR Sensor(Passive Infra-Red Sensor) and a Pi Camera(can be attached to the Raspberry Pi).

The purpose of PIR sensor is to detect or sense the motion. It allows to detect the movement of a human in the sensor's range. This can be used to detect the presence of a person in the room.

Another possible use of PIR sensor could be in a case that the person is watching a show and the person falls asleep during the show. The PIR sensor does detect the person of the person but does not find any motion associated with him which pushes the PIR sensor into the belief that the person is asleep and tells the model to turn OFF the TV. This is a good energy saving idea as there is a possibility that the person might watch something late in the night and they might be subjected to wastage of energy due to negligence and carelessness.

The purpose of Pi Camera is to detect the person present, and also to detect if he is in the viewing range of the TV to indicate that he is there to watch the TV.

These are connected to the Raspberry Pi and then it is sent for data pre-processing which is serving the purpose as mentioned in phase 2.

Phase 2: Data Pre-Processing:

As the name says, this stage is used to process the raw data. The data that the machine learning algorithm uses is usually fed as numbers. The data we collect in real life is has some semantic or has a real-world entity attached to it. Sometimes there are chances that the data isn't captured or something is corrupt with the data. To remove all the above inconsistency in data, data pre-processing is required. The corrupt or missing data is removed, the data is encoded into a way that it can fed to the algorithm.

Phase 3: Algorithms:

Algorithms are used to learn and predict various parameter that is necessary for decision making and automation.

We can divide this phase into 2 divisions:

3.1 Naïve Bayes Classifier

3.2 Decision Tree Classifier

Let us go through each of them individually.

3.1 Naïve Bayes Classifier

It is the simplest of all probabilistic classifiers. It is based on applying the Bayes Theorem with strong independence assumptions and are equal between the features. This is also a highly scalable classifier.

We assume that all features are independent. And secondly, all the features are given equal importance. We cannot be ignorant in any of the attributes.

Naïve Bayes is used in our survey paper to predict the probability of a person watching a show at a particular time instance.

Now the questions that arise are what if I watch something for a day and do not watch it on the next day? What is there is any guest at home watching something and will it be predicted the next day again? How many days should I watch a show in order to allow the automatic process take control and turn it ON automatically for me? What if a show is completed and is not going to be telecasted again, should I turn OFF the TV manually? What if I have lost interest in the show and don't want to watch it again?

Let's look at the answers for all the above questions. Firstly, we will set a threshold value for the program to turn ON the show automatically. On the dataset that was collected for 7 days, on using the Naïve Bayes algorithm, the threshold value was set to 21%. It was found that a person needs to watch a show for 3 consecutive days in order to make the algorithm turn ON automatically without manual intervention. This threshold value can be set according to the users comfort.

Secondly, coming to the scenario of a guest, we will be discussing it in section 3.2.

Moving on, the show will be stopped being recommended when the probability value falls below the threshold value. As it takes time for value to go down, the PIR sensor detects the absence of person and records it and it is used to reduce the probability value. Next up, coming to the point of show being completed, it requires a little bit of complex alteration where in the show list of a particular channel is obtained and the programme is searched, if the search doesn't find the show, it will not turn ON the TV. The same ideology can be used for any festival days or special occasions.

3.2 Decision Tree Classifier:

Now we come to the most vital part of our paper that is the Decision Tree Classifier. As the name says, it is a tree that is going to take decisions based on a series of questions. The questions that can be asked here is the person present in the room? Is he in front of the TV to watch? Is the person who is present has a slot to watch the TV(Authentication)? Is the person going to watch any show now?

There could many more questions arising. Let's discuss the purpose of the Decision Tree Classifier.

Firstly, the decision tree gets the processed inputs. The source of inputs is the output of Naïve Bayes Classifier, processed data from PIR Sensor and Pi Camera.

It checks for all 3 inputs. Firstly from Naïve Bayes which sends which person is watching and the time slot. Secondly it checks the input from PIR sensor which is used to the identify the presence of a person in the room. Thirdly, it uses the Pi Camera which makes use of computer vision to authenticate the person present and also to see if the person is in the viewing range of the TV. If all the 3 factors turn out to be true, then the Decision Tree makes the decision to say that the person is present in the room and is willing to watch the TV now. It sends a signal further to the Raspberry Pi to do the further process.

Using the Decision Tree Classifier eases up few of the problems such as we might have a scenario where in 2 people come at the same time who want to watch the TV. It is an unlikely situation as the TV will be viewed by only one person at a time. But just in case this happens, the person who is identified first by the Pi Camera will be given priority. Also not to turn ON the TV during the absence of a person or if the person is unwilling to watch the TV at this juncture even though it is his slot to watch.

Coming to the scenario of guest watching, it is evident that the Decision Tree being a supervised learning algorithm requires training data to make predictions. When a data belonging to person category is unidentified, it discards the history unless the algorithm is being told that the person belongs here.

Coming to our dataset and testing the efficiency of the Decision Tree Classifier, on providing 20 datasets, the efficiency turned out to be 42%. Further on training with 100 datasets, the efficiency shot up to 82%. On providing a dataset of 2000 entries, the efficiency was 100%. The prediction of the algorithm was accurate even to new samples provided.

Phase 4: Raspberry Pi and Channel Switch

Now we come to the final phase of the survey paper which is about turning ON the television and setup box and making the channel switch.

The output of the Decision Tree Classifier is given to the Raspberry Pi where in it gets the indication to power up the TV and Set-Up Box. This is done with the help of a relay which powers up on receiving the information from Raspberry Pi.

Once this is done and the devices are powered up, the channel is made by providing an input from the Raspberry Pi provided with the information of channel number.

VI. FUTURE WORK AND CONCLUSION

As we see, this system is limited strictly to remotely controlled automation and does not use any cloud architecture or any mobile application. Furthermore, it can be extended to universally controlled system where in the device can be controlled from any part of the world as long as it is connected to an active internet connection and also a mobile application can be developed to control it.

Also we have limited this technology only to the television. The scope of this technology can be extended to various devices that provide automation.

This can be extended to latest technologies such as voice control, gesture control to provide better interaction and make it more user friendly.

Also various other algorithms can be explored to see if there are much efficient ones or algorithms can be ensembled. Deep Learning can be added on to this as it provides higher efficiency and accurate results.

So, we have proposed a new system which is used to make smarter devices smarter in a way that provides an energy saving option and makes the usage of device much more efficient and increases its scope of working and usage.

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