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Smart Firefighting System for Smart Cities Adopting Fog/Edge Computing

P. Punitha Ilayarani, M. Maria Dominic

***Abstract:** Security ought to be the highest concern for everyone's sovereignty from prospective destruction caused by unusual incidents or intruders. Constant monitoring mostly refers to protection against hostile forces. Home security confirms smart decision making at the peak time, activated alarms and detectors are to be avail 24/7. Highest inspiration of this proposed system is to notify the emergency incidents to the appropriate authorities like fire station, police station and the residence owner if the owner is not in house. To prove the domino effect support Vector Machines (SVM) algorithms are implemented and tested. In this paper we explore close watch and stay connected devices and also peace of mind through controlling and monitoring our homes by adopting Fog/Edge computing technologies.*

***Keywords:** Fog Computing, Edge Computing, Detectors, Alarms and Control Panels, Support Vector Machines (SVM) Algorithms.*

I.INTRODUCTION

Saving human life and their properties are very important process. Time is extremely essential while fire accident happens at homes. Awareness from fire alone will not help the residents; instead they should have knowledge and conscious about the fire safety prevention detectors. Immediate decision making during critical time is highly possible signals are collected from sensors and communication channels and devices to process the received data using machine learning based algorithms and AI capabilities [1]. To achieve high computing power and large data transmission for accessing the received data and analyze the required large amount of storage and localized data centers for speedy results. Moreover, edge nodes which include base station and routers to receive data for rapidity accessing. A fog node moderates the intelligent practice and the local process received from edge nodes. Fog architecture will take care of the significant functions like, decision making while the situation is out of control, also cares about the storage, processing and communicating vital messages. These critical function's responses will be intimated to the connected IoT devices or the fire detectors. Accessibility, security and low latency are the primary advantages of shifting into Fog computing from Cloud computing.

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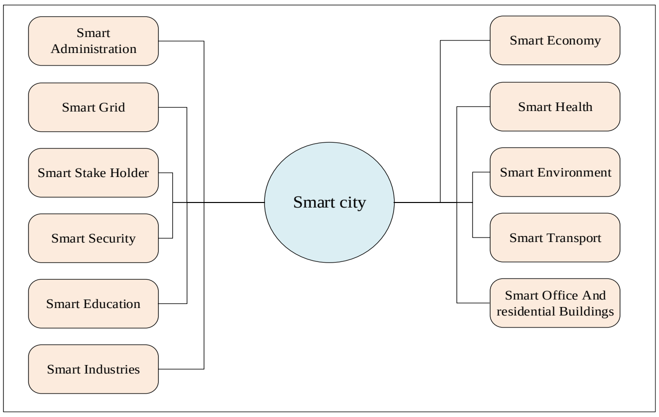

Fig. 1. Smart City Architecture

A. SMART CITIES

The foremost intention of smart city is meeting the demands of the citizens by uplifting life and the working environment. Automating the electrical, electronically and technology based tasks. The ideal concepts of smart cities are intelligent use of time, information and communication technologies in an efficient way. By doing this optimal process client can be benefited by energy saving, cost and peak time delivery services [2].

B. HOW IS IT SMART

A smart city is an urban zone that uses diverse types of electronic data collection sensors to deliver information which is used to administer possessions and resources professionally. Smartness integrates people, technology and infrastructure to obtain without delay results at the precise time.

C. BENEFITS

Smart cities technology makes more effective and efficient growth to enhance the smart people's service levels. The following benefits are highly influenced by the smart people [3]. Supplementary valuable data determined decision making

Massive amount of information to retrieve peak times data. Decision making is highly possible in risk areas in risk times.

A. Superior civilian and administration commitment

Citizen's experts digital services to promote connected relationships [4].

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B. Safer Communities

City is connected all the time so criminal activity will be reduced and the crime rate predictably low.

C. Concentrated ecological hand marks

Smart city struggles to lessen the negative effects on the environment. Efficient fixed structures like buildings, atmosphere eminence. Sensors reacts peak time data transaction during low air quality.

D. Enhanced moving

Smart transportation controls traffic congestion and smart parking services, providing road maps, online ticket booking and payments, updated schedules and available schedules.

E. Amplified digital fairness

Digital world provides high speed internet facility to affordable devices by the requisition of users as well as residents. with a minimum charges [5].

F. Latest cost-effective progress opportunities

Desired decision can be made during the peak situations with minimum economical charges.

G. Well-organized communal utilities

Human demands are highly satisfied identifying leakage pipes with a minimum time by smart sensors.

H. Better communications

Infrastructure failure can be easily defined by the smart technologies. Immediate identification of the failure and sending message to the concerned personnel will lead accident prevention.

I. Enlarged personnel commitment

Improved services, implementation latest version, careful planning ideal decision making helps [7].

II. TECHNOLOGY

A. CLOUD COMPUTING

The word Cloud represents wide area network which has the common storage for sharing through virtual machines. Cloud supports virtualization instead of using traditional personal computers. Cloud computing provides scalable services, pay as you go method and pool of resource sharing [8].

B. FOG COMPUTING

Fog computing or intelligent computing is a localized computing, aggregate the bits in routers instead of sending all the way to the cloud. Localized processing happens in LAN called intelligence and computing power that is data transmitted to gateways from the end points that is from IoT devices. These processing can be taken place by PAC(Programmable Automation Controller) [9].

C. EDGE COMPUTING

Edge computing pushes data and computing power closer to the origin where it is created. Aggregating data further and distance is reduced with the help of localization. All the processing happens in Edge nodes and these nodes are not necessarily connected or communicated with the centralized network [10].

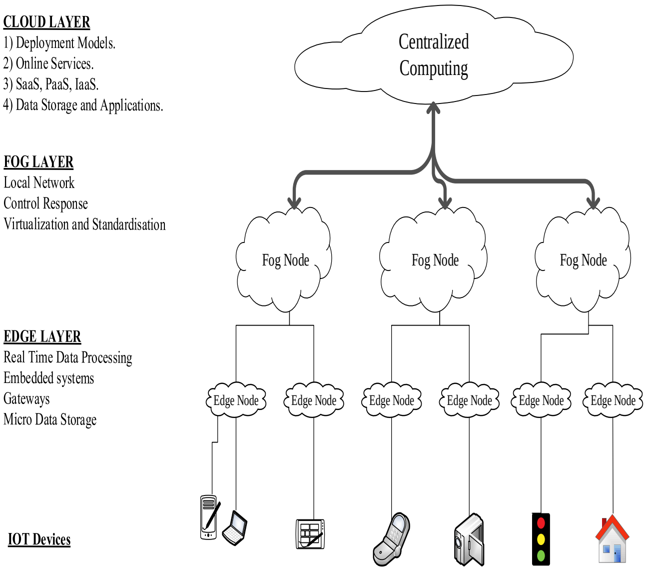

Fig. 2. Three Tier Computing Architecture

III. SMART FIREFIGHTING

Traditional fire fighting systems have several limitations like delay and security issues. To overcome these limitations introducing new system called smart fire fighting system provides critical data identifying, locating and cooling the fire by implementing smart sprinklers. Fire fighting incidents can be categorized into pre-incidents or pre-events and post-incidents or post-events to handle the critical situation in during incidents.

A. RESEARCH FOCUS IS ON DATAANALYSIS AND RESPONSE

This investigation presents a number of all the rage instance insightful applications for firefighting. Smart firefighting contains 3 elements [11].

a) Data congregating from different sources
b) Applying procedures to be processed and scrutiny
c) Effective anti-fire measures

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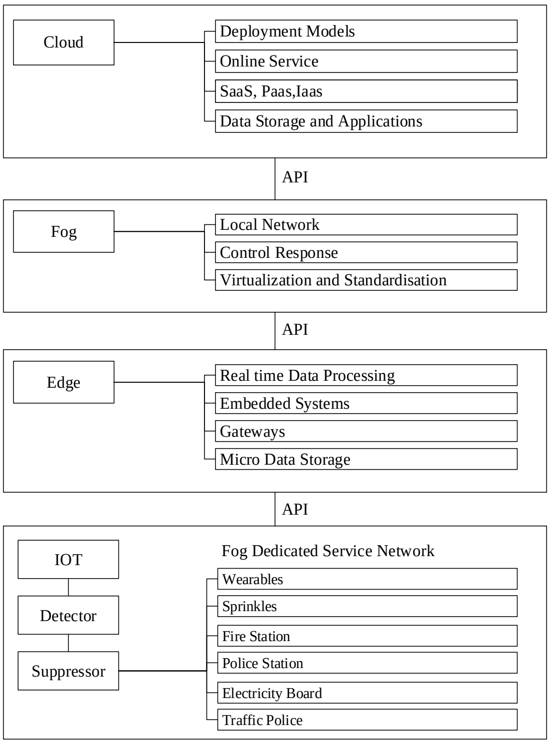

Fig. 3. Deployment Model of the Proposed System

B. SYSTEM ARCHITECTURE

System architectural model represents the Cloud, Fog and Edge computing deployment models, services, security maintenance and their applications are discussed in Fig. 4. In this proposed system IoT devices are detectors and suppressors. Fog dedicated service network provides intelligent decision making, responses and the security maintenance [12]. Unusual happenings of the residence will be intimated immediately to the authorities like police station, fire station, traffic police, electricity board, and house owner.

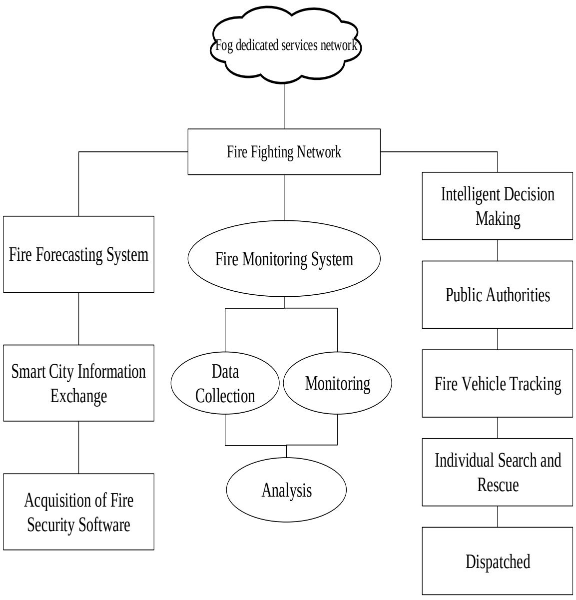

Fig. 4. Structural Representation of the Fire Fighting and Fog Network.

C. EDGE ENABLED FIREFIGHTING

Edge Computing is more powerful than cloud computing. This computing breaks the complicated computational tasks into smaller elements to achieve quick response while dealing with time sensitive data. Edge gateways are the one act as intermediate between the network and the end points. By doing this process massive data transmission over the cloud can be avoided. Bandwidth is high and latency is very low. A hybrid model represents the timeliness process and provides accuracy [14].

D. FIRE SENSING COMPONENTS, ROUTING NETWORK, REMOTE CLOUD SERVER

Fire fighting technologies are discussed remarkably to introduce the features which are available in this proposed system. Zero oxygen waves are used to produce sound waves which are highly helpful for suppressing the fire accidents. These waves expose the fire suppression waves [15].

E. WIRELESS COMMUNICATION

Smoke detector and Carbon Monoxide detector spills the air quality and if any abnormal smoke detects from the detector then the emergency message is passed to the connected cell phones and connected landlines [16].

F. BATTERY CHARGED LIGHTING DEVICE

There are two special types of power saving batteries discussed at this investigation. One is lead acid batteries and the other one is nickel cadmium batteries. These are smaller in size and the cost is very low. Weather proof and long life capacity batteries are useful for home security system. These bulbs' voltage is very low, so it is very easy to charge the bulbs. It provides the availability and the replacement is very efficient.

G. SPRINKLERS

Sprinklers are the device used to convert the water droplets into steam spray to suppress the fire completely. Steam absorbs more fire than water droplets. High pressure ceiling sprinklers are introduced to react upon the fire immediately [17].

H. COMMAND ISSUE

Voice evacuation and messaging prevents the occupants from the fire incidents. Pre recorded messages, announcing the easy exit routes and dictating the safety rules to the occupants.

I. EMERGENCY SERVICES COMMUNICATOR

Basic understanding while emergency messages are important for fire accidents are communicated through electronic signals and these signals are converted analog sounds.

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Looking out the situation promptly, communicating the message correctly, identifying the exit routes, and helping out the occupants to identify the safety zones are the important tasks for the communicators [19].

IV. DEVELOPMENT OF THE MODEL

Let us consider three parameters from the above context. They are heat, flame and smoke. Heat range is measured at the maximum of 65°C to 150°C, Flame wavelength is measured between 185 to 260 µm and the peak wave length is 200µm. Smoke range is measured at the maximum of 50dB/m. If smoke range exceeds beyond 50dB/m then it causes fire [26].

Dependent parameters represented as heat, smoke and flame. H-> X, S->Y and F -> Z.

$(x_1, y_1, z_1), (x_2, y_2, z_2)\ldots\ldots\ldots\ldots\ldots(xt, yt, zt)$ variables are existing in R^n X R

Based on the time series, prediction takes place and the proper decision making process will be executed.

Time series ranges represented as 0 to 60 minutes, fire ranges are represented from 0 to 100 positive values and -5 to -100 negative values[5].

To measure the loss function for classification

L(y, f(x)) and L(z, f(y)) where L(y, f(x)) = 0 if y= f(x)

and

L(y, f(x)) and L(z, f(y)) where L(y, f(x)) = 1 if y $\neq$ f(x).

Risk function R(w) where 'w' is the generalized parameter.

$$R(f) = 1/L \sum_{i=1 \text{ to } n} L(yi, f(yi, w)) \quad (1)$$

$$R(f) = 1/L \sum_{i=1 \text{ to } n} L(yi, f(zi, w)) \quad (2)$$

$$R(f) = 1/L \sum_{i=1 \text{ to } n} L(yi, f(xi, w)) \quad (3)$$

The main objective of this proposed system is to classify the decisions as positive class and negative class, action is represented as 'a'. Hyper planes are classified into three categories,

Fig 5. Workflow of the Proposed System.

Parameters/ Threshold Values	Normal	Prospective	Extreme
HEAT	< 40	> 40 and < 65	> 40
FLAME	< 180	> 180 and < 190	> 190
SMOKE	< 50	> 50 and < 150	> 150

f(x)= 0, f(x) = -1 and f(x) = 1.

To minimize the nonlinear optimization tasks, calculating the weight vector,Edge detection ranges are represented as,0 indicates initial state0.25 indicates Normal state 0.50 indicates Actual or potential level or state, 0.75 indicates Dangerous level, indicates Dangerous level. x1 heat with normal temperature represents y1, x2 represents flame with moderate temperature y2 and x3 represents smoke with high temperature and the extreme value is represented as y3.

$$Z = x1y1+x1y2+x1y3+x2y1+x2y2+x2y3+x3y1+x3y2+x3y3\ldots\ldots\ldots\ldots\ldots+xnyn$$

Time interval represents t = 0.1… 1.0.

$$Z = \sum_{t=1\ldots12}^{i,j=1\ldots n}$$

A. WORK FLOW OF THE PROPOSED SYSTEM

Restricted and connected time analytics and data processing. Connected with Edging (Lightweight programming model) embedding the small sensors Small sensor runs data analysis algorithm and remote computing hub to route composite data [24]. This investigation involves Machine Learning techniques which influences to the local distributed system. Restricted field devices figure out resource band. Local federal management center performs the task division. Offload all the sub tasks. Assemble the final results.

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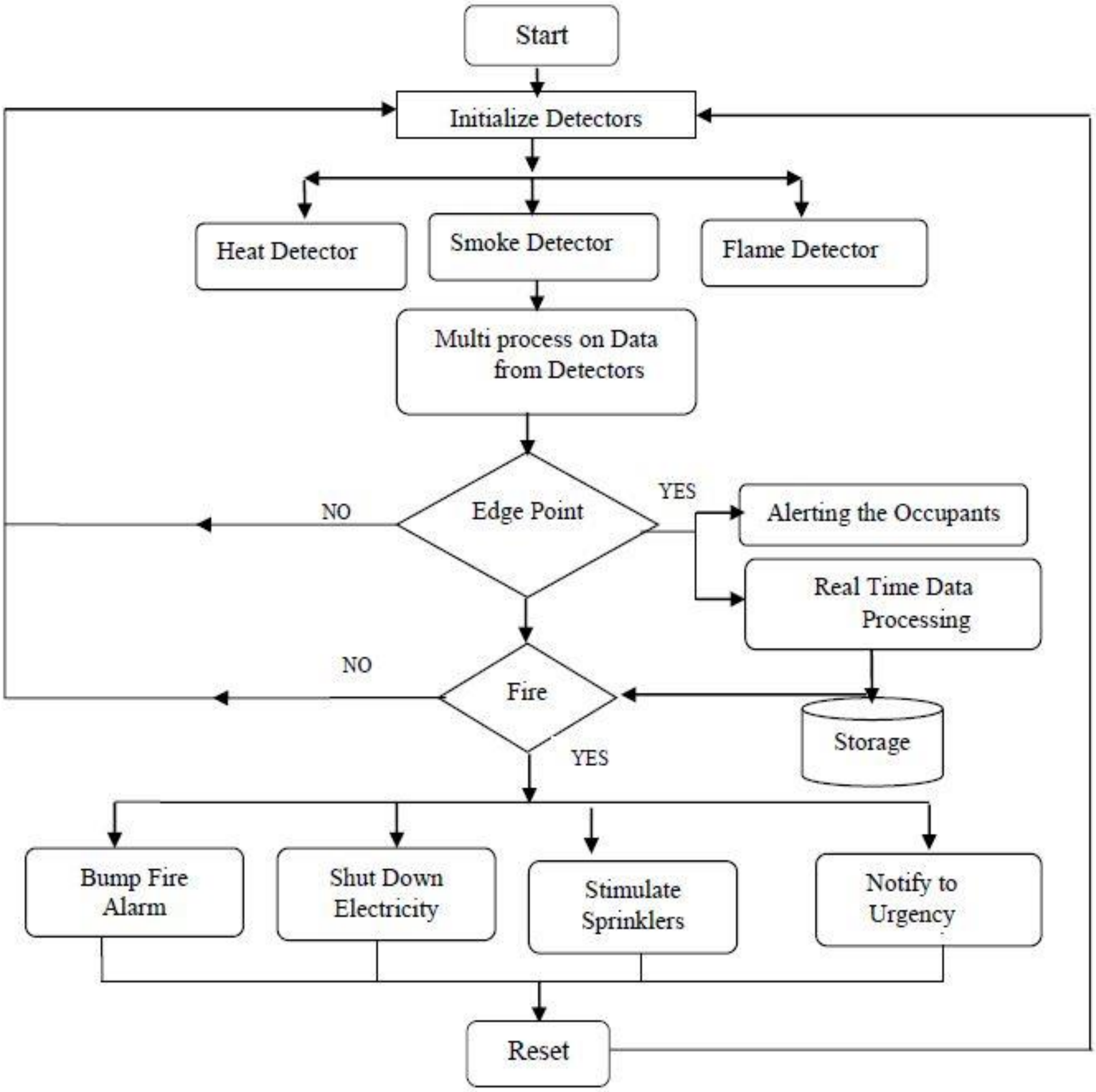

Table I: Performance Chart - Fire Parameters And Their Threshold Values [25].

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B. ALGORITHM

Step 1: Start the process

Step 2: Initialize Temperature Level = 0

Step 3: Assignsensor = W1ThermSensor ()

Step4: Assign the values, temperature = sensor.get_temperature ()

step 5: If the smoke_Level < 40

Step 6: Print("Low level temperature reached")

Step 7: If temperature > 65 then

Step8:Print("Potential level temperature reached")

Step 9: Elseif temperature > 105

Step 10: print("High Level temp reached, can cause fire")

Step 11: Alarm triggers and intimating safety devices to calm down the fire.

Step 11: Stop the process.

V. CONCLUSION

This research paper presents smart fire fighting system to detect the fire and secure the households when the time is in high demand. A machine learning algorithm promotes the accuracy of the output. The proposed model satisfies the entire safety against fire and also adapted edge computing technologies for intensive data processing.

REFERENCES

1. Albert W. Jones Anthony P. Hamins, Nelson P. Bryner and Galen H. Koepke. [n. d.]. Research Roadmap for Smart Fire Fighting. ([n. d.]). Retrieved July 1st, 2017 from https://www.nist.gov/publications/research-roadmap-smart-fire-fighting? pub_id=918636.
2. https://www.plantemoran.com/explore-our-thinking/insight/2018/04/thinking-about-becoming-a-smart-city-10-benefits-of-smart-cities
3. https://www.nfpa.org/-/media/Files/News-and-Research/Resources/Research-Foundation/Current-projects/Smart-FF/SmartFirefightingReport.pdf
4. M. J. Karter, Fire loss in the United State during 2013, National Fire Protection Association(Quincy, MA, 2014).
5. Platt, Fast Training of support vector machines using sequential minimal optimization, in Proc. of Advances in Kernel Methods Support Vector Learning (MIT Press, 1998).
6. Bredensteiner and K. P. Bennett, Multicategory classi¯cation by support vector machines, Comput. Optim. Appl. 12 (1999) 53–79.
7. Crammer and Y. Singer, On the algorithmic implementation of multiclass kernel-based vector machines, J. Mach. Learn. Res. 2 (2002) 265–292.
8. Bernstein, E. Ludvigson, K. Sankar, S. Diamond, M. Morrow, Blueprint for the intercloud - protocols and formats for cloud computing interoperability, in: Proceedings of the 4th International Conference on Internet and Web Applications and Services, 2009, pp. 328–336.
9. Fog Computing Challenges: A Systematic Review Avirup Dasgupta School of Software University of Technology Sydney Sydney, AustraliaEmail:avirup.dasgupta@student.uts.edu.au Asif Qumer Gill School of Software University of Technology Sydney Sydney, Australia Email: asif.gill@uts.edu.au.
10. IEEE INTERNET OF THINGS JOURNAL, VOL. 3, NO. 5, OCTOBER 2016 637 Edge Computing: Vision and Challenges Weisong Shi,IEEE, Quan Zhang, Student Member, IEEE, Youhuizi Li, and Lanyu Xu.
11. Murphy, R. R. 2013. A roadmap for the adoption of unmanned systems into public safety. 2013 IEEE International Conference on Technologies for Homeland Security (HST), 350–353.
12. IOT based control of Appliances by Ravi Kishore Kodali, SreeRamya Soratkal and Lakshmi Boppana.International Conference on Computing, Communication and Automation (ICCCA2016)
13. R. K. Kodali, S. Soratkal and L. Boppana, ”IOT based control of appliances,” 2016 International Conference on Computing, Communication and Automation (ICCCA), Noida, 2016, pp. 1293-1297. doi: 10.1109/CCAA.2016.7813918
14. N. Landwehr, M. Hall and E. Frank, Logistic model trees, Mach. Learn. 59 (2005) 161–205.
15. T. Tou and R. C. Gonzalez, Pattern Recognition Principles (Addison-Wesley, London,
16. P. Bennett and O. L. Mangasarian. Multicategory di scrimi nation vialinear program ming. Optimization Methods and Software, 3:27–39, 1994.
17. Cortes and V. N. Vapnik. Support vector networks. Machine Learning, 20:273–297, 1995.
18. Vapnik, V.N.: An Overview of Statistical Learning Theory, IEEE Trans. Neural Network, 10(5) (1999) 988–999
19. Wang, Xiangying; Zhong, Yixin; Statistical learning theory and state of the art in SVM. Cognitive Informatics, 2003. Proceedings. The Second IEEE International Conference on 18-20 Aug. 2003 Page(s):55 – 59.
20. Statistical Learning Theory and Support Vector Machines Dewi Nasien Soft Computing Research Group Universiti Teknologi Malaysia Johor Bahru, Malaysia dwien82@gmail.com Siti S. Yuhaniz Soft Computing Research Group Universiti Teknologi Malaysia Johor Bahru, Malaysia sophia@utm.my Habibollah Haron Soft Computing Research Group Universiti Teknologi Malaysia Johor Bahru, Malaysia sophia@utm.
21. https://www.youtube.com/watch?v=Xm8frqTZRVI[IoT]
22. https://www.youtube.com/watch?v=IZj8hLrkABs
23. https://www.youtube.com/watch?v=Xm8frq TZRAVI&feature=youtu.be
24. Smart Fire Detection System with Early Notifications Using Machine Learning Mohammad Sultan Mahmud*, Md. Shohidul Islam† and Md. Ashiqur Rahman‡ Department of Computer Science and Engineering World University of Bangladesh Dhaka 1205, Bangladesh.
25. Stojmenovic and S. Wen, “The Fog Computing Paradigm: Scenarios and Security Issues,” Proc. 2014 Federated Conf. Computer Science and Info. Systems, 2014, pp. 1–8.
26. Atzori, A. Iera, G. Morabito, The internet of things: A survey, Computer Networks 54 (15) (2010) 2787–2805.
27. T. Kleinberger, M. Becker, E. Ras, A. Holzinger, and P. Muller, ¨ “Ambient intelligence in assisted living: enable elderly people to handle future interfaces,” in Universal Access in HumanComputer Interaction. Ambient Interaction: 4th International Conference on Universal Access in Human-Computer Interaction, UAHCI 2007 Held as Part of HCI International 2007 Beijing, China, July 22–27, 2007 Proceedings, Part II, vol. 4555 of Lecture Notes in Computer Science, pp. 103–112, Springer, Berlin, Germany, 2007.
28. R. Bellazzi, S. Montani, A. Riva, and M. Stefanelli, “Webbased telemedicine systems for home-care: technical issues andexperiences,” Computer Methods and Programs in Biomedicine, vol. 64, no. 3, pp. 175–187, 2001.

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